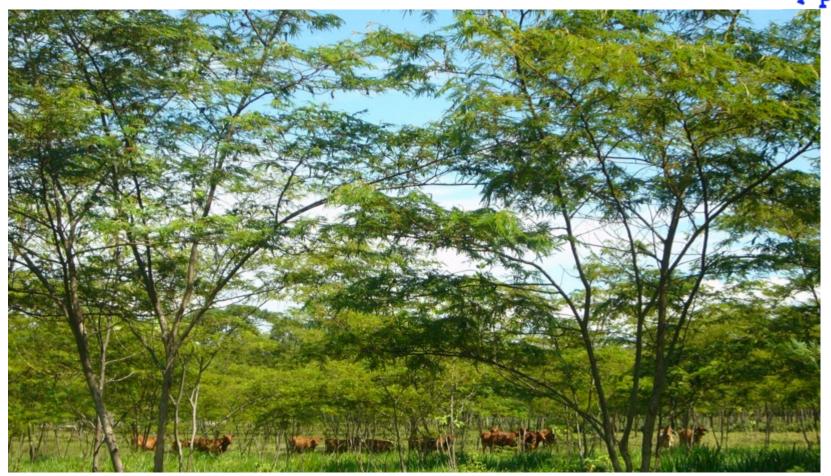
# A strategy for scaling-up intensive silvopastoral systems in Colombia



Zoraida Calle<sup>1</sup>, Julián Chará<sup>1</sup>, Andrés Felipe Zuluaga<sup>2</sup>, Enrique Murgueitio<sup>1</sup>, Fernando Uribe<sup>1</sup>, Adolfo Galindo<sup>1</sup>, Luis H. Solarte<sup>1</sup>, María M. Murgueitio<sup>1</sup>, Oscar Tafur<sup>1</sup>, Edwin Hurtado<sup>1</sup>, Alicia Calle<sup>3</sup>

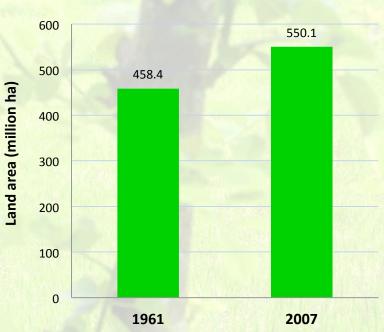
CIPAV - Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria. Cali, Colombia.
 Fedegán – Federación Colombiana de Ganaderos

# Occupation of the territory by cattle ranching

- Cattle ranching is the main current land use:
  - 550 million hectares in Latin
     America
  - 42 million hectares in Colombia



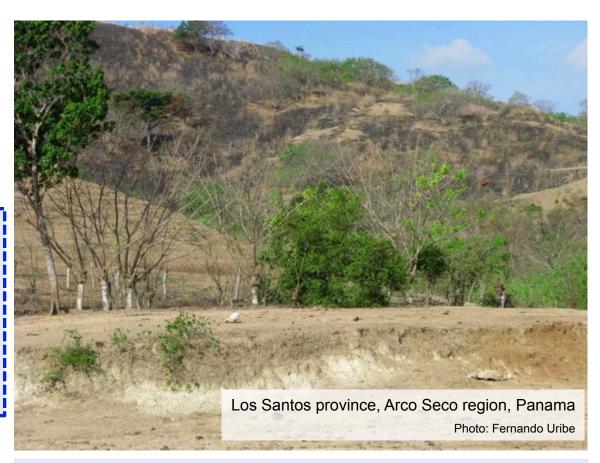
#### Area occupied by pastures in LA & C



FAO, 2002; IGAC 2002

## Land use efficiency?

- Average annual per hectare stocking rate:
   0.59 animals
- Average annual per hectare productivity:
  - 19.9 kg of beef
  - 89.7 L of milk



- Minimum animal loads
- Low per animal and per hectare production indexes
- Meager contributions to rural employment

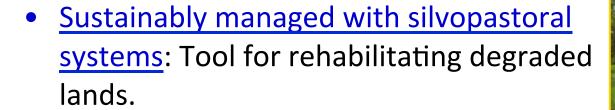


- For centuries we have practiced a simplified cattle ranching based on grass monocultures, against the natural dynamics of tropical ecosystems.
- In this model, cattle have been a major driver of environmental degradation.
- However, this should not be so if we understand the potential of cases as mobile sun-powered catalytic converters\* with the potential of restoring fertility in degraded lands.

  Patriquin and Moncayo, 1991
  Murgueitio and Calle, 1999

### Cattle ranching can be:

<u>Conventionally managed</u>: Efficient tool for ecosystem degradation.



 Silvopastoral systems integrated with connectivity corridors and protected areas: Part of a strategy for the ecological restoration of agricultural landscapes.







# Cattle ranching is not likely to decline any time soon in Latin America!



- 1. This activity is deeply rooted in the Spanish and Portuguese ancestry of the region.
- 2. It has often been a reaction to agricultural failures that result from biophysical constraints
- 3. It has become instrumental as a means to consolidate land control.

# The environmental transformation of livestock production is a priority for Latin America



<u>Underlying principle</u>: Cattle production needs to shift from its current path of ongoing degradation of the natural and social capitals, onto one which generates goods (milk, meat, and timber) while maintaining some ecosystem attributes and rendering ecosystem services.

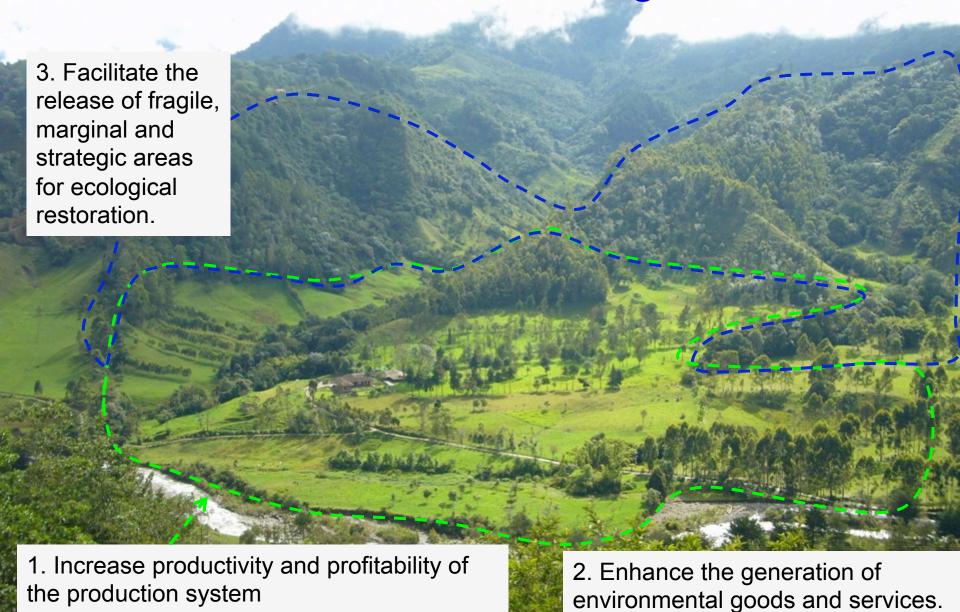


# This change should consist of 4 basic elements:

- 1. Increasing plant biomass and diversity
- Curbing soil degradation and promoting its recovery
- 3. Protecting water sources and using them rationally
- 4. Increasing animal productivity on a per hectare basis.



#### Rehabilitation of cattle ranching lands must:



## Silvopastoral Systems - SPS

 Agroforestry arrangements that combine fodder plants, such as grasses and leguminous herbs, with shrubs and trees for animal nutrition and complementary uses.



### Four silvopastoral systems



Scattered trees in pastureland



Intensive silvopastoral system



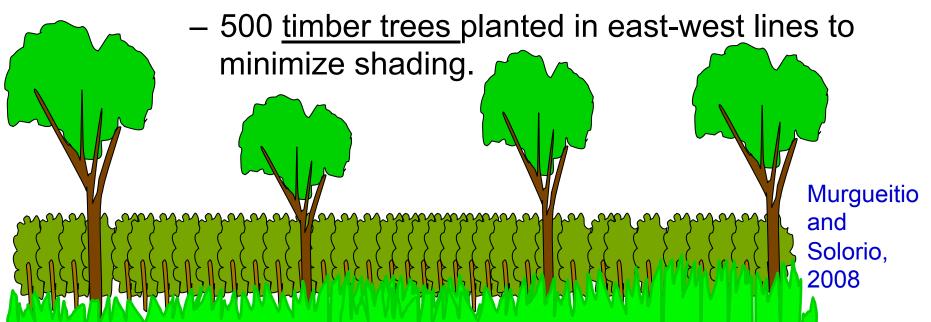
Live fence

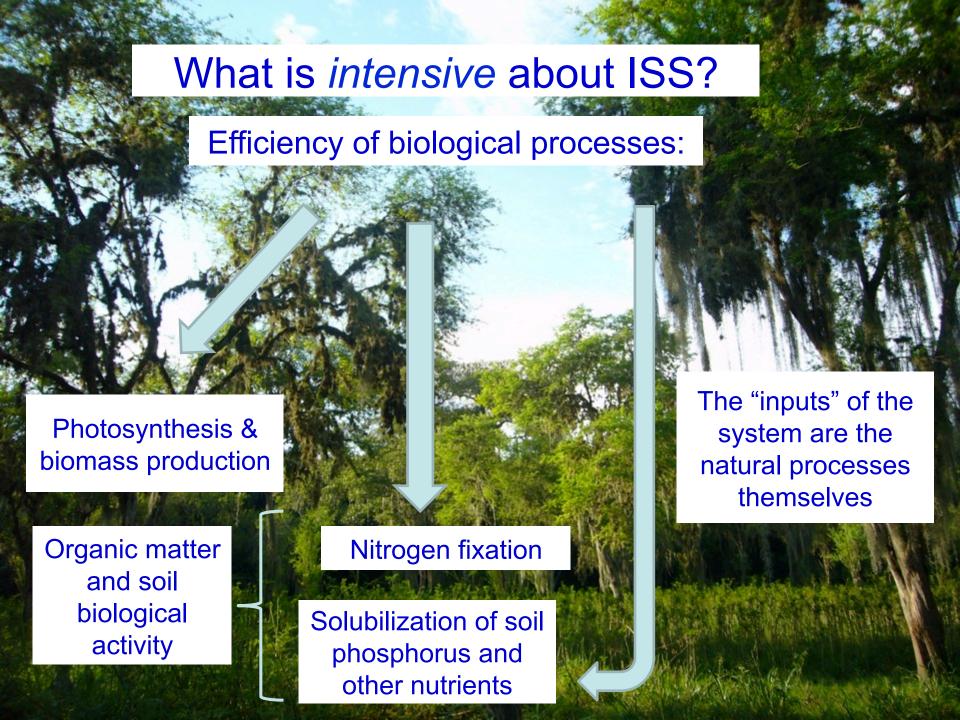


Mixed fodder bank (cut-and-carry system)

## Intensive silvopastoral system ISS

- A system that can be directly grazed by livestock. It combines:
  - Fodder shrubs planted at high densities (>10,000 plants ha<sup>-1</sup>), intercropped with
  - highly-productive <u>pastures</u>, and





The key to successful ISS is the adequate selection of the species, <u>particularly the fodder shrub that is the backbone of the system.</u>





Two species have shown the best results:

- Mexican sunflower Tithonia diversifolia Helms
- and in particular leucaena Leucaena leucocephala (Lam.) de Wit



#### Leucaena leucocephala (Lam.) de Wit





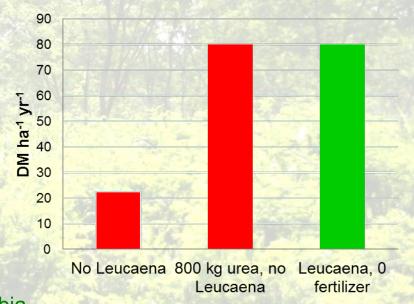
- <u>Very high rate of nitrogen</u> fixation.
- Nitrogen is easily transferred to neighboring plants.
- High rate of consumption by livestock.
- Associates well with grasses.
- Elasticity of stems provides exceptional tolerance to grazing.
- Rapid and vigorous regrowth.
- Its shade conserves moisture without interfering with pasture growth.
- Fast litter decomposition.
- Extract nutrients from deep

   layers that are not available for
   other species of legumes a
   trait explained by the ecosystem where it evolved!

# What makes *L. leucocephala* irreplaceable?

- Leucaena directly contributes 15 ton DM ha<sup>-1</sup> yr<sup>-1</sup> to the system, but increases DM production to 80 ton ha<sup>-1</sup> yr<sup>-1</sup>.
- The catalytic function of <u>Leucaena</u> allows associated grasses to express their full potential.
- Additionally, the prunings of Leucaena provide 3 ton DM ha<sup>-1</sup> yr<sup>-1</sup>, which is incorporated into the soil.

No Leucaena + No chemical fertilizer	400 kg N ha <sup>-1</sup> yr <sup>-1</sup> (800 kg of urea) <u>No Leucaena</u>	With Leucaena planted in high density  No chemical fertilizer
20-25 ton	80 ton DM ha <sup>-1</sup>	80 ton DM ha <sup>-1</sup>
DM ha <sup>-1</sup> yr <sup>-1</sup>	yr <sup>-1</sup>	yr <sup>-1</sup>



### Shifting paradigm in tropical cattle ranching



Maximum biomass production is not achieved in treeless grass monocultures but in agroforests combining pastures, trees and shrubs.

#### Reference agroecosystem:

#### Silvopastoral systems at El Hatico reserve El Cerrito, Valle del Cauca, Colombia





Pioneered the use of silvopastoral systems in Colombia in the 1970s.









#### 1970s:

- Low tree cover: < 10 trees ha-1
- Herbicides, irrigation and chemical fertilizers

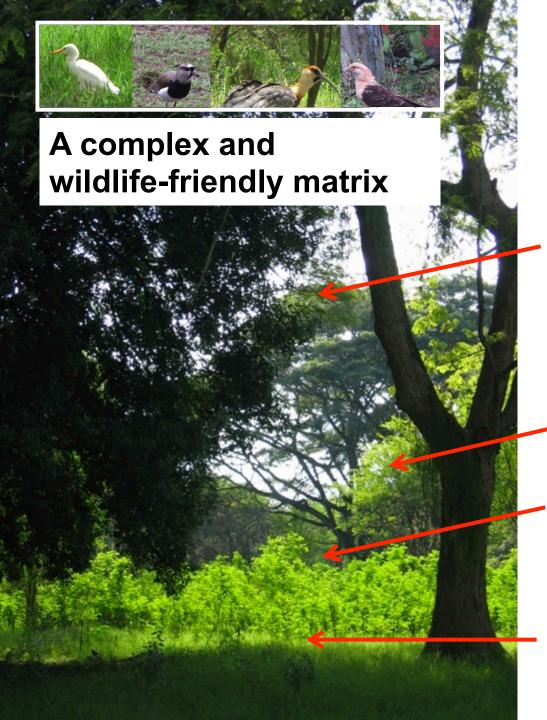


#### **Currently:**

- 70 tree species in silvopastures
- Certified organic milk



Transformation of a conventional farm



Palms Syagrus zancona, Attalea butyracea, and Roystonea regia and timber trees Swietenia macrophylla, Cedrela odorata, Zanthoxylum rhoifolium.

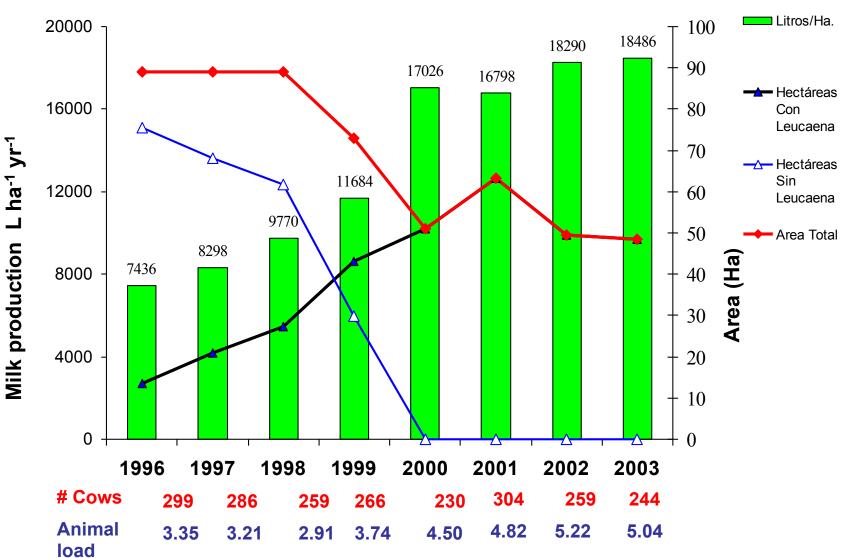
Large trees Ceiba pentandra, Samanea saman, Enterolobium cyclocarpum at low density

Medium sized trees Prosopis juliflora, Senna spectabilis, Guazuma ulmifolia, Guarea guidonia, 30-50 ha-1

**Leucaena** 10.000-15.000 shrubs ha<sup>-1</sup>

Creeping grass cover Cynodon plestostachys, Panicum maximum, Cynodon dactylon and Paspalum notatum

# Change in milk production and its relation to the expansion of intensive silvopastoral systems at El Hatico reserve



Lands degraded by cotton monoculture

Rehabilitation with silvopastoral systems

Cesar river valley, Colombia

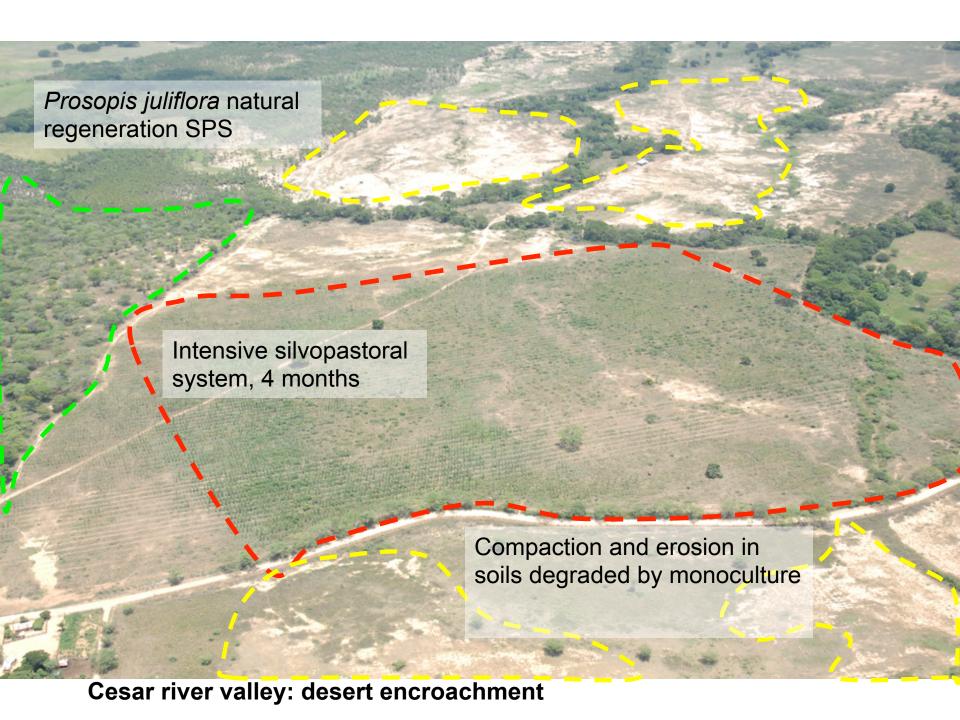


#### San Diego and Codazzi, Cesar

Cesar river valley, Caribbean region

Rainfall: 1000-1200 mm

Monomodal regime, few rain events



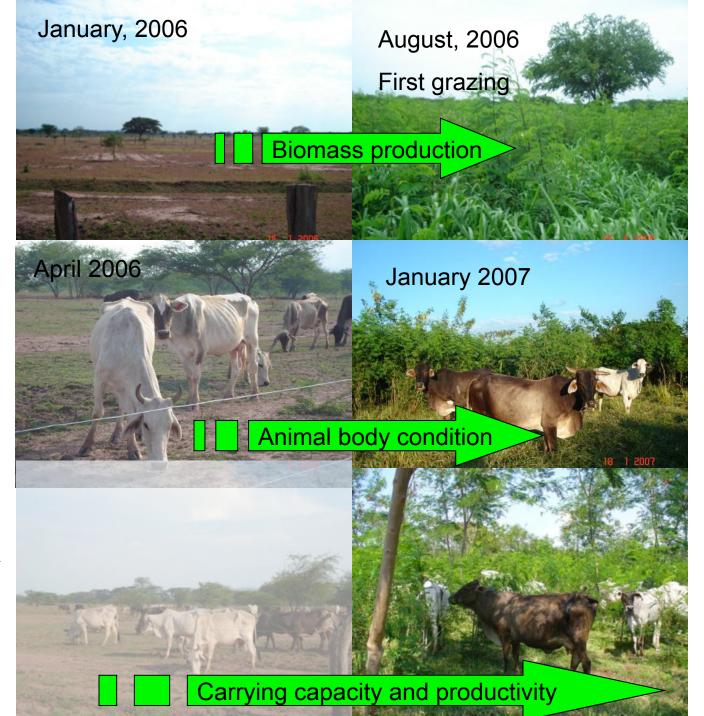
# Baseline situation: low productivity, extensive and treeless cattle ranching systems



Rapid pasture degradation



The edible biomass disappears during the dry months



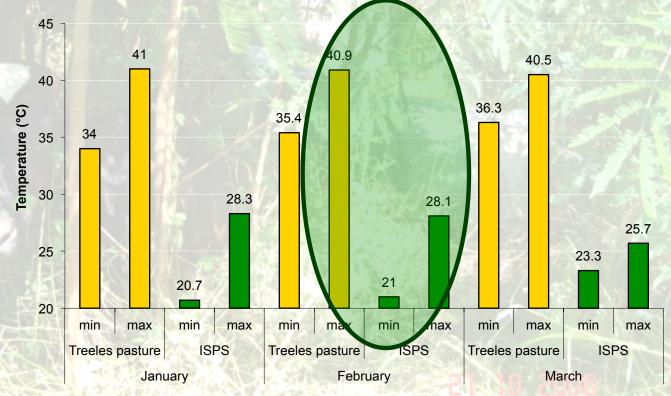
1.2 large animals 1.7 L milk cow<sup>-1</sup> day<sup>-1</sup> 5.1 large animals
4.1 L
milk
cow<sup>-1</sup>
day<sup>-1</sup>



Temperature variation in treeless pastures and intensive silvopastoral systems ISPS during the driest months of 2007 in the Colombian dry Caribbean region

Climate change adaptation:

Silvopastoral systems are 12°C cooler!



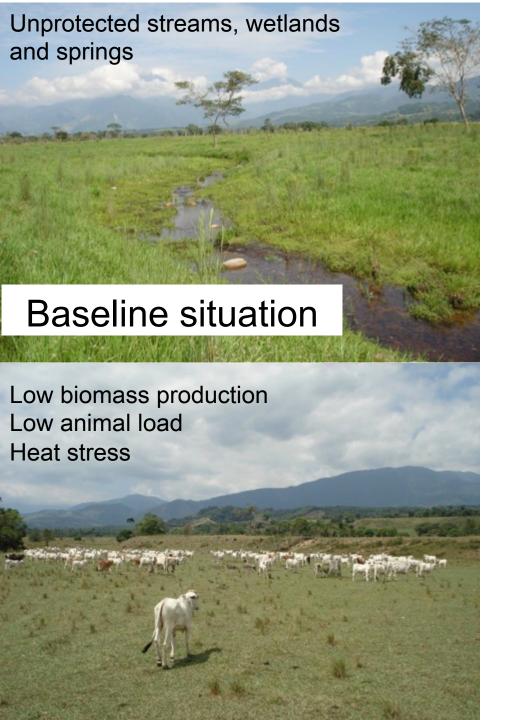


#### A win-win situation

The productive advantages that make SPS so attractive for landowners ultimately originate from the myriad environmental benefits they provide.







#### Cubarral, Meta

#### **Andean foothills**

Rainfall > 3000 mm



Andorra Farm, Cubarral, Meta

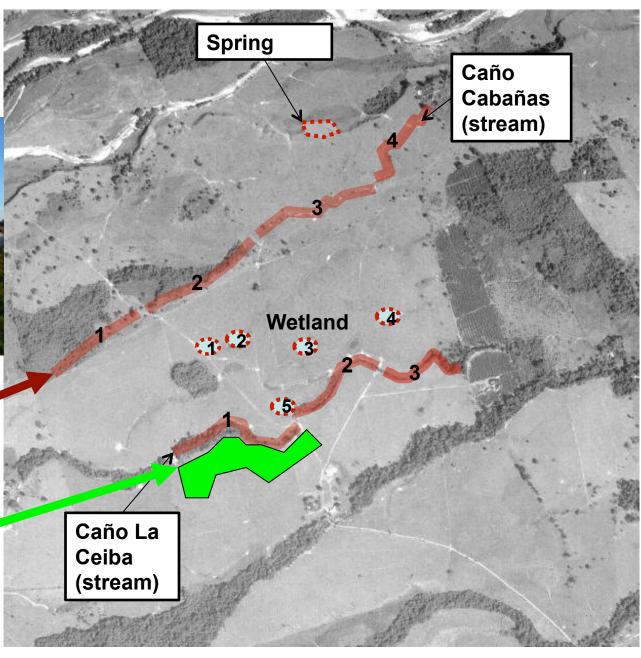


Riparian buffers, wetlands and springs

Intensive silvopastoral system

219 hectares

Rainfall > 3000 mm



Owned by: Benhur Herrera

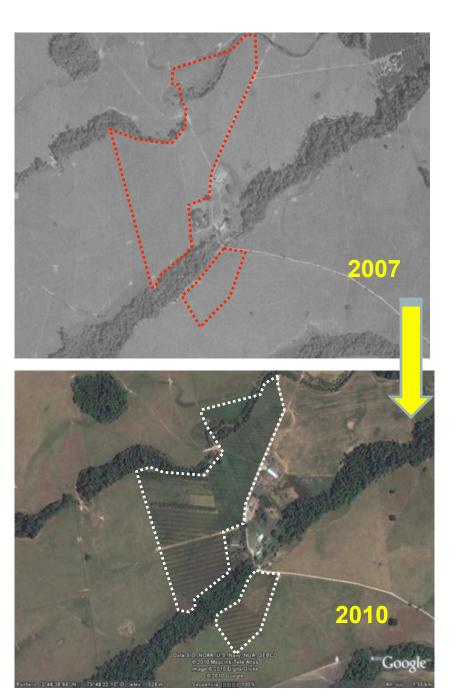
### Rehabilitation of riparian buffers 2007-2010

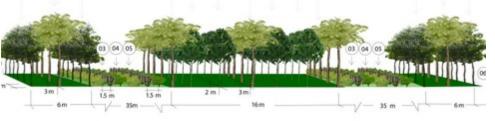






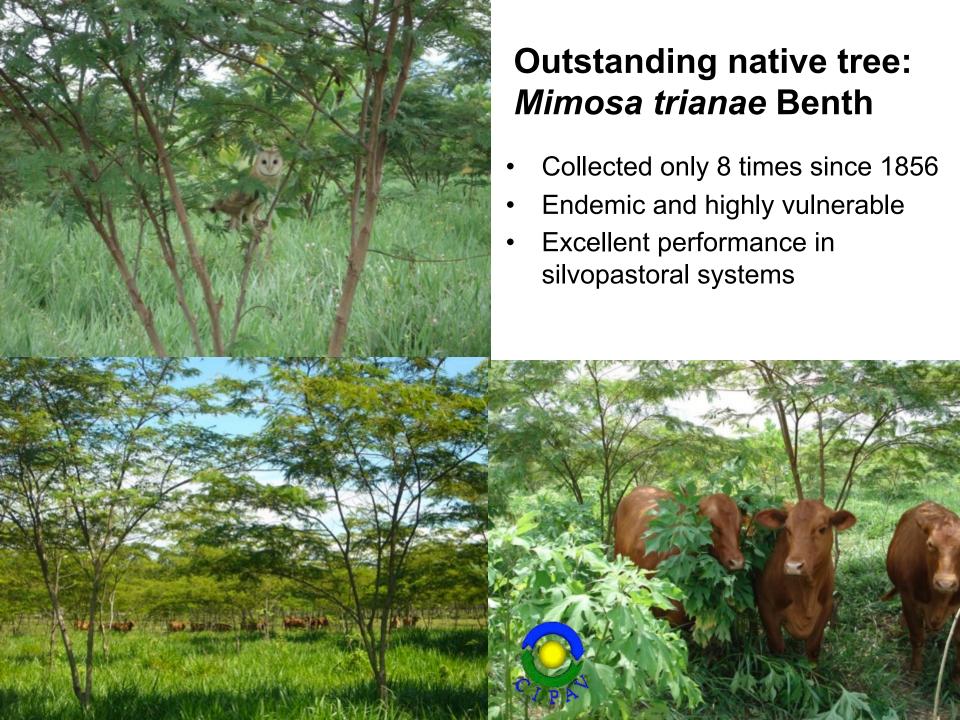














#### Piedras, Tolima

Meseta de Ibagué, Alto Magdalena

Tropical dry forest

Rainfall: 1200-1300 mm





Land use	Area (ha)
Forests	16.6
Rice monoculture	300
Silvopastoral systems	59.3
Gliricidia fodder bank	3.3

### **El Chaco Farm**

Roberto Mejía C., Alberto Mejía F.

605 m.a.s.l. 413 ha Tropical dry forest

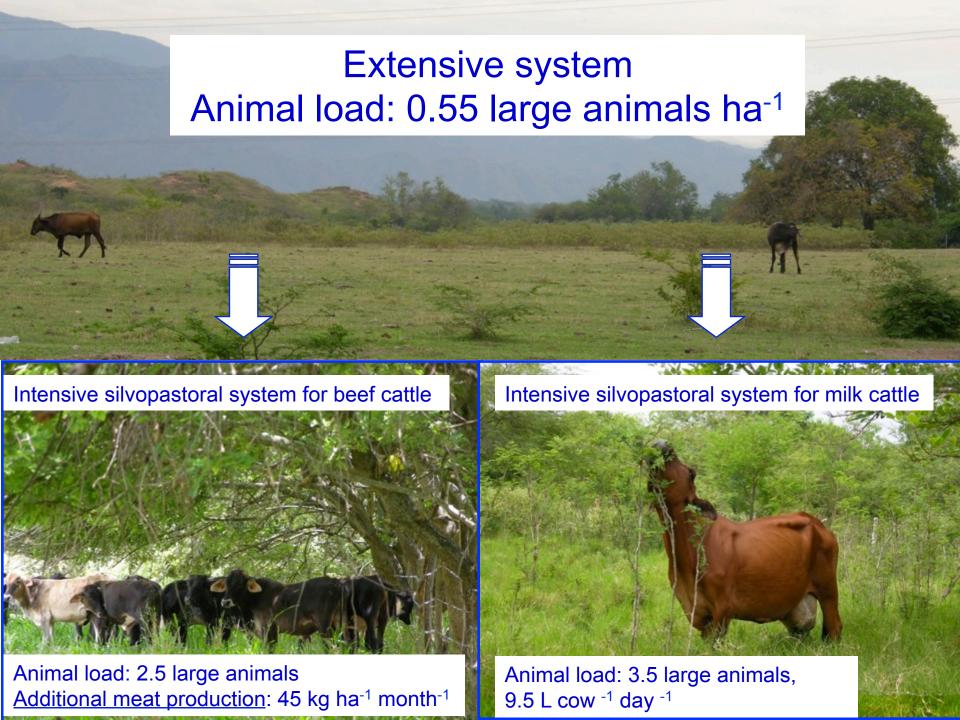


National Cattle Ranching Award 2009. Sustainable livestock enterprise



"Desert to paradise"



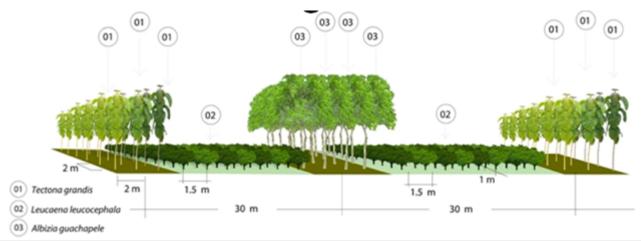






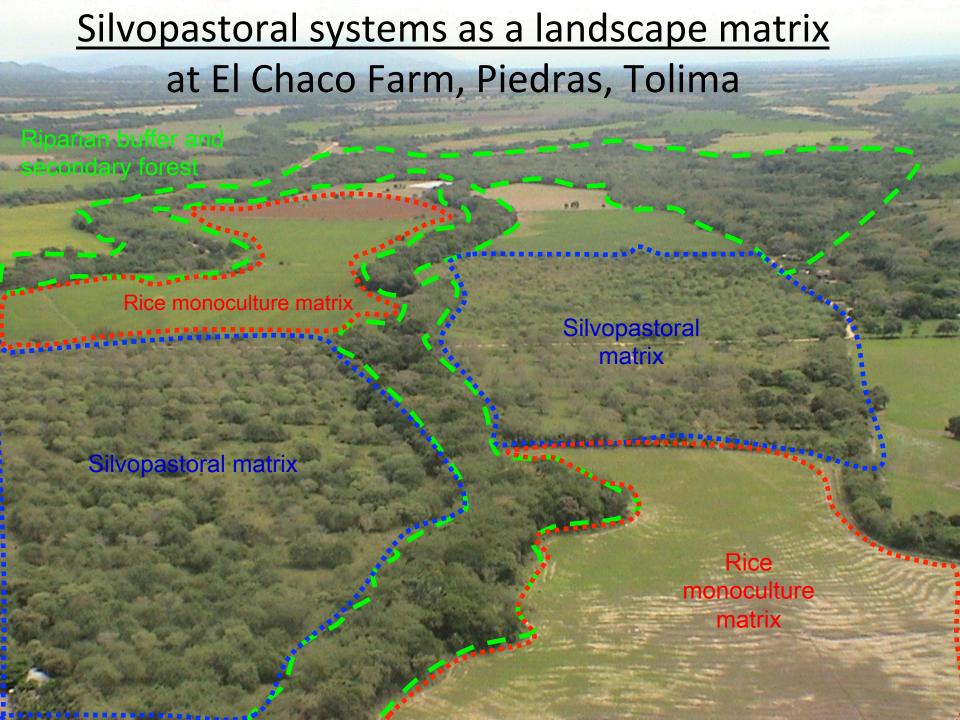


Intensive silvopastoral systems with timber trees Tectona grandis, Albizia guachapele and Azadirachta indica



36 months







Silvopastures enhance landscape connectivity



# Scaling-up: Bringing more benefits to more people, more quickly and more lastingly





#### Requires a cultural and intellectual shift from farmers, scientists, educators and politicians, leading to the transformation of cattle-based forms of land use.

 Based on a clever combination of scientific and technological innovation and economic and market incentives at all scales.

#### Strategy for scaling-up SPS

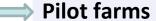
#### **Participatory research**

Optimizing silvopastoral systems for different agroecosystems, in real cattle farms



"Learning projects" - Pilot projects exploring the role of different incentives

- •PES
- Tecnical assistance
- Soft loans
- •Bonus prices for sustainable cattle products



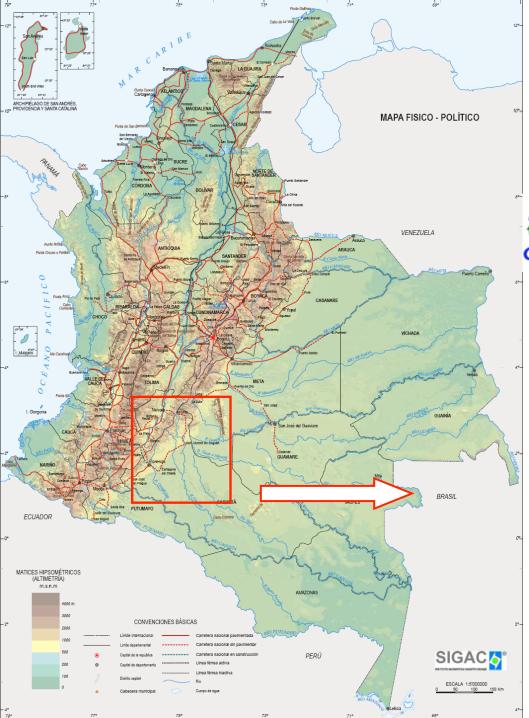


- Students (school to PhD)
- Farmers, field workers and administrators
- Researchers, technicians and extensionists
- Politicians and decision makers

Large projects, mainstreaming silvopastoral systems and applying the lessons learned in pilot projects

- Landscape-scale effects
- Climate change adaptation and mitigation
- Green markets





#### **Caquetá**

Eastern Andes - Amazon foothills Rainfall > 3000 mm





## **Environmentally Sustainable Milk**Project



#### "Environmentally Sustainable Milk" Project









Baseline situation: land degradation in a cattle ranching farm

Eastern Andes - Amazon foothills

Rainfall > 3000 mm

### Nestlé de Colombia and CIPAV Environmentally Sustainable Milk Project

(Leche Ambientalmente Sostenible)

- Credit: Soft loans < US \$13,000; 8 year term and one year of grace (paying interest but not capital)
- Specialized technical assistance
- Bonus price for "sustainable milk" > US \$ 0.04 L-1 (depending on the rate of progress in meeting the farm's goals).

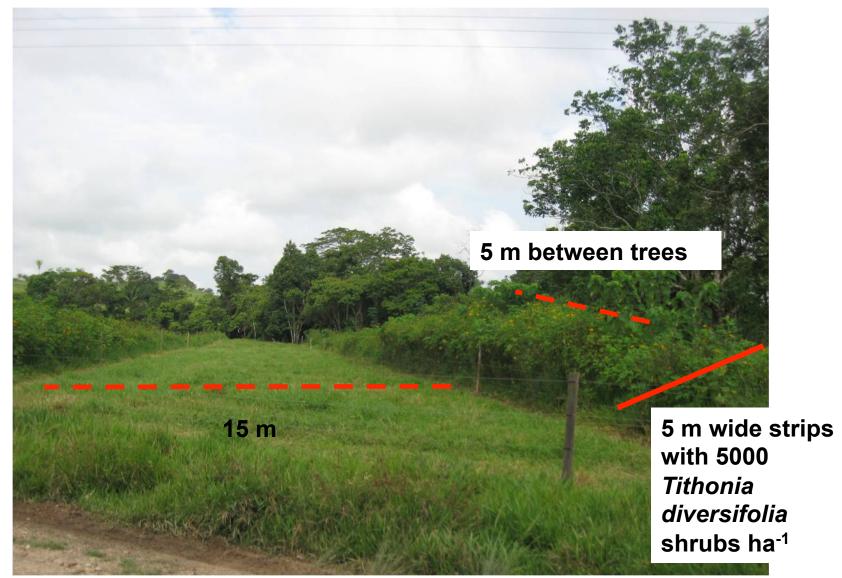


To sustainably increase milk production and quality in the Amazon foothills (NESTLE's Caquetá dairy district) without increasing the land area used for grazing, through silvopastoral systems that promote the protection and restoration of forests, water and soil."

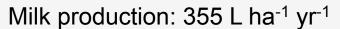




### Intensive silvopastoral system









Buenos Aires Farm, San Juan del Doncello, Caquetá

Owned by: Hernán Grajales



- 100 trees ha<sup>-1</sup> in lines each 20 m
- 5000 shrubs ha<sup>-1</sup> in double strips at both sides of trees.
- 15 m wide pasture strips between shrub & tree strips (5 m)

#### Regional Integrated Silvopastoral Approaches to Ecosystem Management (RISAEM) Project, 2002-2007



- Objective: evaluating the role of Payment for Environmental Services PES in the conversion of conventional cattle grazing systems into silvopastoral systems.
- In Colombia, the project contributed to the ecological rehabilitation of 3700 hectares at La Vieja river basin (Quindío and Valle del Cauca) through:
  - Transforming 78% of treeless pastures into silvopastoral systems
  - A 2040% increase in live fences
  - 140 hectares of intensive silvopastoral systems.





Banco

Mundial









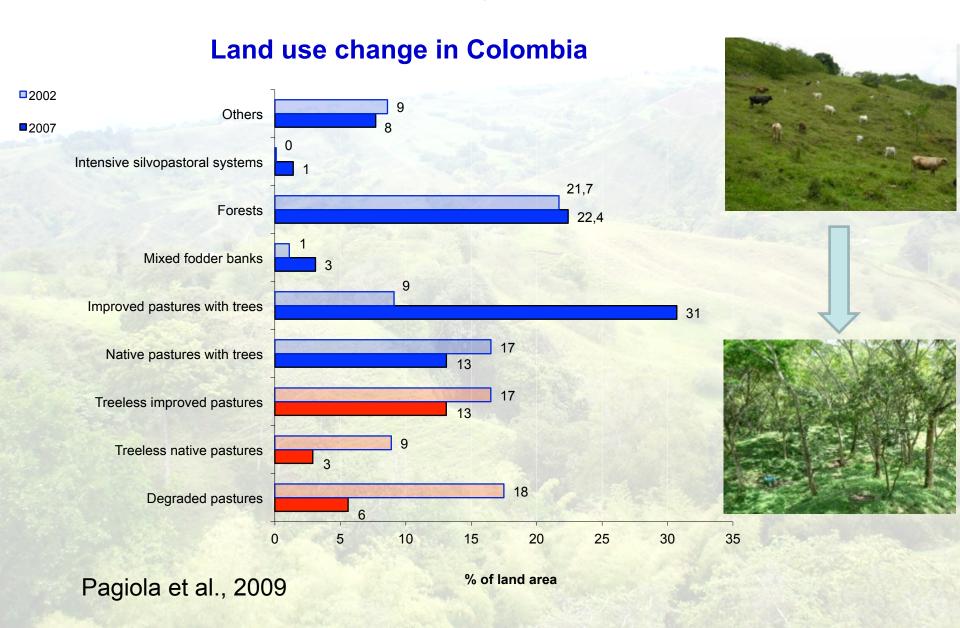


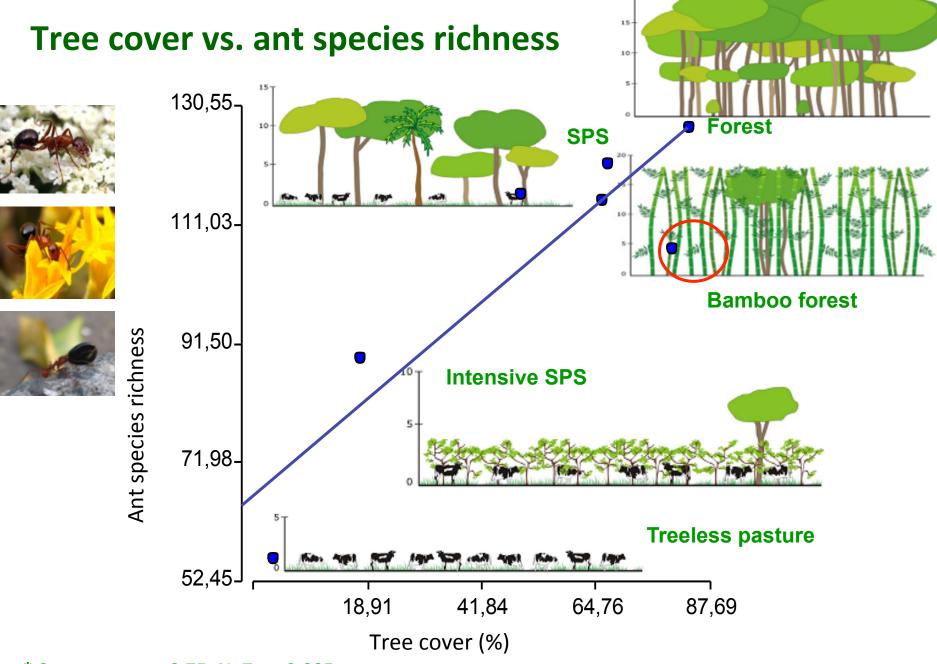






## Regional Integrated Silvopastoral Approaches to Ecosystem Management Project

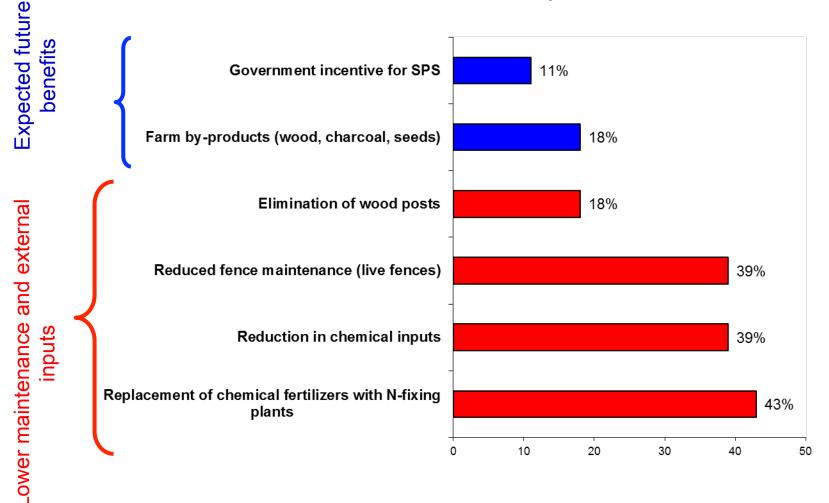




<sup>\*</sup> Spearman  $\rho = 0.75$ , N=7, p<0.005

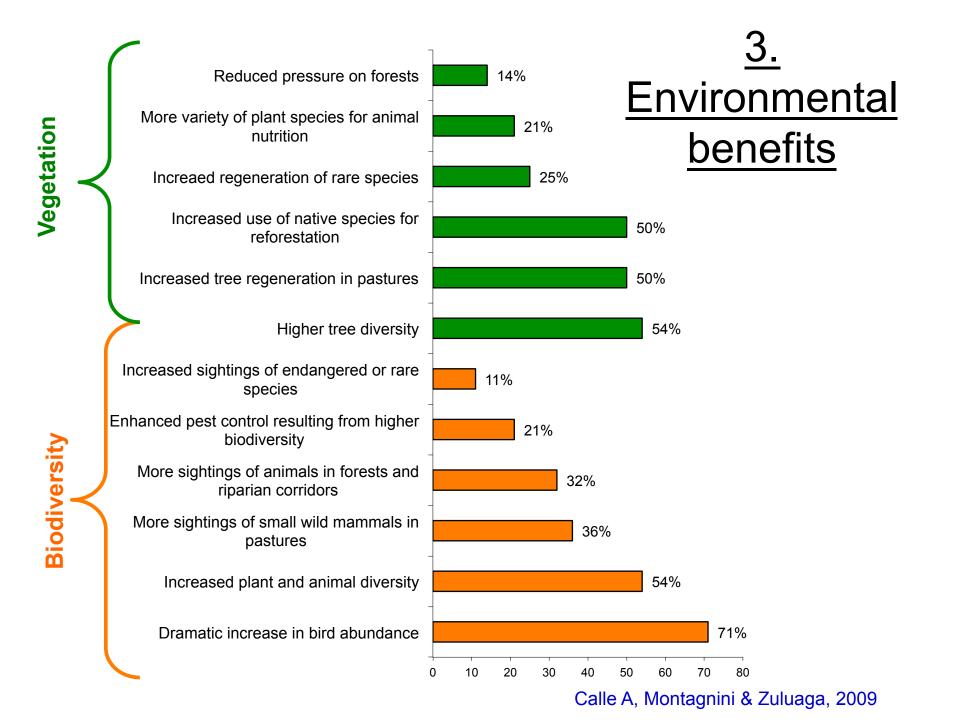
#### **RISAEM** Project

## Farmers' perceptions on the benefits of the adopted silvopastoral systems



#### 1. Economic benefits

Calle A, Montagnini & Zuluaga, 2009



### **Lessons learned from RISAEM Project**

- Farmers respond to PES.
   The project induced substantial land use change.
- SPS generate significant benefits for biodiversity, carbon sequestration and water.
- Some SPS are highly profitable.
- The high profitability of some SPS means that they do not need PES but other incentives such as credit and technical assistance.





## **Mainstreaming Biodiversity into Sustainable Cattle Ranching Project**























# Barriers to the adoption of SPS

# Incentives to address barriers

Financial capital barriers
 High initial costs required to establish many SPS defy the prevailing view of

tropical cattle ranching as a

low-investment activity.



Access to financial capital

2. Knowledge barriers



The technical complexity of some SPS demands specialized knowledge.

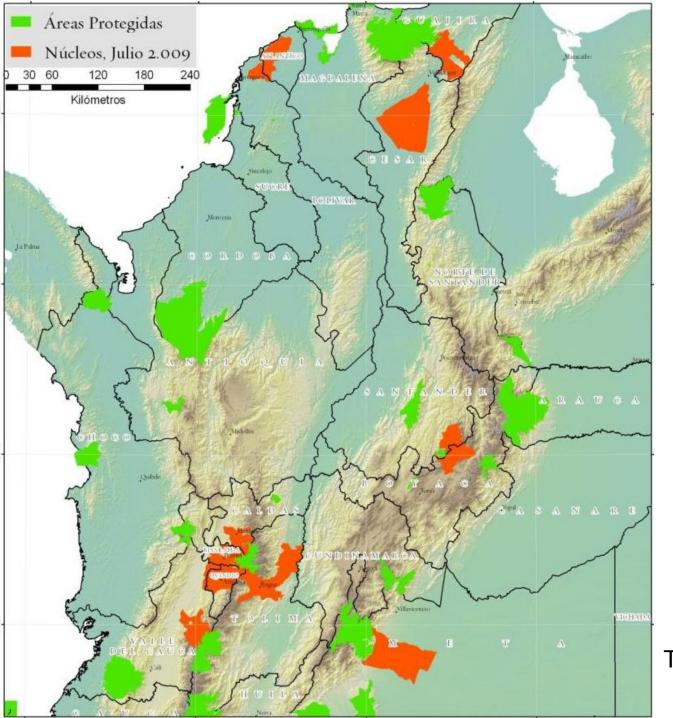
Training and technical assistance

# Mainstreaming biodiversity into sustainable cattle ranching Project



#### General objective

Inducing the adoption of biodiversity-friendly cattle ranching in areas with degraded pastures through different strategies, in order to: (1) create more suitable landscapes for biodiversity, water and soil, and (2) increase the income of farmers.



# **Project areas Protected areas**

TNC Colombia, 2009

### **Project goals**

- 45,500 ha of pastures converted into biodiversityfriendly systems
  - 12,000 ha of intensive SPS
  - 31,500 ha of pastures with trees and live fences
  - 11,000 ha of pastures with scattered trees
  - 5,000 km of live fences
  - 2,000 ha of degraded land, recovered
- 5,000 ha of forests, conserved





#### **Project goal: connectivity corridors**

- Project goal: 15,750 ha of connectivity corridors through a combination of secondary succession and enrichment planting.
- "Stretches of tree or shrub vegetation connecting fragments of natural ecosystems through riparian strips, pastures with high tree density, and other elements of the landscape."

# Connectivity corridors – MBSCR Project

Core strip (10 m wide)

- Natural ecosystem fragments
- Forest restoration

Only farmers that commit to strict conservation receive payment

## Buffer strips (25 m wide)

- Natural ecosystem fragments
- Scattered trees
- Intensive silvopastoral systems
- Live fences
- Wind breaks

Payment for land uses sufficiently compatible with conservation

### **Strategies**

- Low interest loans for implementing silvopastoral systems - Rural Capitalization Incentive.
- Technical assistance through Tecnig@n to promote cost-effectiveness and sustainability
- A PES scheme for biodiversity-friendly land uses

# Compensation for small and medium farmers for land use changes

PES – Payment for Environmental Services

Treeless pastures in areas unsuitable for grazing; degraded areas



Conservation of native forests
Corridors
Riparian buffers
Protection of wetlands
Restoration of degraded areas

Technical assistance and access to credit

Treeless pastures in areas suitable for cattle grazing



Intensive silvopastoral systems with timber trees
Mixed fodder banks
SPS with rotational grazing and good management practices

PES - Biodiversity and soil conservation scores for different land uses

Land use	Basic points	Additional points	
		In biological corridors	Focal species*
Mature forest	100	-	-
Secondary forest	95	-	-
Scattered trees and managed tree succession in pasturelands	70	10	10
Agroforestry systems (> 2 strata)	50	20	10
Live fences and windbreaks (Km)	10	5	5
Agriculture plots with plant cover >80%	10	-	10
Intensive SPS and mixed fodder banks	0	30	10
Seasonal crops and forest plantations	0	30	10
Degraded soil and degraded pasture	0	20	0

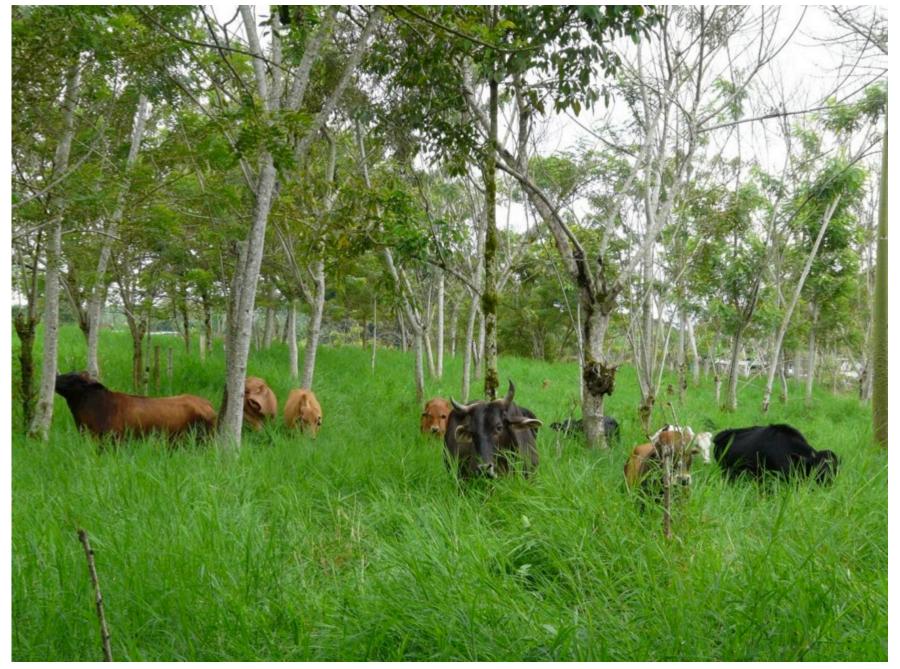
<sup>1</sup> point = US\$ 0,75 ha-1

SPS: Silvopastoral systems

<sup>\*</sup> Species of global conservation concern according to official project list (TNC-CIPAV)



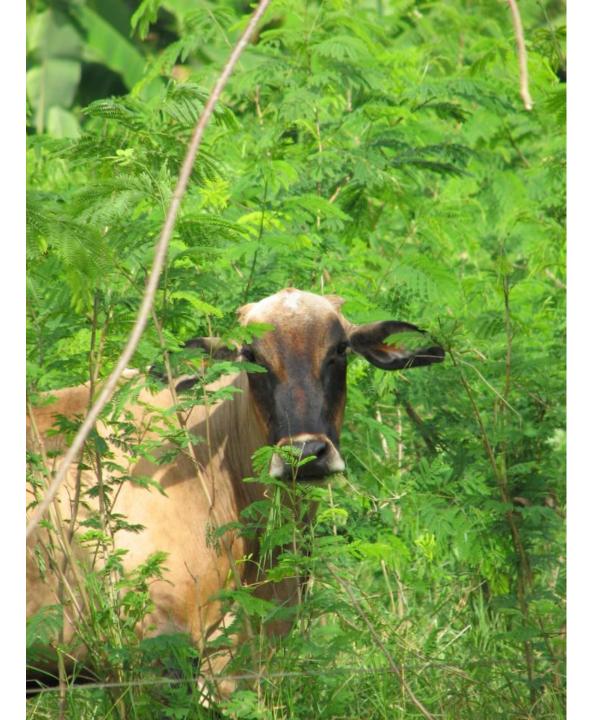
Mature forest: US\$ 75 ha<sup>-1</sup>



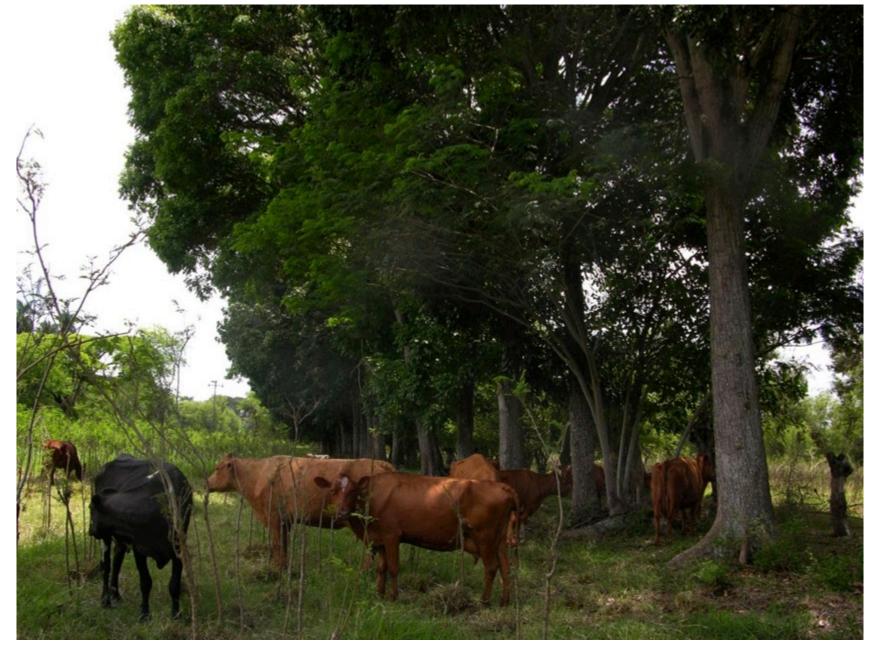
Managed tree succession in pasturelands: US\$ 52.50 ha<sup>-1</sup>



Live fences: US\$ 7.5 km<sup>-1</sup>



Intensive silvopastoral system: US\$ 0 ha<sup>-1</sup>

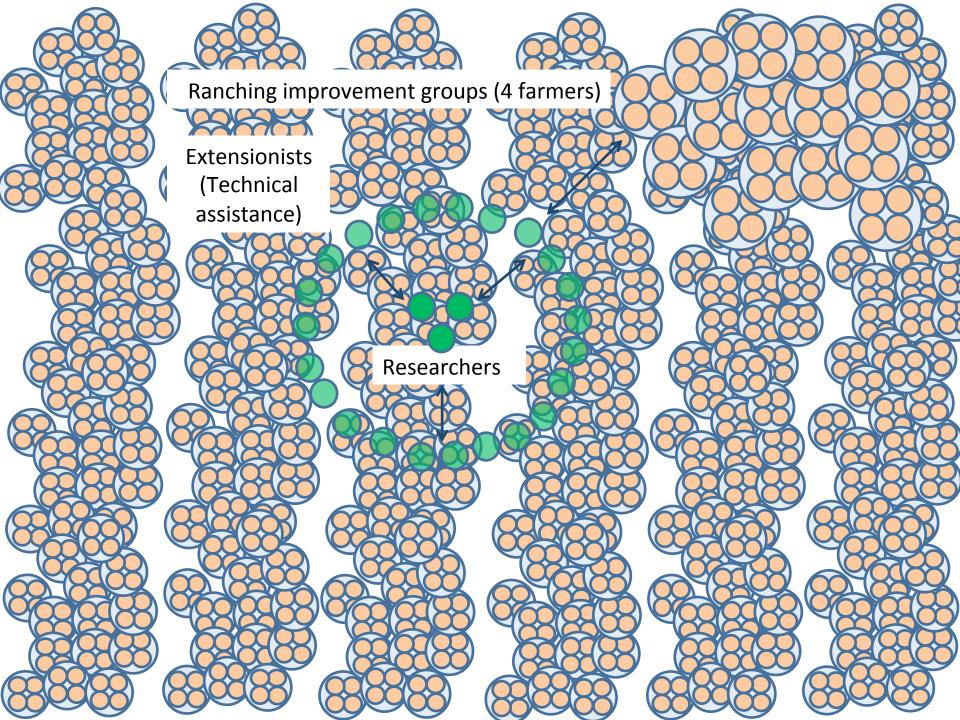


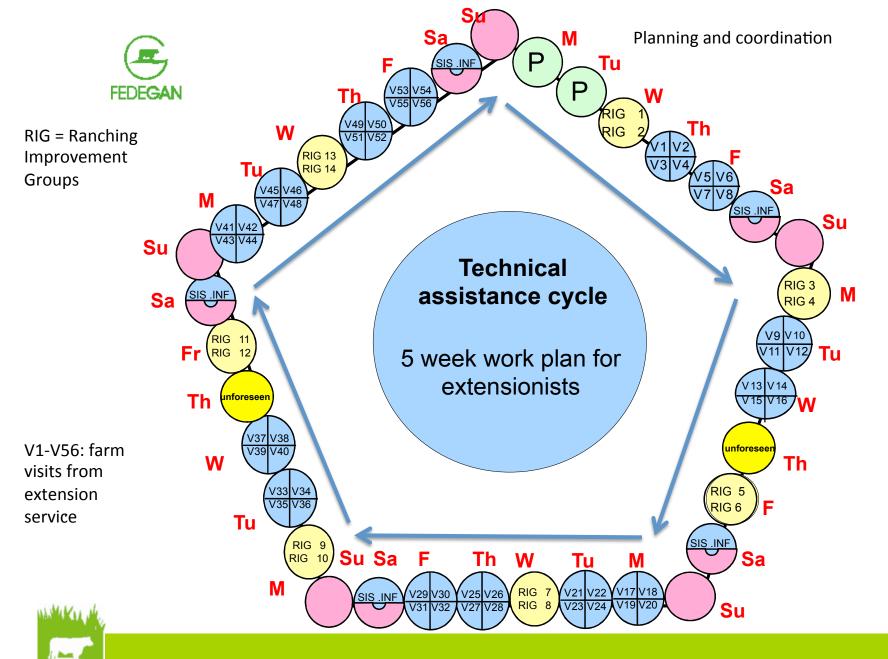
Intensive silvopastoral system + native trees: US\$ 7.50 ha<sup>-1</sup>



Mixed fodder bank with native trees: US\$ 7.50 ha<sup>-1</sup>







### Field courses jointly organized by ELTI and CIPAV

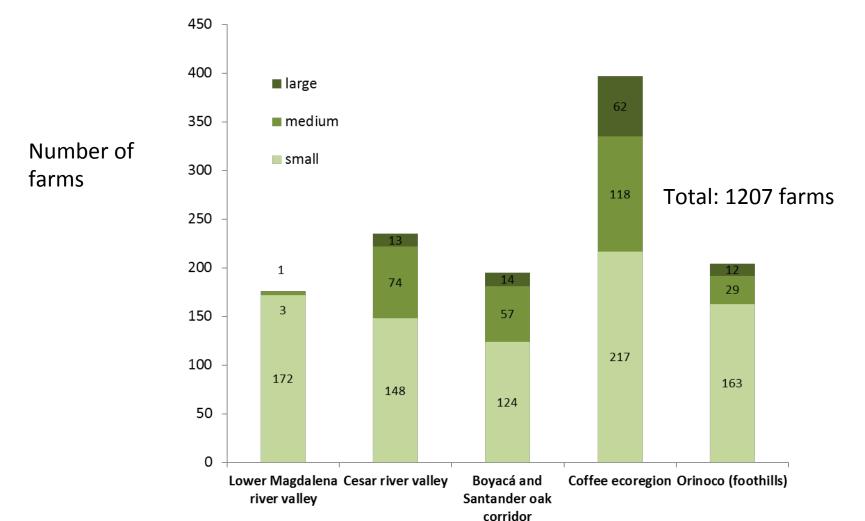
- Connectivity Corridor Restoration in Cattle Ranching Landscapes May 21-26, 2011
- Sustainability of Connectivity Corridors October 8-13, 2011

Armenia, Quindío, Colombia





### Farms enrolled in the Project after first call



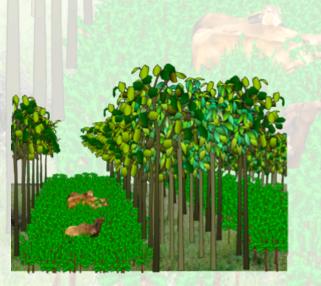
**Project region** 

# In summary, we propose that

- The mainstreaming of silvopastoral systems in degraded tropical landscapes can simultaneously address environmental and productive issues, making cattle ranching part of the solution rather than the problem.
- Tools for scaling-up SPS
  - Financial incentives
  - Payment for Environmental Services (PES)
  - Specialized technical assistance
  - Innovation awards for farmers
  - Market preferences



Colciencias, Ministerio de Agricultura y Desarrollo Rural, The Nature Conservancy, FPAA, Fedegán, Reserva Natural El Hatico, Roberto Mejía y Alberto Mejía (Hacienda El Chaco), Benhur Herrera (Hacienda Andorra)



¡Gracias! zoraida@cipav.org.co



### Strategy for scaling-up SPS

- Participatory research: optimizing silvopastoral systems for different agroecosystems in real cattle farms
- Pilot farms
- Capacity building, training & outreach
  - Students (school to PhD)
  - Farmers, field workers and administrators
  - Researchers, technicians and extensionists
  - Politicians and decision makers
- "Learning projects" Pilot projects exploring the role of different incentives
  - PES, tecnical assistance, soft loans, bonus prices for sustainable cattle products
- Large projects mainstreaming silvopastoral systems, applying lessons learned in pilot projects.

## **Conditions for scaling-up SPS**

#### Empirical evidence

- Grazing in forests exists since the domestication of Bos taurus and Bos indicus.
- Tree forages known for centuries: (i.e. mulberry *Morus alba* in China, Central Asia and Europe)

#### Scientific knowledge

 30 years of research on fodder trees, agroforestry systems and silvopastoral systems: CATIE (Costa Rica), CIPAV (Colombia), ICA (Cuba), Indio Hatuey (Cuba), FIRA (Mexico), EMBRAPA (Brasil), universities, Queensland University and CSIRO (Australia), ICRAF (Africa)

#### Public policy

- International cooperation FAO, TWB, USAID, EU
- International treaties on biodiversity and climate change

### Steps in scaling-up SPS in LA

#### S & T outreach

- Countless books, manuals, posters, videos, TV shows during the last decade.
- Papers in Latin American journals Revista de Producción Animal,
   Livestock Research for Rural Development
- 1999-2012: 7 agroforesry congresses

#### Social, political and market pressure

- UN convention on CC, IPCC. Livestock production has been identified as one of the main sectors responsible for greenhouse gas emissions.
- Increase in environmental awareness creates a demand for sustainable milk and meat products

### Pilot projects

 Learning and technology transfer projects on SSP help break the hamburger connection image of cattle ranching – Regional Integrated Silvopastoral Approaches to Ecosystem Management Project (GEF-The World Bank)

### **Tools for scaling-up SPS**

- Financial incentives
- Payment for Environmental Services (PES)
- Specialized technical assistance
- Innovation awards for farmers
- Market preferences





