

Trees and shrubs, key elements to improve sustainability of livestock-based agroecosystems in Colombia.

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# Colombia Country Profile



- ▶ Area: 1.138.910 KM<sup>2</sup> - Population: 45 M inhabitants
- ▶ 77 % urban - 23 % rural
- ▶ Natural Forest 61.2 M Ha - Pasture 39 M HA
- ▶ Indigenous 785,000 people - Land: 30.5 million Ha in 641 reserves.
- ▶ Afro-Colombian: 4.2 million- - Land: 5.2 million Ha in 113 land titles.
- ▶ Natural Parks 56 -> 12.6 million Ha (11.3%)
- ▶ Colombia is globally recognized as one of the world's most highly biodiverse countries.



# Colombia 10% of the planet biodiversity

Rank	Mammals	Bird	Amphibians	Reptiles	Flowering plants
1	Indonesia 515	<b>Colombia 1,810</b>	Brazil 650	Mexico 717	Brazil 56,000
2	Mexico 449	<b>Peru 1,701</b>	<b>Colombia 648</b>	Australia 686	<b>Colombia 51,000</b>
3	Brazil 428	Brazil 1,622	<b>Ecuador 358</b>	Indonesia c. 600	China 27,100
4	Zaire 409	Indonesia 1,519	Mexico 282	Brazil 467	Mexico 18,000 – 30,000
5	China 394	<b>Ecuador 1,447</b>	<b>Venezuela 275</b>	India 453	South Africa 23,420
6	<b>Peru 361</b>	<b>Venezuela 1,381</b>	Indonesia 270	<b>Colombia 383</b>	Borneo 20,000 – 25,000
7	<b>Colombia 359</b>	Bolivia c. 1,250	China 265	<b>Ecuador 345</b>	<b>Venezuela 21,070</b>
8	India 350	India 1,200	<b>Peru 251</b>	<b>Peru 297</b>	<b>Ecuador 17,600 – 21,100</b>
9	<b>Venezuela 340</b>	Malaysia c. 1,200	Zaire 216	Malaysia 294	<b>Peru 18,000 – 20,000</b>
10	Tanzania 310	China 1,195	USA 205	<b>Venezuela 292</b>	Papua New G. 15,000 – 20,000



# Landscape transformation and biodiversity losses.

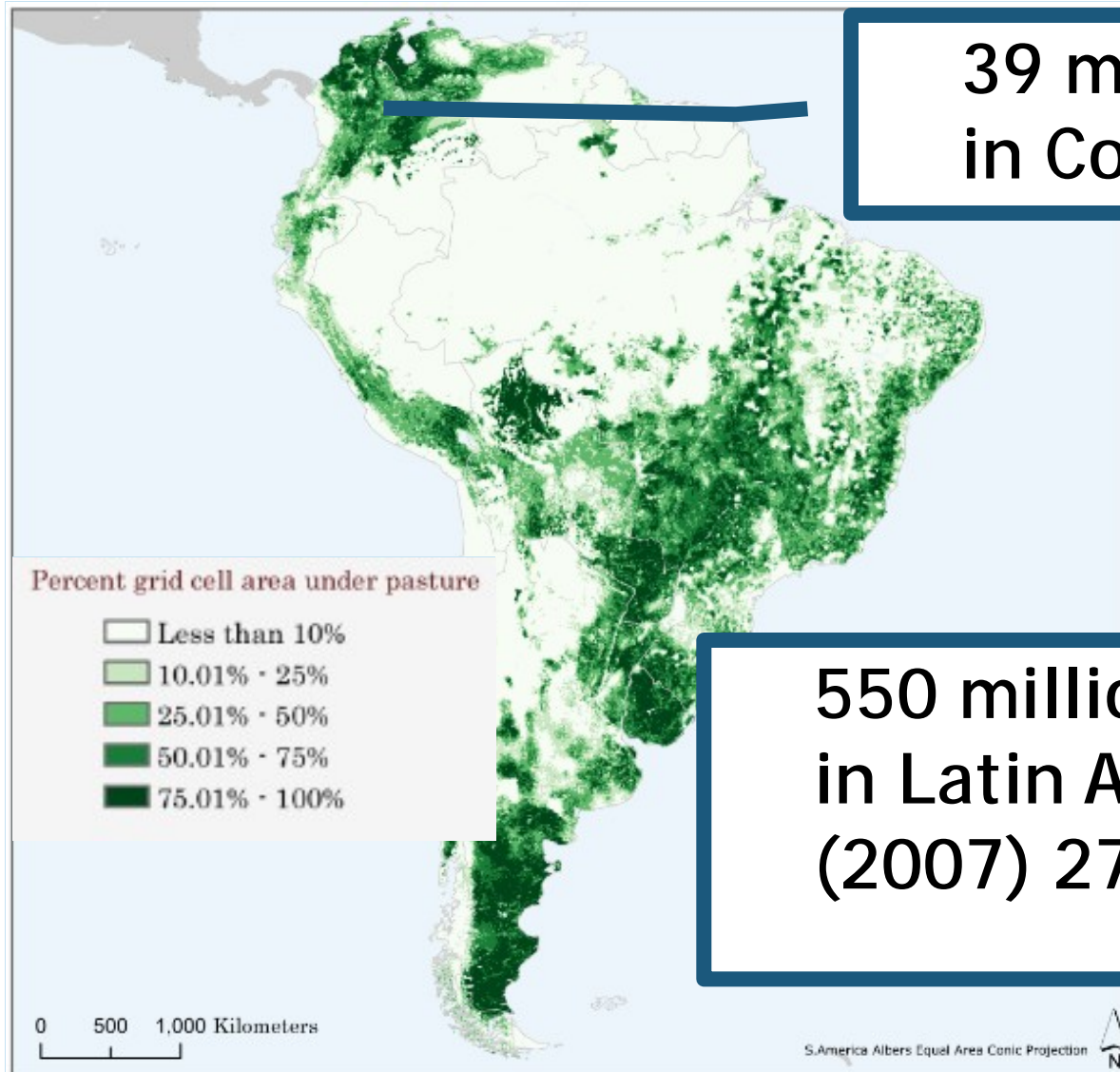




# Pastures in South America

39 million hectares  
in Colombia

550 million hectares  
in Latin America  
(2007) 27% of area





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



Underlying principle: 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.



# Cattle ranching can be:

- ▶ Conventionally managed: Efficient tool for ecosystem degradation.



- ▶ Sustainably managed with silvopastoral systems: Tool for rehabilitating degraded lands.



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



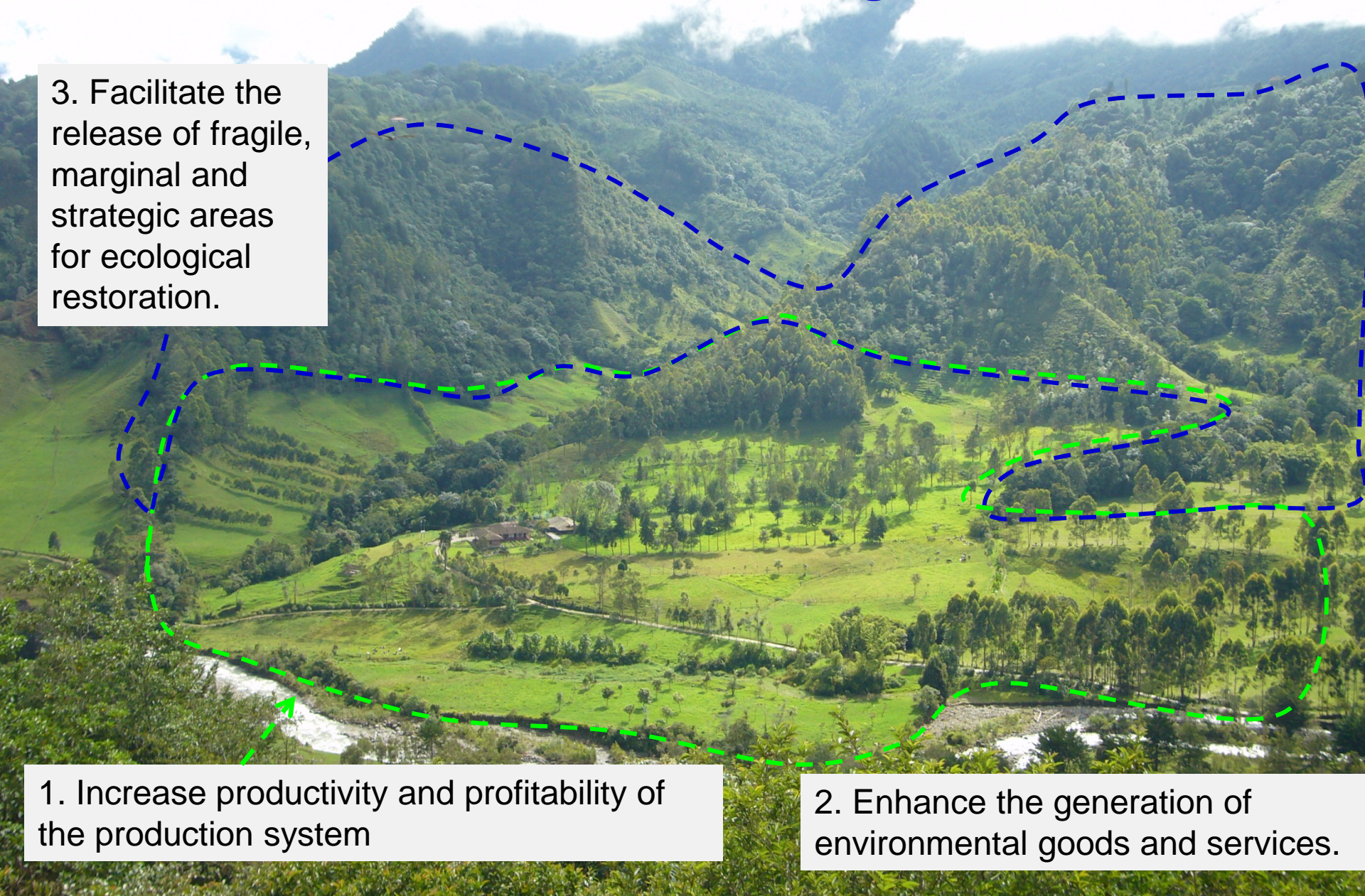


# Rehabilitation of cattle ranching lands must:

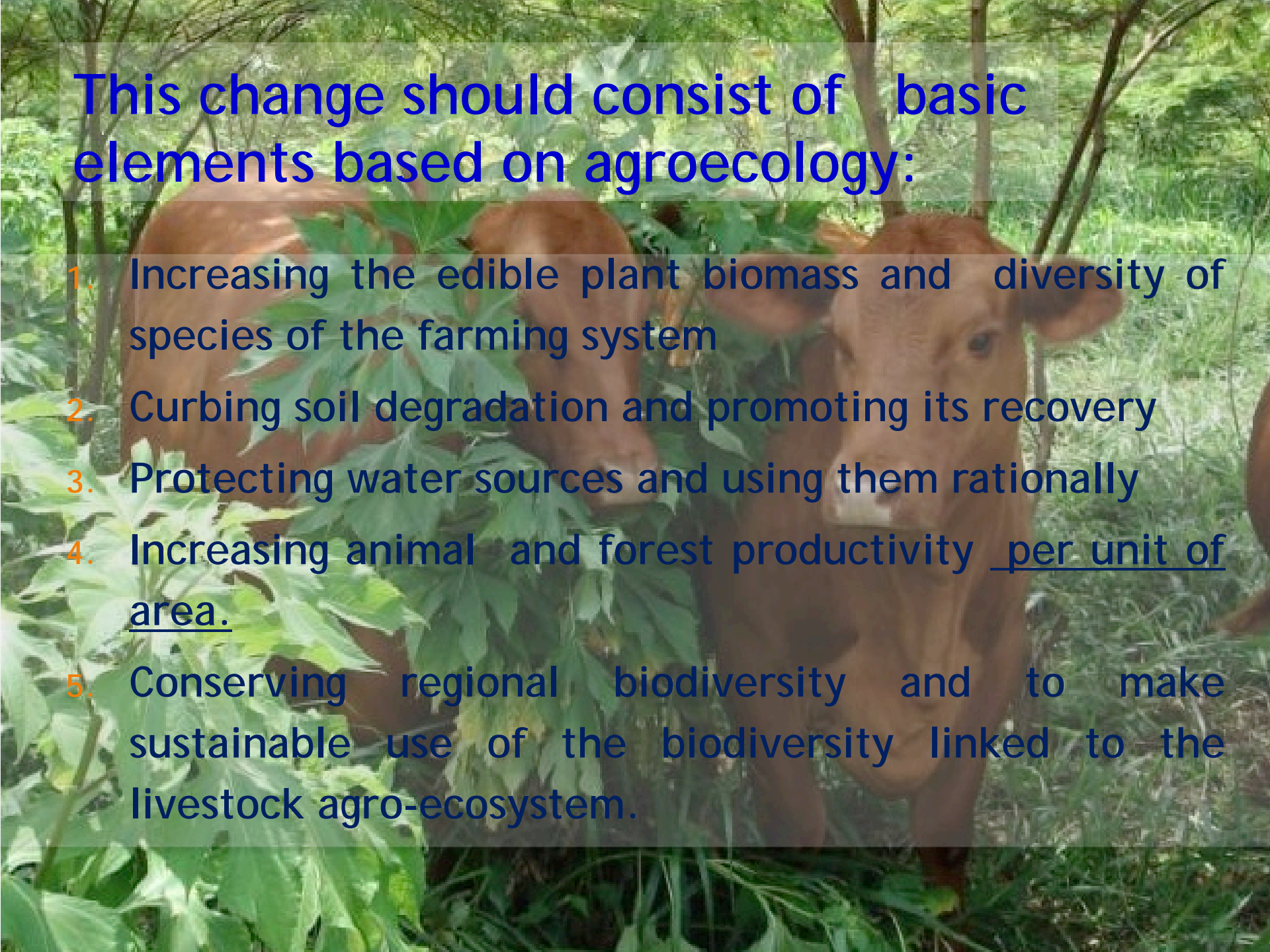
3. Facilitate the release of fragile, marginal and strategic areas for ecological restoration.

1. Increase productivity and profitability of the production system

2. Enhance the generation of environmental goods and services.





A brown cow is shown grazing on green leaves in a forest setting. The cow is positioned in the center-right of the frame, facing slightly towards the left. It is surrounded by dense green foliage, including large leaves in the foreground and trees in the background. The overall scene is a lush, green agro-ecosystem.

# This change should consist of basic elements based on agroecology:

1. Increasing the edible plant biomass and diversity of species of the farming system
2. Curbing soil degradation and promoting its recovery
3. Protecting water sources and using them rationally
4. Increasing animal and forest productivity per unit of area.
5. Conserving regional biodiversity and to make sustainable use of the biodiversity linked to the livestock agro-ecosystem.



# 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.





# Main silvopastoral systems



Scattered trees in pastureland



Live fence



► <http://funcitree.nina.no/>

Intensive silvopastoral system



Mixed fodder bank (cut-and-carry system)





**Browsing is a natural ability of domesticated and wild ruminants**





(*Cassia grandis*)



Guayaba (*Psidium guajaba*)



Oil Palm (*Elaeis guineensis*)



Cañafístola (*Cassia moschata*)



SUN

BIOMAS  
YIELDING  
CROPS

MULTIPOURPOSE  
TREES

FAMILY

LIVESTOCK  
SPECIES

RECYCLING SYSTEM:  
BODIGESTOR – EARTH  
WORMS

AQUATIC  
PLANTS



# Shifting paradigm in tropical cattle ranching

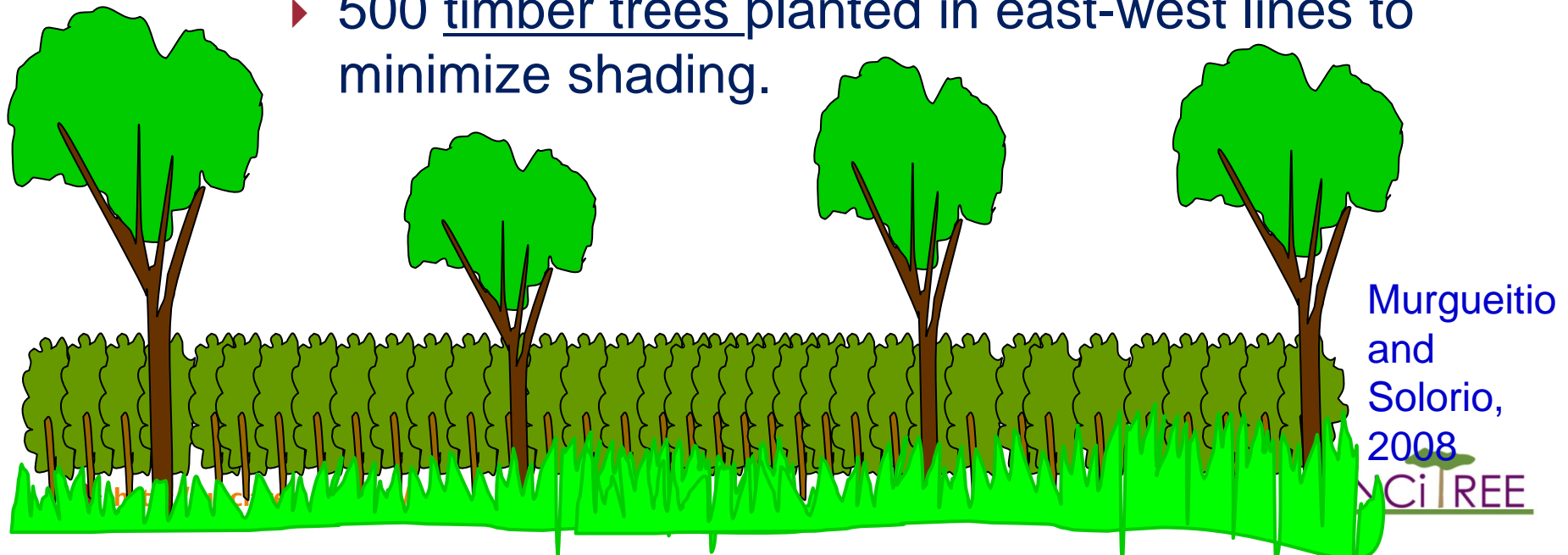


Maximum biomass production is not achieved in treeless grass monocultures but in agroforests combining pastures, trees and shrubs.



# Intensive silvopastoral system ISS

- ▶ A system that can be directly grazed by livestock. It combines:
  - ▶ Fodder shrubs planted at high densities ( $>10,000$  plants  $\text{ha}^{-1}$ ), intercropped with
  - ▶ highly-productive pastures, and
  - ▶ 500 timber trees planted in east-west lines to minimize shading.



Murgueitio  
and  
Solorio,  
2008

NCiTREE



A photograph of an intensive silvopastoral system (ISS). The foreground is filled with lush green, low-growing vegetation, likely a cover crop or pasture. In the middle ground, a dense stand of tall, slender trees with light-colored bark and green foliage is visible. The background shows more trees and a clear blue sky. The overall scene depicts a well-managed, integrated agricultural and forestry system.

**Intensive silvopastoral system ISS**



# ISS: MULTI-STOREY PRODUCTIVITY



**Trees and palms**



**Fruit and timber trees**



**Fodder shrubs**



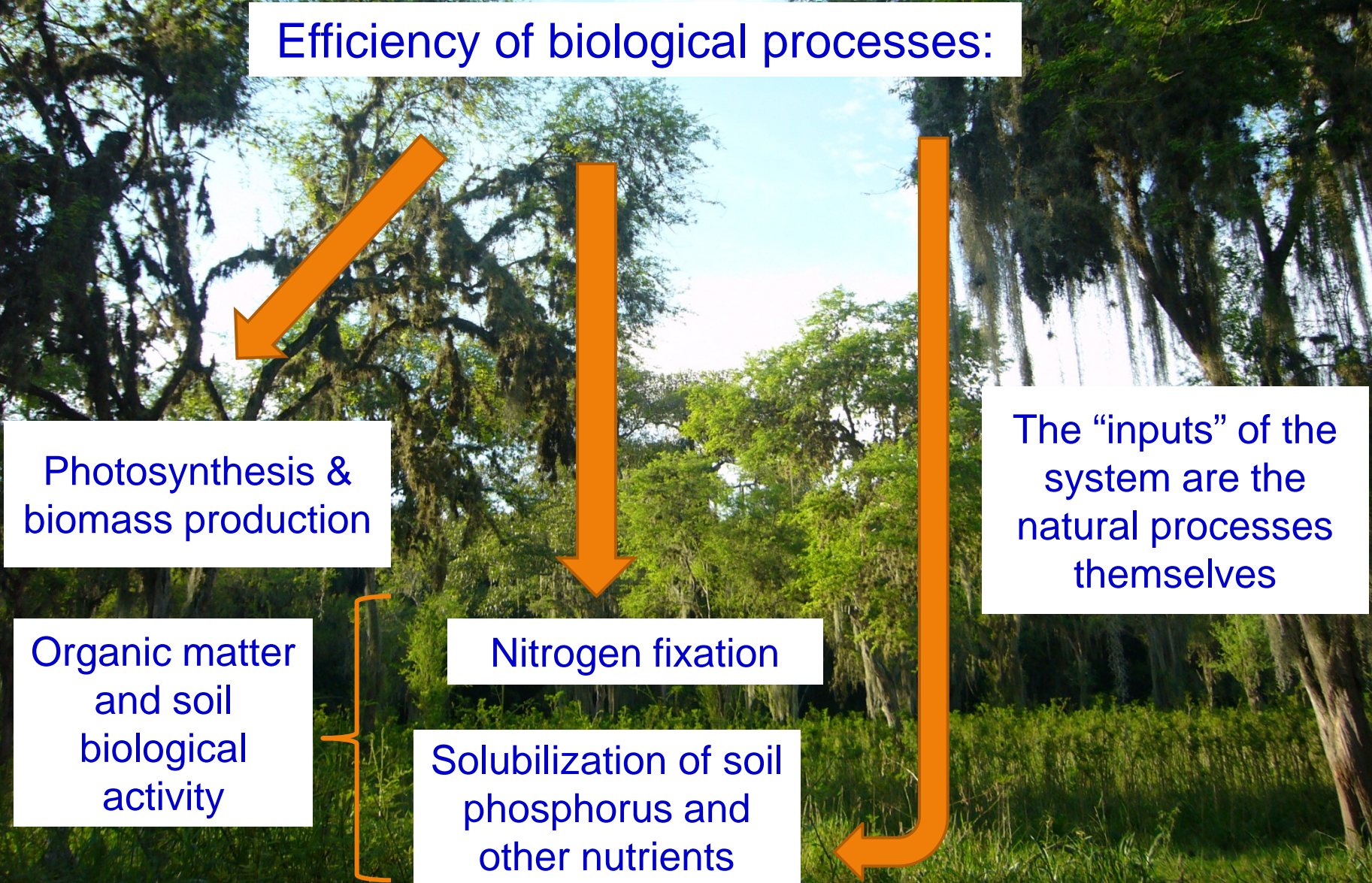
**Grasses and legumes**





# What is *intensive* about ISS?

Efficiency of biological processes:



Photosynthesis &  
biomass production

Organic matter  
and soil  
biological  
activity

Nitrogen fixation

Solubilization of soil  
phosphorus and  
other nutrients

The “inputs” of the  
system are the  
natural processes  
themselves

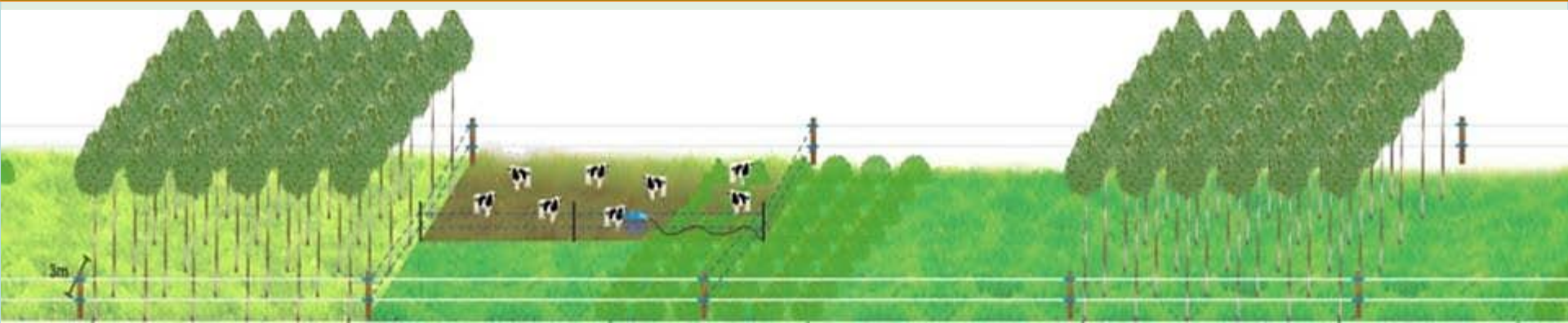


**SSPI alta carga instantânea (8 dias no ano) e longos períodos de descanso (297 dias no ano). Fazenda Asturias, Quindío (Colombia)**





# ISS + timber trees

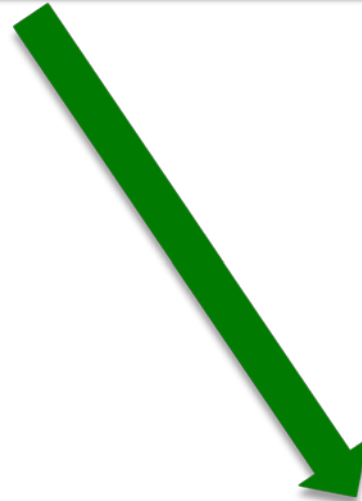




INCOME



Long term  
income



Short term income



High cash  
flow

Lacorte y Esquivel 2009

Capital turnover



*Leucaena leucocephala* (Lam) de Wit., + *Eucalipto tereticornis*



Fazenda La Luisa, Cesar, Colômbia



# ISS - Acid soils

*Tithonia diversifolia* + *Acacia mangium* + *Brachiaria humidicola* - 18 months

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



Two species have shown the best results:

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

▶ <http://funcitree.nina.no/>



# *Leucaena leucocephala* (Lam.) de Wit



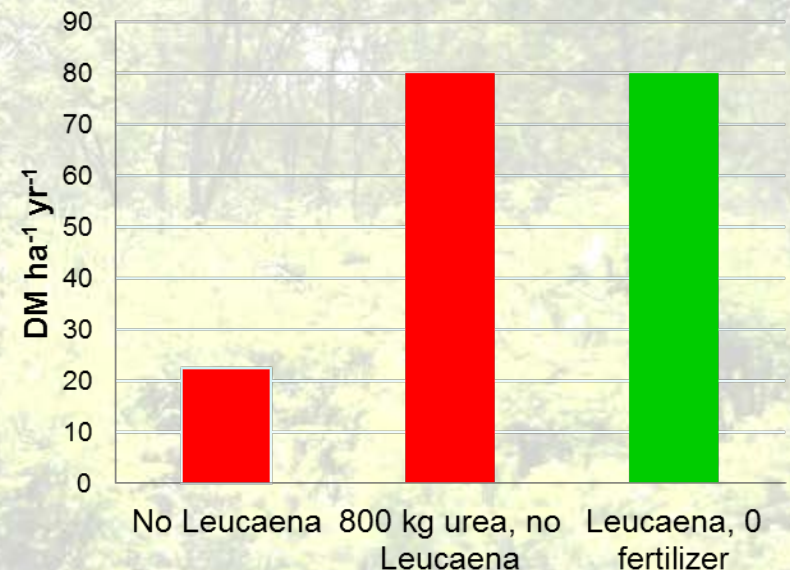
- ▶ Very high rate of nitrogen fixation.
- ▶ Nitrogen is easily transferred to neighboring plants.
- ▶ High rate of consumption by livestock.
- ▶ Associates well with grasses.
- ▶ Elasticity of stems provides exceptional tolerance to grazing.
- ▶ Rapid and vigorous regrowth.
- ▶ Its shade conserves moisture 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!



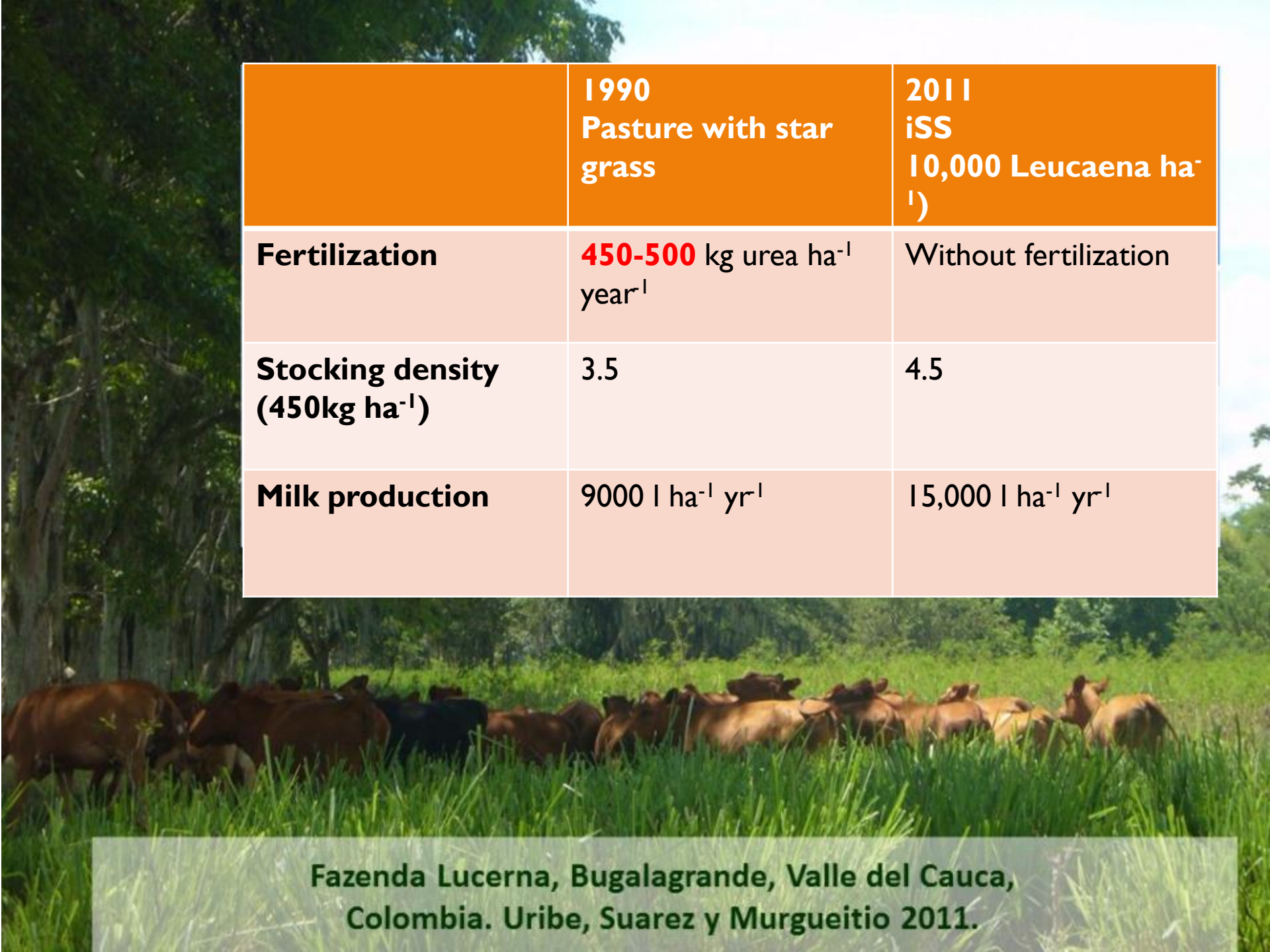
# What makes *L. leucocephala* irreplaceable?

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







	1990 Pasture with star grass	2011 iSS 10,000 <i>Leucaena</i> ha <sup>-1</sup> )
<b>Fertilization</b>	<b>450-500</b> kg urea ha <sup>-1</sup> year <sup>-1</sup>	Without fertilization
<b>Stocking density (450kg ha<sup>-1</sup>)</b>	3.5	4.5
<b>Milk production</b>	9000 l ha <sup>-1</sup> yr <sup>-1</sup>	15,000 l ha <sup>-1</sup> yr <sup>-1</sup>

Fazenda Lucerna, Bugalagrande, Valle del Cauca,  
Colombia. Uribe, Suarez y Murgueitio 2011.





***ISS Guazuma ulmifolia* Lam.**





3

2

1



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





*Prosopis juliflora* natural  
regeneration SPS

Intensive silvopastoral  
system, 4 months

Compaction and erosion in  
soils degraded by monoculture



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



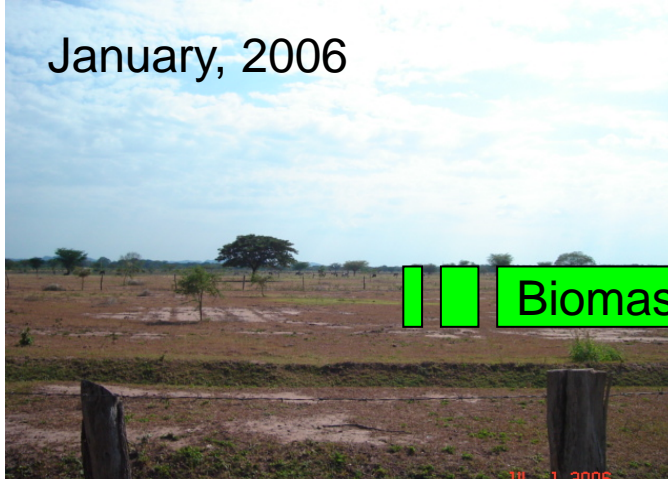
Rapid pasture degradation



The edible biomass disappears during the dry months



January, 2006



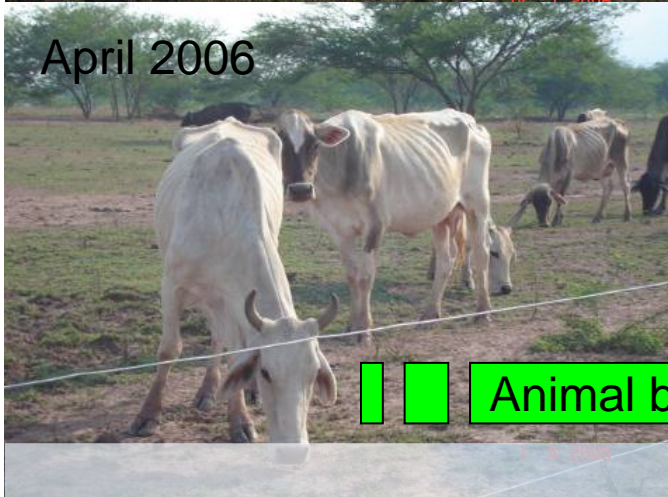
August, 2006

First grazing

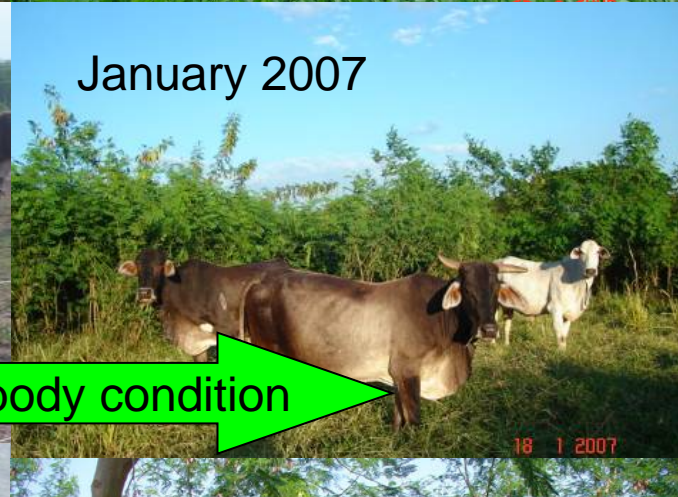


Biomass production

April 2006



January 2007



Animal body condition

1.2 large  
animals  
1.7 L milk  
 $\text{cow}^{-1}$   
 $\text{day}^{-1}$

5.1 large  
animals  
4.1 L  
milk  
 $\text{cow}^{-1}$   
 $\text{day}^{-1}$



Carrying capacity and productivity



# ISS : HIGHER MEAT PRODUCTION



## STOCKING RATE (SR) AND ANIMAL PERFORMANCE DAILY GAIN OF WEIGHT (DGW)

Region	FARMING SYSTEM	SR (Heads/ha)	DGW (g/head/day)	MEAT (kg/ha/Year)
Bajo Magdalena	Traditional	1,2	296,0	129,6
	Improved pasture	3,6	453,8	596,2
Valle del Cesar	ISS + FRUIT TREES	3,5	651,3	827,3
	ISS + TIMBER	4,7	790,2	1341,2



## ► ISS higher stocking rate and milk production.

	Animals/ha	UGG/ha	L /ha/Year
SSPi	3,9	3,34	5551,6
S. Tradicional	0,9	0,8	1149,7



Kg/ha/Year				
	FAT	Protein	Non-Fat Solids	Total solids
SSPi	294,20	188,74	499,50	793,7
S. Tradicional	49,43	37,94	103,47	152,9



**ISS, (Cesar), Caribbean zone of Colombia**  
**Baseline, rainy season april 2011.**  
**Low productivity >25 year - Hacienda *La Luisa***





**4 months later in period of the rainy season,  
august 2011**





# ISS, after 9 moths – dry period January 2012





**ISS after 14 months- rainy season june 2012**





# Bebedouros para o gado





Unprotected streams, wetlands  
and springs



Baseline situation



Low biomass production  
Low animal load  
Heat stress

Cubarral, Meta

**Andean foothills**

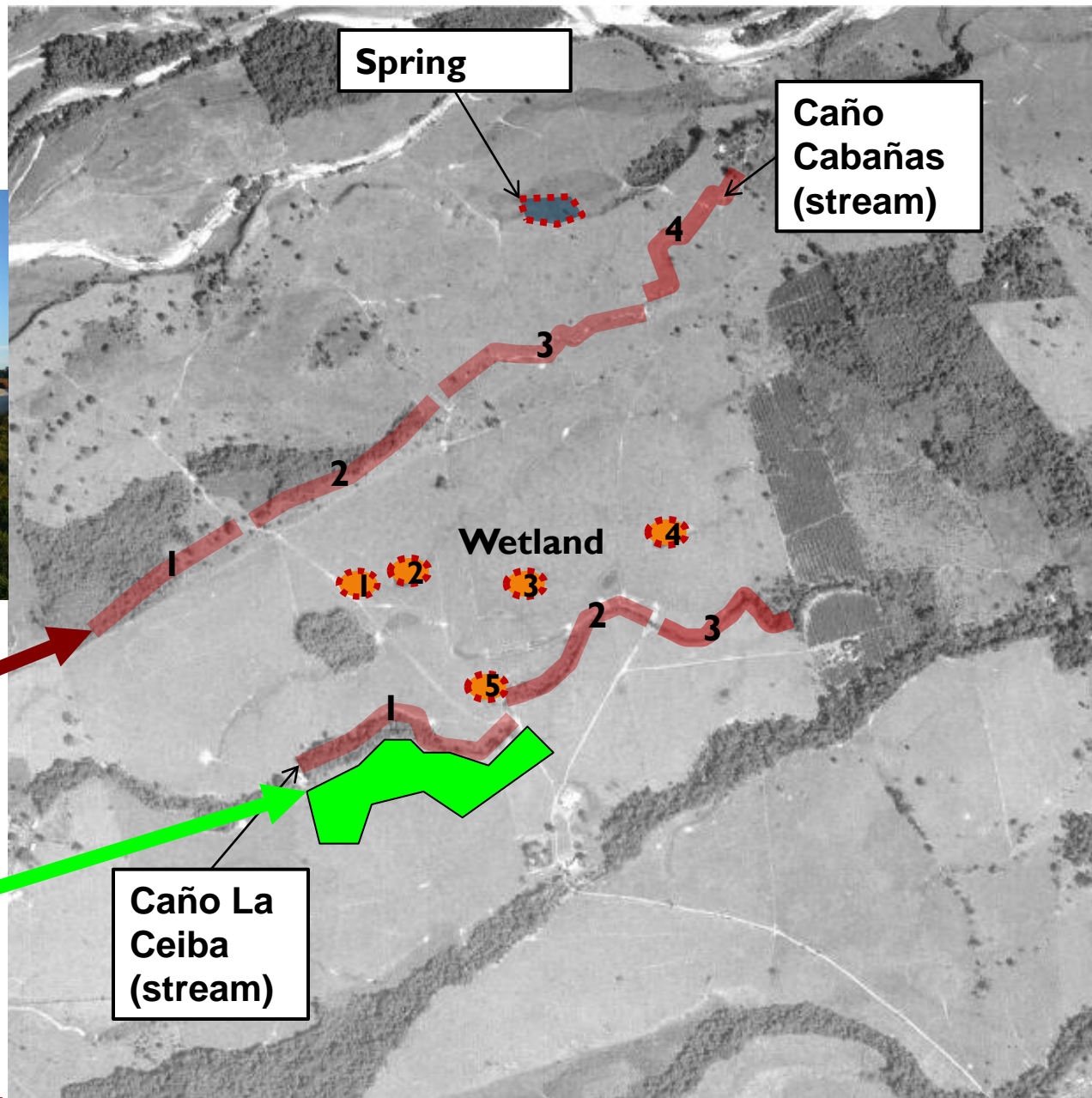
Rainfall > 3000 mm



FUNCIREE



# Andorra Farm, Cubarral, Meta



Riparian buffers,  
wetlands and springs

Intensive silvopastoral  
system

219 hectares

Rainfall > 3000 mm

Owned by: Benhur Herrera

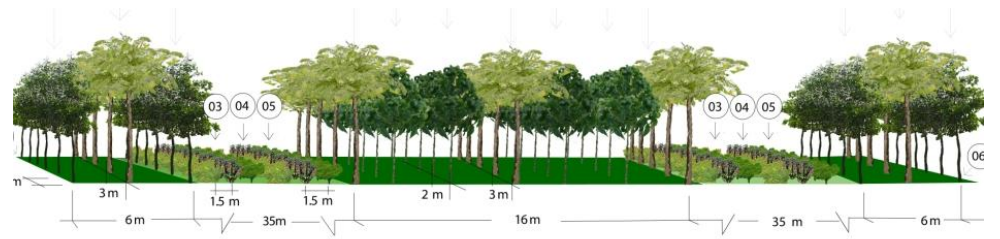
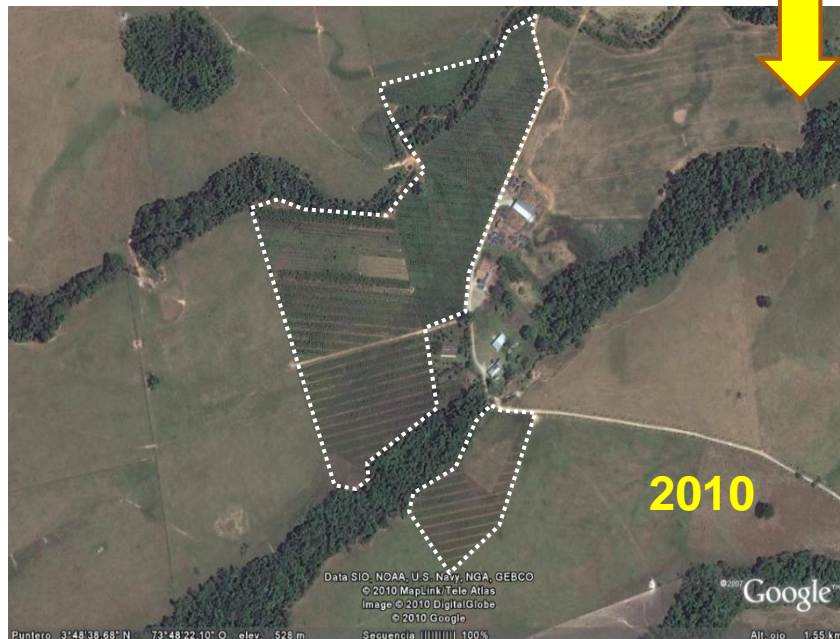
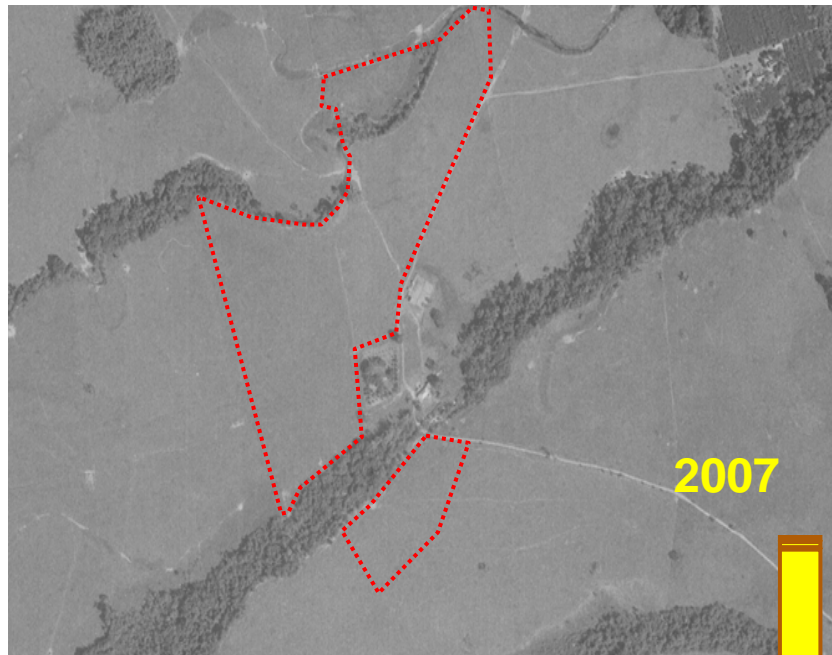
FUNCI TREE



# Rehabilitation of riparian buffers 2007-2010







Intensive silvopastoral  
systems





## Piedras, Tolima

Meseta de Ibagué, Alto Magdalena

Tropical dry forest

Rainfall: 1200-1300 mm







# El Chaco Farm

Roberto Mejía C., Alberto Mejía F.

605 m.a.s.l.

413 ha

Tropical dry forest

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



National Cattle Ranching Award 2009. Sustainable livestock enterprise

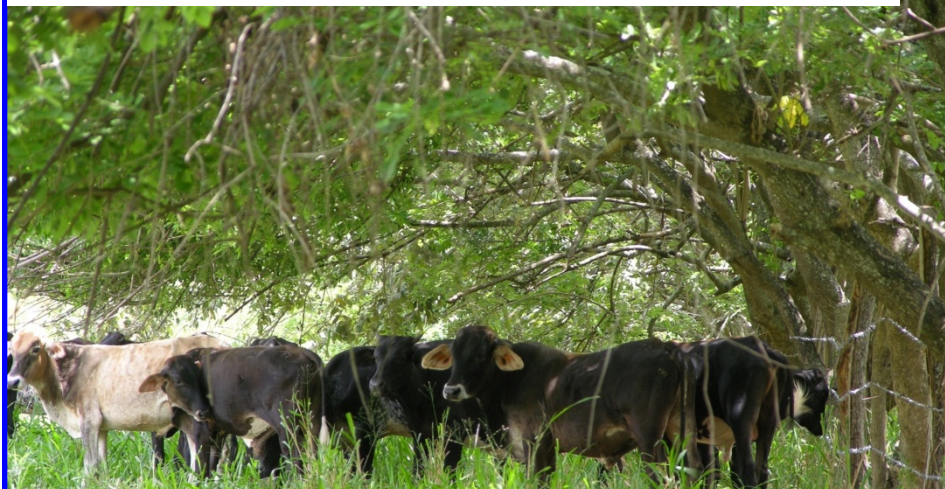


# Extensive system

Animal load: 0.55 large animals ha<sup>-1</sup>



Intensive silvopastoral system for beef cattle



Animal load: 2.5 large animals  
Additional meat production: 45 kg ha<sup>-1</sup> month<sup>-1</sup>

Intensive silvopastoral system for milk cattle



Animal load: 3.5 large animals,  
9.5 L cow<sup>-1</sup> day<sup>-1</sup>