Opportunities for biodiversity conservation in cattle production systems

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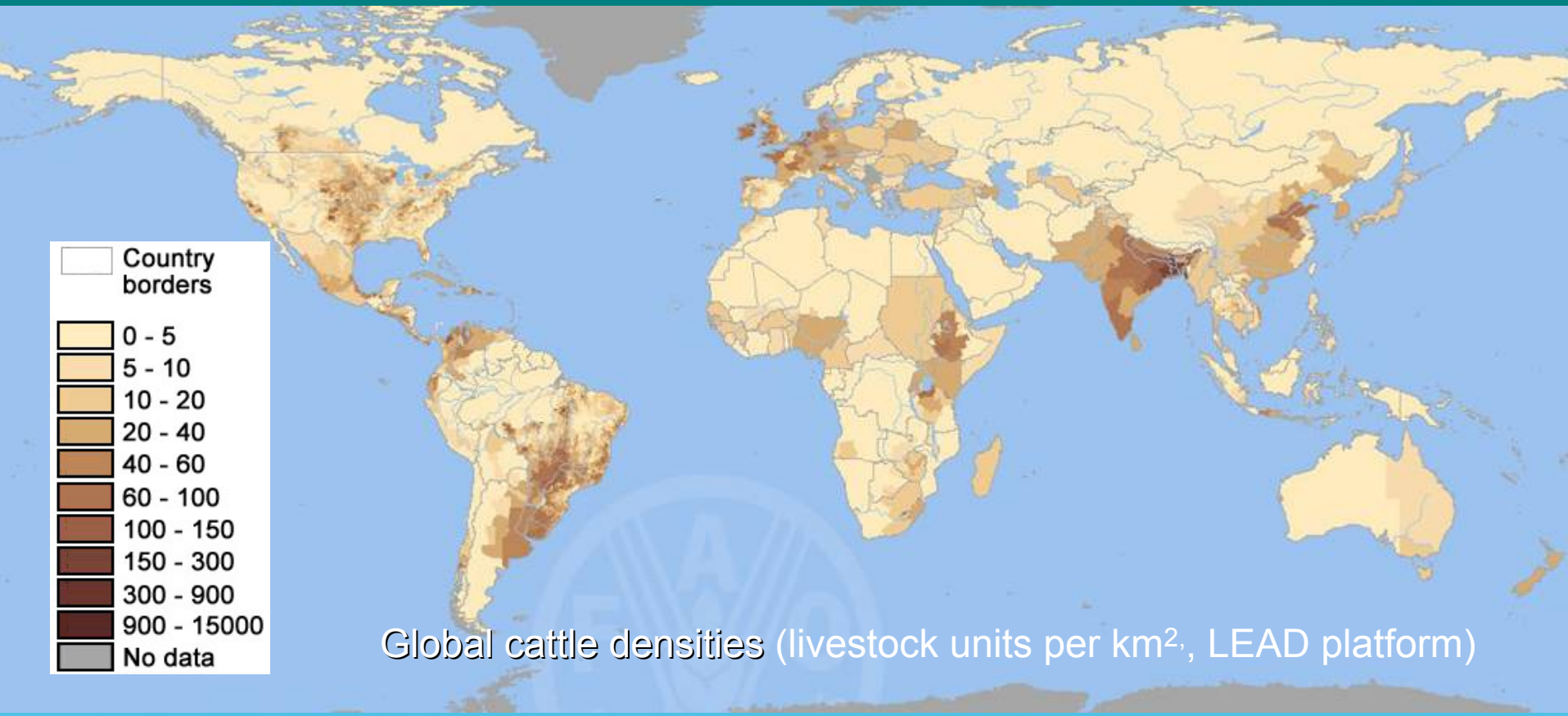
Overview

1. Importance of cattle production worldwide and current production trends
2. Impact of cattle production on biodiversity
3. Factors that determine the impact of cattle production systems on biodiversity
4. Strategies for mitigating the impact of cattle production on biodiversity
5. Case study of biodiversity conservation in cattle production landscapes in Central America

1. Importance of cattle production worldwide



Global cattle densities (livestock units per km^{2,}, LEAD platform)

"Globally, cattle affect more ecoregions of significant biodiversity than any other single agricultural commodity" (Clay, 2004)

Social and economic importance

- Livelihood for millions of farmers
  - >20 million pastoral families depend on livestock as sole source of income (LEAD, 2005)
  - 675 million rural poor depend on livestock for some or all of their food and income (FAO, 2005)
- Important source of protein (milk, meat, cheese, blood) and other products (leather, bone meal fertilizers, manure)
- Draught power for small farmers
- Cattle as ‘walking banks’, petty cash and insurance

Typology of cattle production systems

1. Grazing systems
   - Animals graze in rangelands, pastures and grasslands (little or no integration with crops)
   - Low stocking rates (< 10 LU per ha)

2. Mixed farming systems
   - Animal production integrated with crop production
   - Fed primarily on pastures, crop residues and fallows

3. Industrial production systems
   - Animals fed in stalls, pens and feedlots ('landless'), and occur in very high stocking rates
   – Most fodder brought in from elsewhere

(Seré and Steinfeld, 1996)

Global trends in cattle production

- Increased production of cattle and consumption of meat and milk products ('Livestock revolution' Delgado et al. 2001)
  - driven by population growth, urbanization and income growth
  - growth occurring in developing countries only (4.3 % annual increase in meat, 3.4% increase in milk)
- Continued expansion of agricultural frontier (and cattle production) into previously forested areas
- Intensification of cattle production systems through enhanced use of purchased inputs and homogenization of landscapes

Trends (cont'd)

- Move away from traditional mixed systems towards industrialized production systems
  - with associated increased demand for feed production and associated waste problems
- In some regions, there is a change in location of industrial cattle production, from rural to peri urban areas

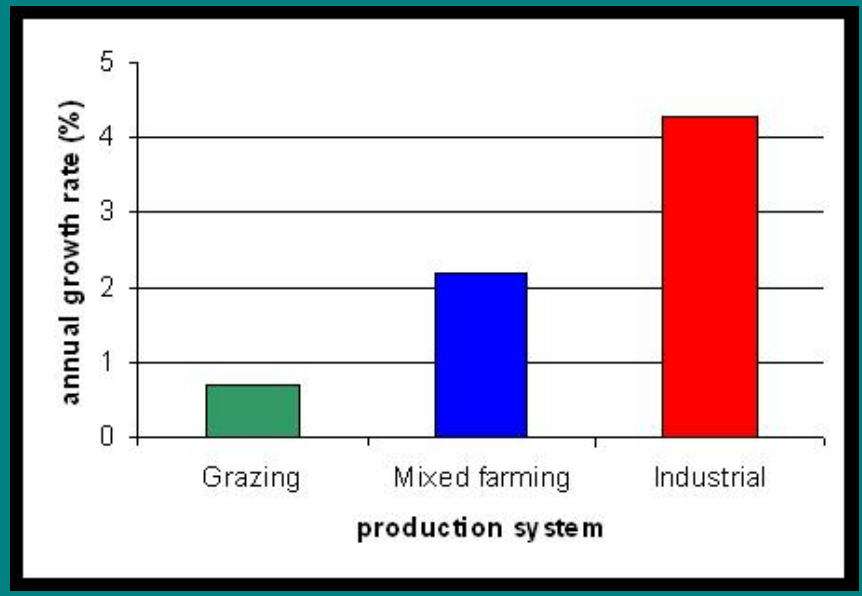


Figure 1. Annual growth of meat production in different systems (Sere and Steinfeld, 1996)

Impact of cattle production on the environment will continue to intensify in future years- but the types of impacts (and their location) may change

2. Impacts of cattle production on biodiversity

- Multiple ways in which cattle production affects biodiversity
  - Includes both direct and indirect effects
  - Includes both on-site and off-site effects
- Impacts can occur over different temporal and spatial scales and will vary across different production systems

?

?

Cattle production

Direct impacts

Indirect impacts

On-site

- Deforestation and conversion of natural habitat
- Fragmentation of remaining natural habitat
- Soil erosion and land degradation
- Contamination of aquatic habitats on farms and feedlots
- Introduction of exotic plants and animals that compete with native species

Off-Site

- Pollution of streams, rivers, mangroves and coral reefs by agrochemicals and animal waste
- Increased siltation of aquatic systems due soil erosion

- Changes in water and nutrient cycles
- Changes in fire and other disturbance regimes
- Production of greenhouse gases (CO^2, methane,etc.)
- Requirement for large areas for feed production

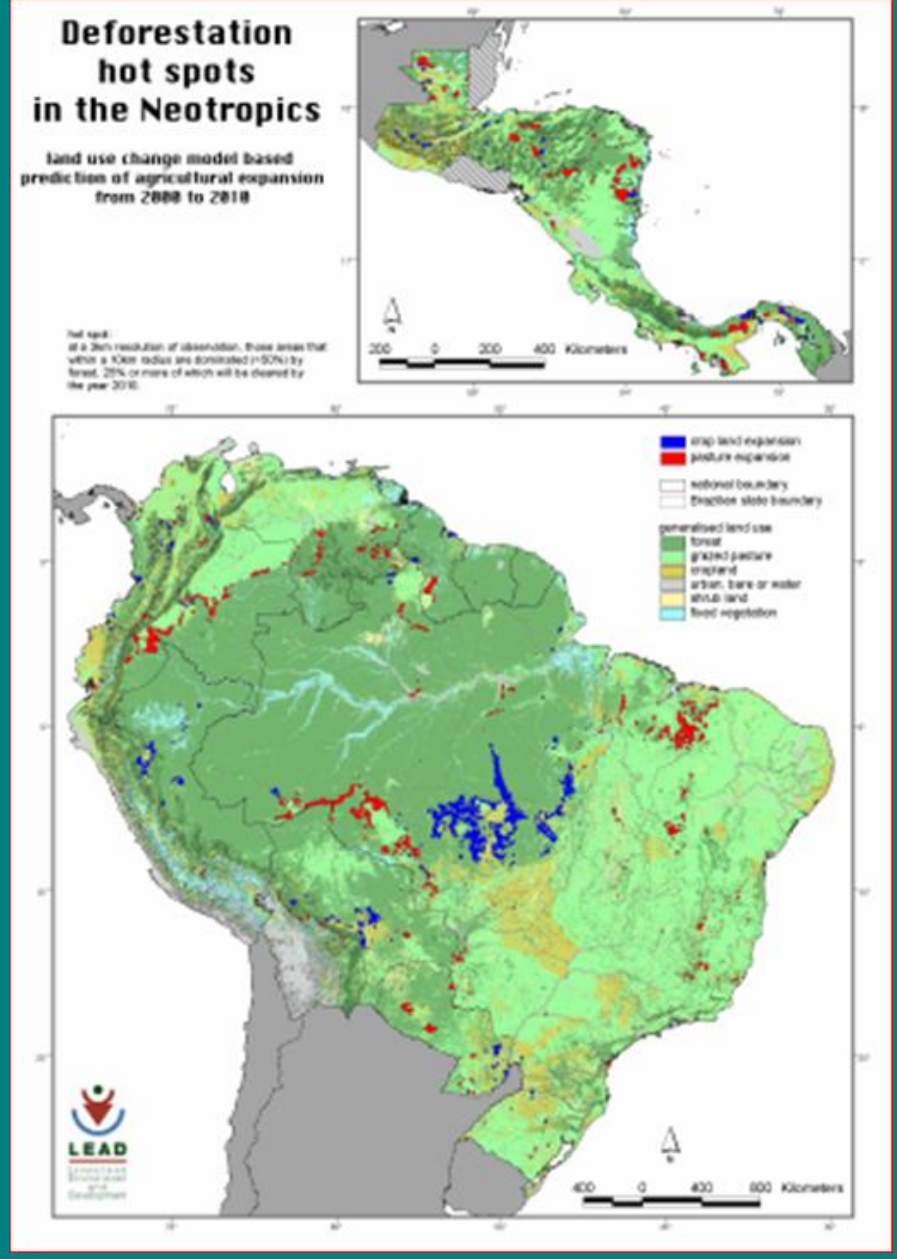
Impact on biodiversity:

- **Gain or loss of genetic, species and/or ecosystem diversity**
- **Changes in composition**
- **Changes in ecosystem functions or services**

(Harvey et al. 2005a)

a) Deforestation, land conversion and loss of natural habitat

- Key threat to biodiversity worldwide
- Pastures continue to encroach on native ecosystems (due to increased demand + degradation of existing pastures)



Red = areas converted directly to pasture
Blue= areas converted first to crops (then to pastures)

- Linkage between cattle production and deforestation ('hamburger connection') particularly strong in Latin America

> 4.4 million ha converted to pasture in Latin America from 2000 to 2005

b) Fragmentation of forested landscapes by establishment of pastures

Fragmentation has three main effects:

- reduces large habitat blocks into smaller areas
- creates edges between forest and non-forest habitats
- isolates fragments from intact forest (affecting movement of organisms and genes)

c) Increased soil erosion and land degradation

- Establishment of new pastures often results in increased soil loss
- Trampling, overgrazing and high stocking rates of pastures:
  - leads to loss of top soil and organic matter, reduction in water infiltration, increased soil compaction, reduced fertility
- Increased soil erosion and land degradation negatively impact both terrestrial and aquatic ecosystems
- Major problem in grazed landscapes:
  - At least 20% of world's grazing land show significant soil degradation

d. Contamination of aquatic ecosystems by waste products and chemicals

- Cattle production generates large quantities of waste which often enter and pollute waterways
  - particularly in industrial operations
- Pesticides, fertilizers and sediment from pastures enter surface and ground water
- Industrial operations with large numbers of animals concentrated in a single area can create pollution problems, contaminating air, land and water
- Pollution and eutrophication cause algal blooms and threaten wetlands, mangrove swamps, and coral reefs that are important reservoirs of biodiversity

(High water use by cattle is also an issue)

e) Introduction of alien plant and animal species

- Competition with native grazers (particularly problematic in Africa and other regions with extensive grasslands)
- Competition with native plants
- Invasion of native ecosystems by alien plant and animal species
  - e.g., Paja blanca (*Saccharum spontaneum*) in Panama canal

3. Factors that determine the impact of cattle production systems on biodiversity

a) Site and landscape characteristics
   - Ecosystem type and climate
   - Historical land use (already deforested?)
   - Location of cattle production system within the landscape
   - Degree of integration with other land uses within the landscape

b) Type of cattle production system

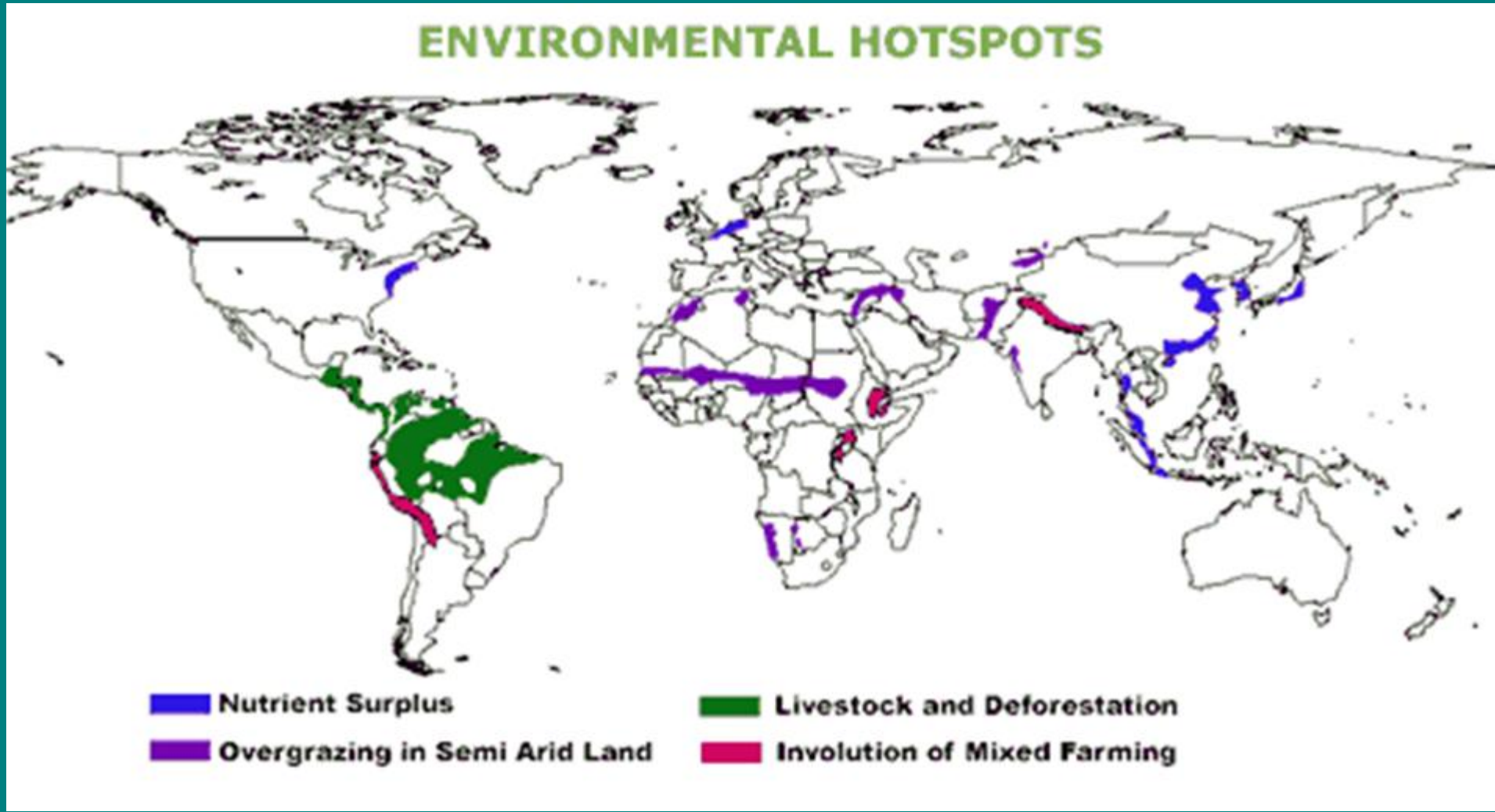
Environmental problem	Grazing	Mixed systems	Industrial systems
Deforestation and fragmentation of native ecosystems	XXX	XX	
Overgrazing and soil erosion	XX	XX	
Contamination of water and aquatic ecosystems	X	X	XXX
Introduction of alien plant and animal species	XX	XX	X

- Different cattle production systems pose distinct threats
- Historically, cattle production has had the greatest impact on biodiversity through deforestation and fragmentation
- However, as land becomes scarcer and industrial production systems become more common, the problems related to intensification are becoming more acute

c) Management of cattle production systems

- Cattle management (stocking rates, herding and grazing practices)
- Dependence on supplementary feed
- Degree of integration with agriculture
- Waste management practices used
- Retention of native vegetation within production system
- Degree of intensification and use of purchased inputs
    - Use of tillage, chemical fertilizers and pesticides to maintain desired pasture composition
    - Use of fire (and possibility for fire to escape)

Regional differences in environmental problems caused by cattle production



(Steinfeld et al. 1996)

4. Opportunities for mitigating the impact of cattle production on biodiversity

a) Prevent the continued expansion of the agricultural frontier (and cattle production) into remaining natural ecosystems:

- establish protected areas, reserves, corridors, etc.

- use legal and regulatory means to discourage further expansion

- stabilize existing agricultural frontiers through intensification of production systems on the frontier

b. Locate cattle production systems appropriately in landscape

Grazing and mixed farming systems:

- Position pastures in areas that have the appropriate soils and slopes
- Leave fragile areas or areas that are unsuitable for cattle production in natural habitat

Industrial production systems

- Ensure that industrial feedlots and effluent lagoons are not located near streams and aquifers, or near ecologically sensitive areas
- Position industrial systems in areas near cropland where nutrients can be used

c. Maintain or establish native vegetation within pastoral landscapes

- Retain existing patches of natural vegetation as habitats and resources for plants and animals
- Retain wildlife corridors that can facilitate animal movement
- Conserve riparian areas
- Establish silvopastoril systems which increase floristic and structural diversity of pastures, while also enhancing productivity

d) Adopt better cattle and pasture management practices that reduce land degradation, soil erosion, and pollution of aquatic ecosystems

- Maintain healthy and intact pastures to help filter pollutants from runoff and control erosion
- Use appropriate stocking rates and cattle management to avoid overgrazing and allow vegetation to recover following grazing
- Reduce application of fertilizer and pesticides on pastures
- Carefully control use of fire within pastures
- Maintain riparian strips as buffers to protect water quality

(Many best management practices exist for appropriately managing waste in industrial systems)

Examples of best management practices and codes

- National Cattleman's Association. The beef handbook-Environment. Available at http://www.beef.org/beef_handbook.
- Florida Cattleman's Association. 1999. Water quality best management practices for cow/calf operations in Florida.
- Hornsby et al. 1998. Managing pesticides for pasture production and water quality production. University of Florida. Available at: http://edis.ifas.ufl.edu/SS032
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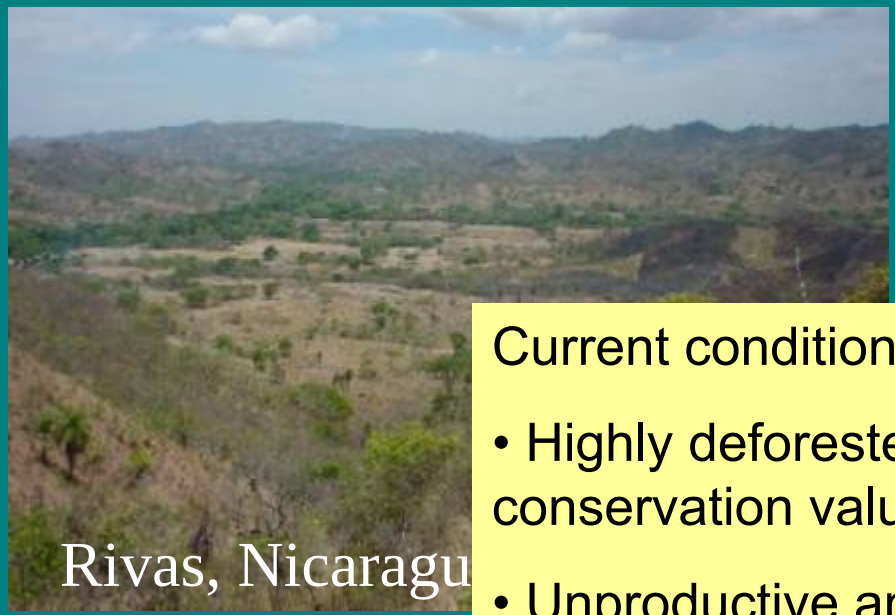
5. Case study: Conserving biodiversity in grazing systems in Central America



Current condition:

- Highly deforested and fragmented (low conservation value)
- Unproductive and degraded pastures (low agricultural value)

Photos: FRAGMENT project

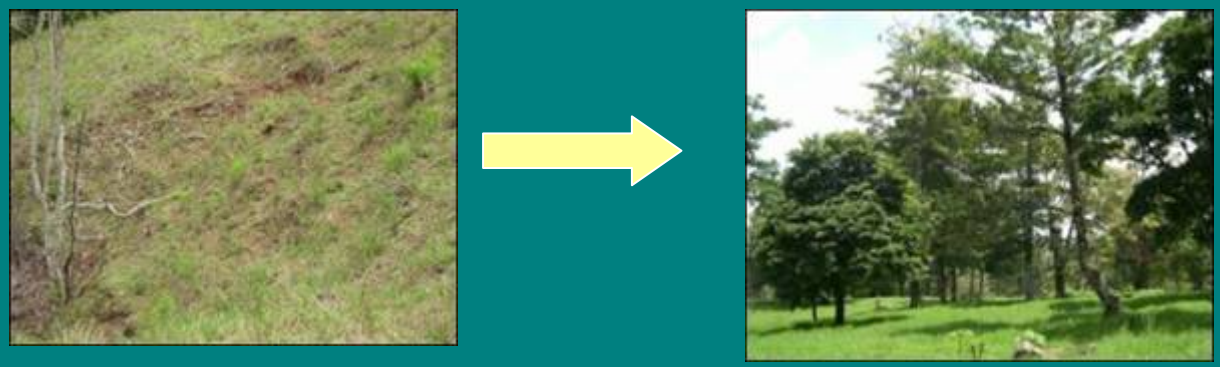
KEY CHALLENGE:

- To establish cattle production systems that provide habitat and resources for plant and animal species, while also enhancing cattle productivity
- ..and to create pastoral landscapes that integrate conservation with production goals

STRATEGY being promoted by CATIE (GEF project, FRAGMENT)

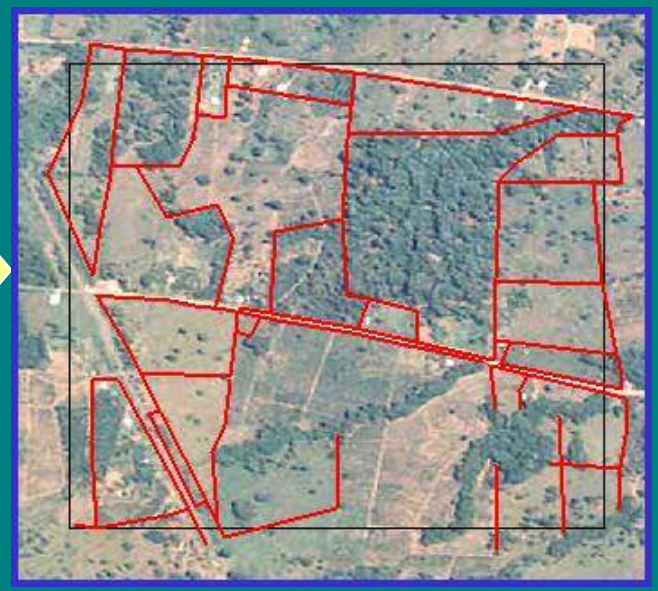
1. Maintain existing on-farm tree cover, particularly forest patches and riparian areas

2. Increase and diversify on-farm tree cover by promoting the establishment of silvopastoril systems (dispersed trees in pastures, live fences, windbreaks, fodder banks, etc.)



3. Enhance landscape connectivity by increasing the number of live fences/windbreaks and strategically locate them so that they connect remaining forest fragments

Conversion of wooden fences to live fences



live fence

(Chacon and Harvey, in press)

4. Identify management practices that negatively impact tree cover and biodiversity conservation in pastoral landscapes

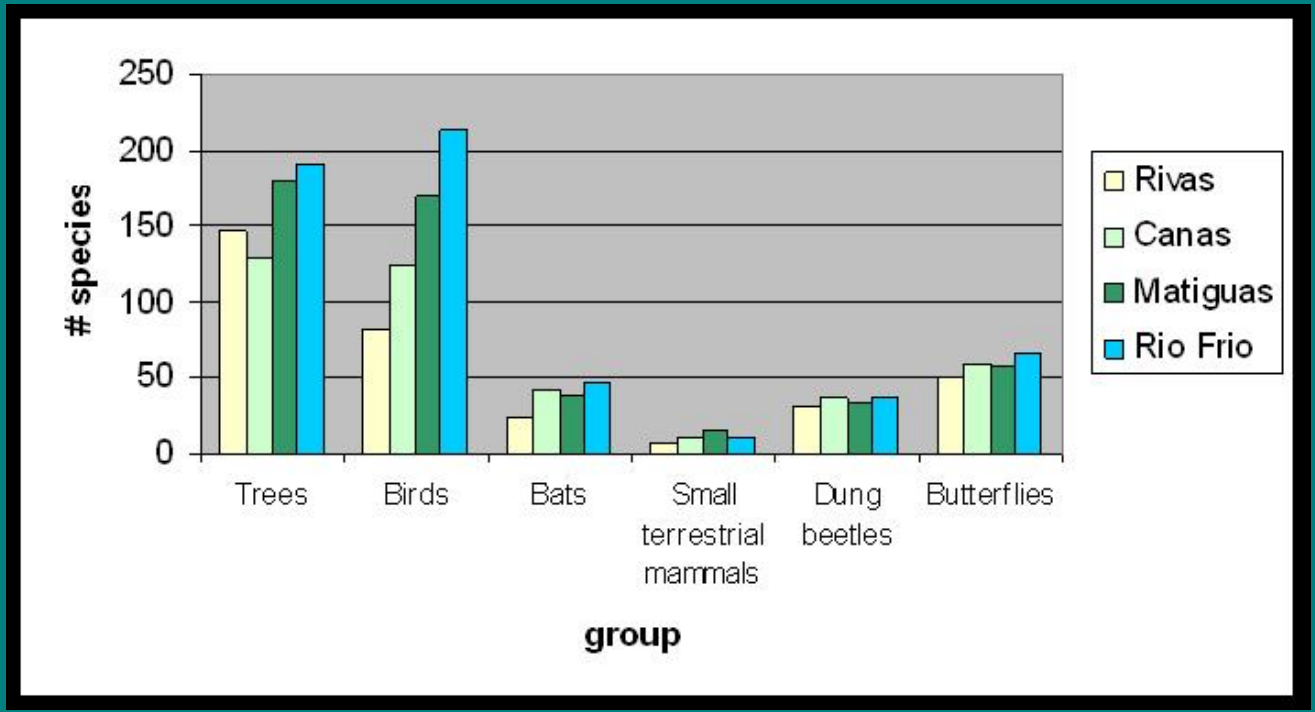
Common pasture management activities that can negatively affect biodiversity:

- Management of natural regeneration in pastures
- Extraction of forest products
- Pollarding of live fences
- Changes in land use (to/from fallows)
- Fire use
- Animal grazing in forests and fallows

..and replace them with alternative management practices

What have we learned so far?

a. Pastoral landscapes that include SPS and other on-farm tree cover retain a high diversity of plant and animal species

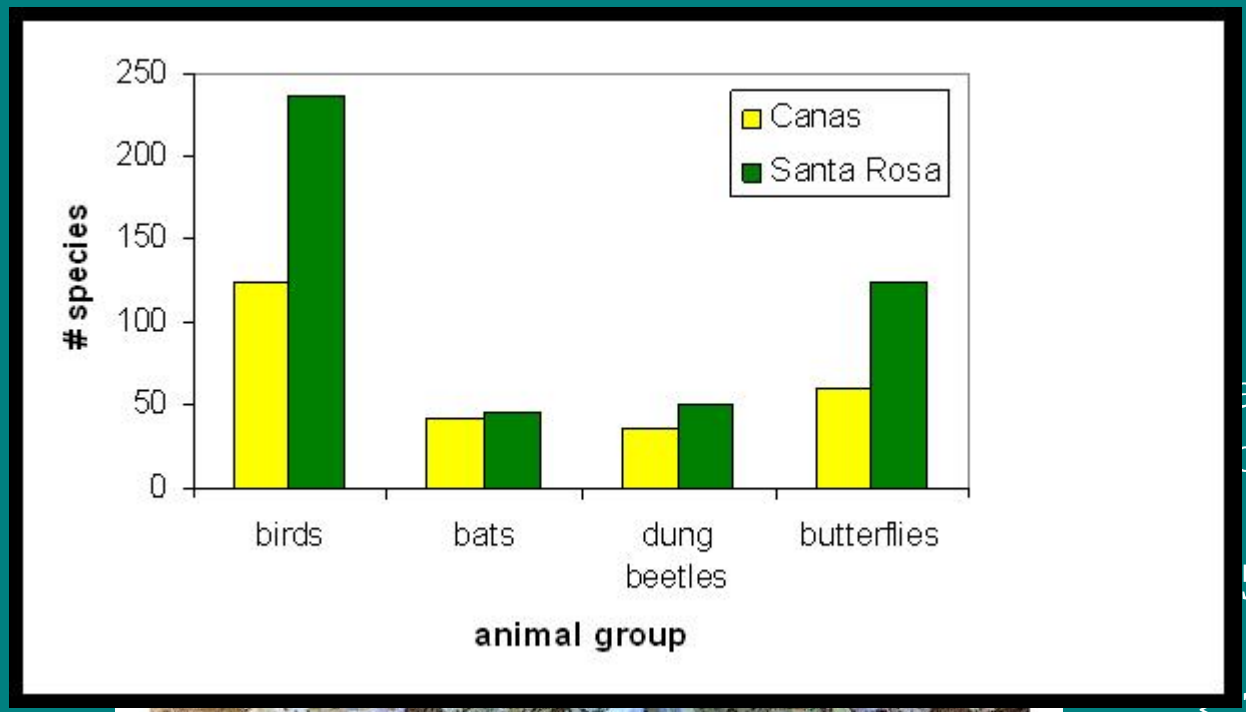


- 130-191 tree spp.
- 83-213 bird spp.
- 24-42 bat spp.
- 32-37 dung beetle spp
- 50-67 butterfly spp.

* Conservative estimates

(Harvey et al., unpublished data)

b. The pastoral landscapes can retain a considerable proportion of the original biodiversity, but less than that of intact forest



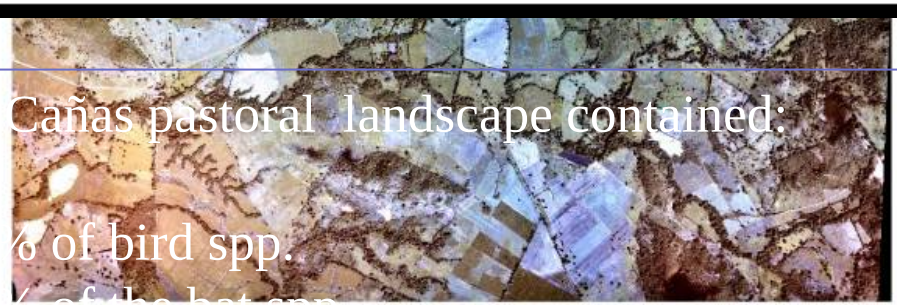
añas landscape,
osta Rica:

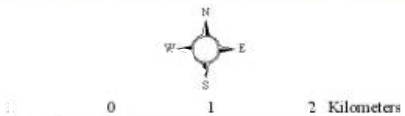
50% pastures

< 20% forest

The Cañas pastoral landscape contained:

- 68 % of bird spp.
- 91 % of the bat spp.
- 68
- 48





Rosa National Park

c. But often the composition of species in pastoral landscapes is distinct from the original ecosystem

- Most species present in landscape are generalist species that have adapted to the agroecosystems present
- Generally, few species of high conservation priority
  - Few forest-dependent species, few species that require large areas, few specialists
- But there are some exceptions:
  - 3 endemic bird spp, 22 threatened bird species in a 10,000 ha pastoral landscape in Niaraguan
  - Pastoral landscapes may even include new (unknown) species

New species registered in a Nicaraguan pastoral landscape

(Harvey et al., in press)

d. Silvopastoril systems provide important resources for plant and animal species, but their importance varies across taxa…

- Live fences and riparian systems critical for bat conservation

- Areas of high tree cover important for birds
- Pastures with low tree cover important for butterflies.

→Different taxa may require different conservation strategies

→ Landscapes with a mixture of different types of SPS and tree cover will host greatest biodiversity

(Harvey et al., in press)

e. Silvopastoril systems play important roles in maintaining landscape connectivity (and can be used to reconnect isolated forest fragments)

- Extend tree cover into the agricultural matrix

- Provide direct connections to forest patches and riparian forests

This enhanced connectivity facilitates movement of birds, amphibians, monkeys and other animals across the pasture matrix
(particularly important for forest species)

f. Silvopastoril systems help retain the regenerative capacity of the land

- The presence of live fences and dispersed trees within pastures facilitates natural regeneration by:
  - Serving as a source of seeds
  - Attracting birds, bats and other animals that disperse seeds
  - Providing appropriate microclimatic conditions for natural regeneration

- If sufficient tree cover is maintained in the pastures, when the land is allowed to go fallow it regenerates quickly

g. The way in which silvopastoril systems are managed influences their ability to conserve biodiversity

Pollarding

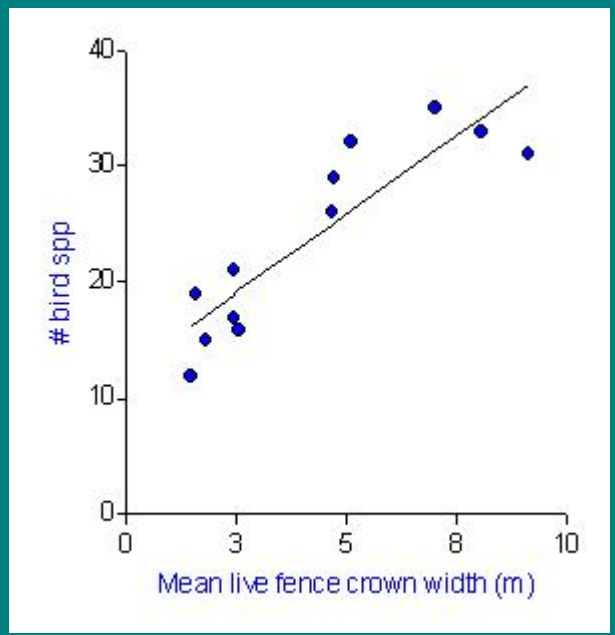
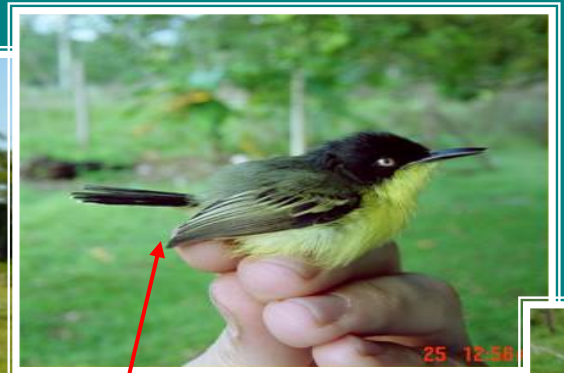


Figure 2. Bird species richness as function of live fence crown width (Harvey et al. 2005).



A total of 45 bird species were found in live fences that were pollarded

Photos: R.Taylor

In live fences with unpruned canopies a total of 81 bird species were found

Photos: R.Taylor

g. Farmers are willing to adopt silvopastoril systems and conservation strategies…

- But these systems must be readily compatible with existing management practice and have clear production benefits.
- Adoption is hindered by initial costs of establishment (labor demand, $$) and lack of planting materials.
- Farmers begin by making the simplest changes (e.g. wooden fences to live fences).
- As they become more familiar with the benefits of SPS, they are willing to adopt them on a larger scales.
- Farmers are very interested in accessing environmental service payments that encourage good land stewardship
  - GEF project has achieved large-scale changes in on-farm tree cover through payments

Conclusions

- Cattle production systems have had an enormous negative impact on biodiversity conservation worldwide and this impact is likely to intensify.

- Many of these impacts can be mitigated or lessened by carefully locating production systems within the landscape and improving the management of cattle and their wastes.

- A wide variety of best management practices already exist, but these are not widely adopted:
  - -Lack of dissemination?
  - -High costs?
  - -Tradeoffs with production?
  - -Lack of laws, regulations and incentives?

Since cattle production accounts for 26% of the world's land, even small changes in the way these systems are managed could have significant biodiversity benefits.

However, there is only a limited window of opportunity…

THANK YOU

(Image and animation: GEF silvopastoril project)

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- Bird photos: Rachel Taylor