MANAGEMENT OF SOIL FERTILITY FOR SUSTAINABLE LIVESTOCK SYSTEMS

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Content

- Context of the cattle ranch in tropical America
- Strategy of sustainable intensification
- Technological options to improve the fertility of acid soils in livestock systems and make efficient use of nutrients
- Gaps in knowledge and strengthening in the management of fertility in livestock systems

Context of livestock in tropical America

- ❖ Increasing demand for meat and milk with the increase in population and income.
- ❖ Pressures to intensify livestock (reduction of grazing areas, increase in livestock population and production rates).
- ❖ Pressures to afforest livestock areas or dedicate them to other agricultural activities.
- ❖ Problems of pasture degradation.

Lascano, personal comm

Limiters of soil for livestock production

Limiting	Oxisols (Sabanas)	Ultisols (Amazonia)	Alfisols (Valleys)	Inceptisol (Steep hills)	Andisols (Mountain)
Low nutrient reserve	+++	+++	+++	++	++
Toxicity Aluminum	+++	++			+++
Fixation of P	+++	+++			+++
Acidity without Al			++	++	
Low CEC	+++	+++	++	++	++
Low availability of N	+++	+++	+++	+++	+++
Ponding	++	+++	+++		

735 million hectares in Tropical America are dedicated to livestock (FAO 2014)

Extensive low-input livestock systems

Use of native and naturalized species with fire.

- Samples eutrophic and dystrophic with native grasses
- Ultisols in humid areas under naturalized pastures
- Inceptisols and Alfisols with species of moderate quality.
- Seasonal production of forage.
- Low content of protein and minerals in the forage.
- Periodic burning provides ash rich in N and P, increases soil pH and mineralizes M.O.

Low production of meat / milk per head and per ha

Contribution of the ashes resulting from the Burning savannas and tropical forests

Ecosystem	N	P	K	Ca	Mg	S
	(kg/ha)					
Savannas	1	1	8	9	4	2
Forests	53	8	96	64	17	10

Sanchez, 2019

Problem: pasture degradation

Causes

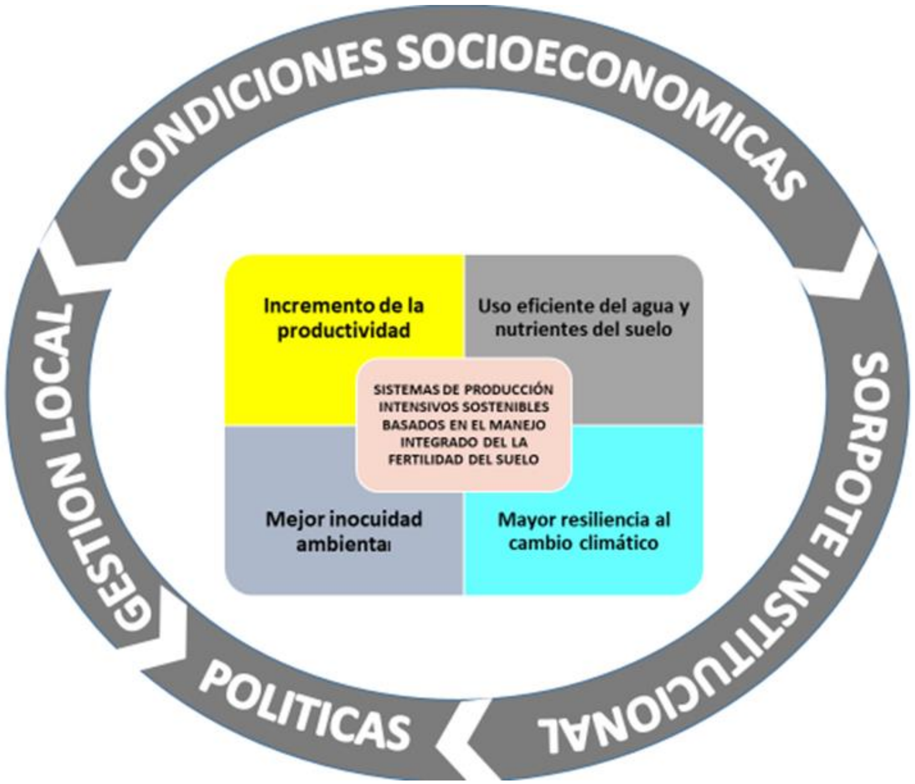
Overgrazing
Bad establishment
Loss of fertility
Plagues and diseases

Consequences
Loss of coverage
Low forage production
Invasion of weeds
Comparison

Research approach to intensify tropical livestock systems in a sustainable manner

GENERAL OBJECTIVE OF THE APPROACH

Satisfy the demands of society, markets and agrifood chains, with differentiated products in terms of quality, safety, biosecurity and animal welfare, making use and valorization of agrobiodiversity and natural resources in a sustainable manner



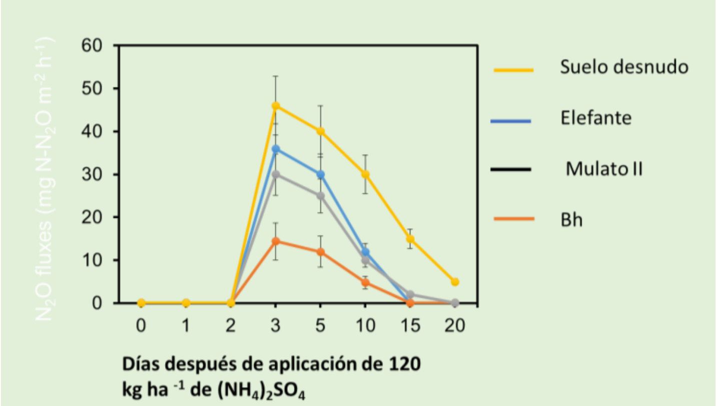
AGROSAVIA, 2016

Management options to intensify livestock production and improve the use of soil nutrients




Forage species adapted to low soil fertility

- ❖ Deep root systems that allow you to absorb more water and nutrients per root unit.
- ❖ Greater efficiency of use of P absorbed to produce fodder (Rao et al., 1999).
- ❖ Ability to absorb insoluble forms of P from the soil and to associate with mycorrhizae (Rao, 2001).
- ❖ Ability to reduce soil N losses (inhibition of nitrification)
- ❖ Forage legumes with ability to improve the availability of N in associations with grasses



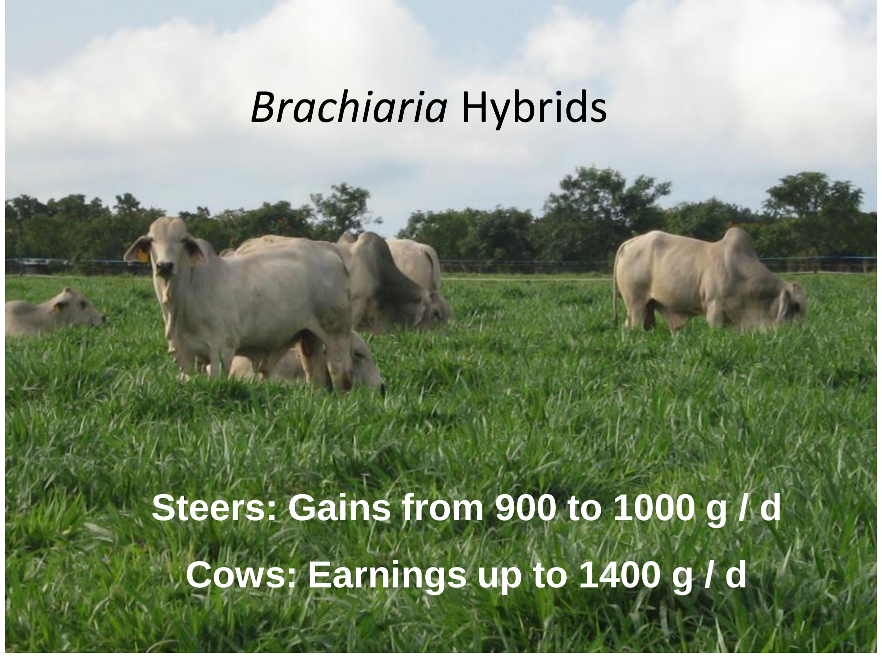
Impact of improved pastures

Changes in soil fertility

- Increases in O.M.
- Better soil aggregation and porosity
- Higher N mineralization rates
- Greater biological activity

Thomas et al, 1992

Impact of pasture genetic improvement



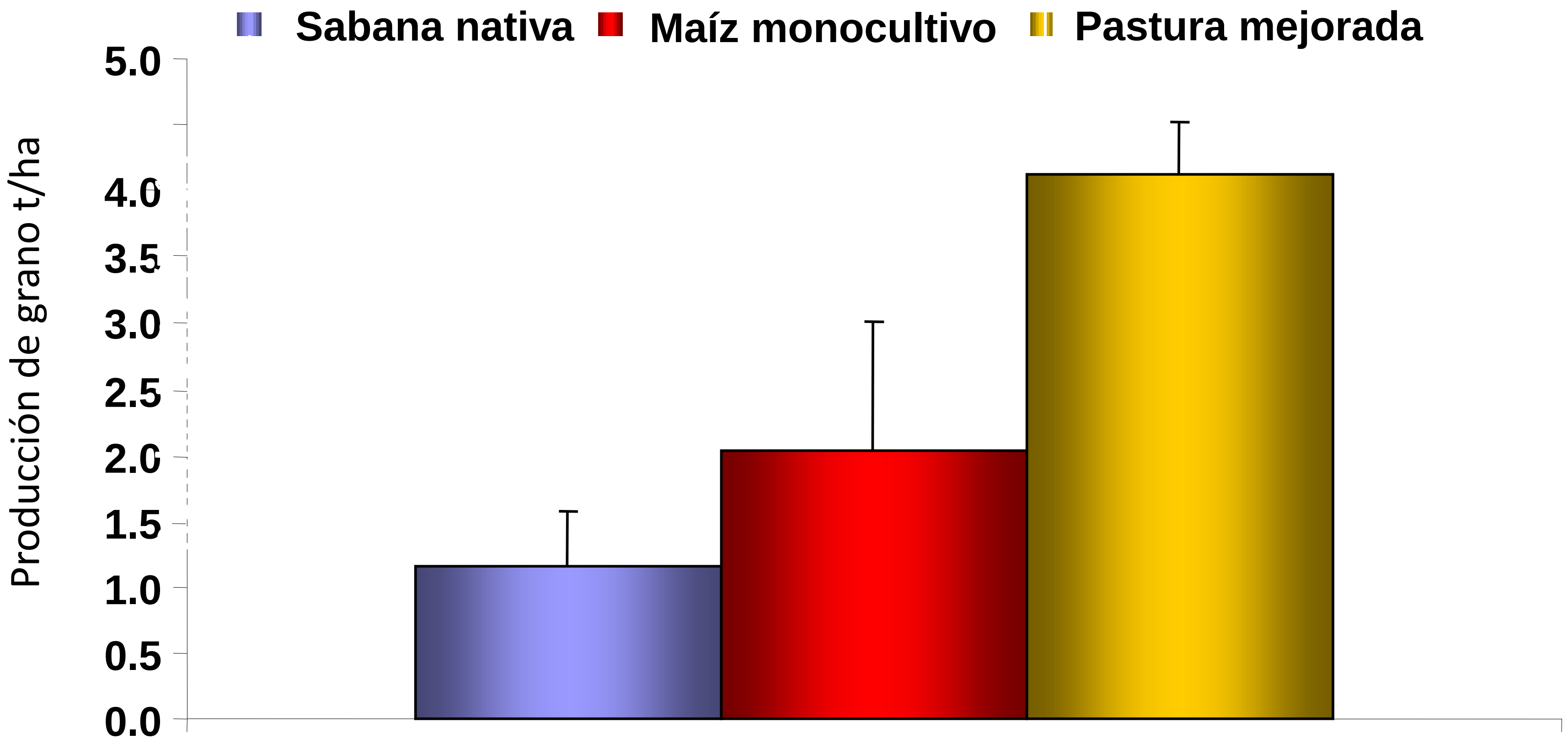
They combine high productivity, better quality, resistance to pests, tolerance to drought and adaptation to soil acidity (Miles, 2004)

Control **Líneas resistentes**

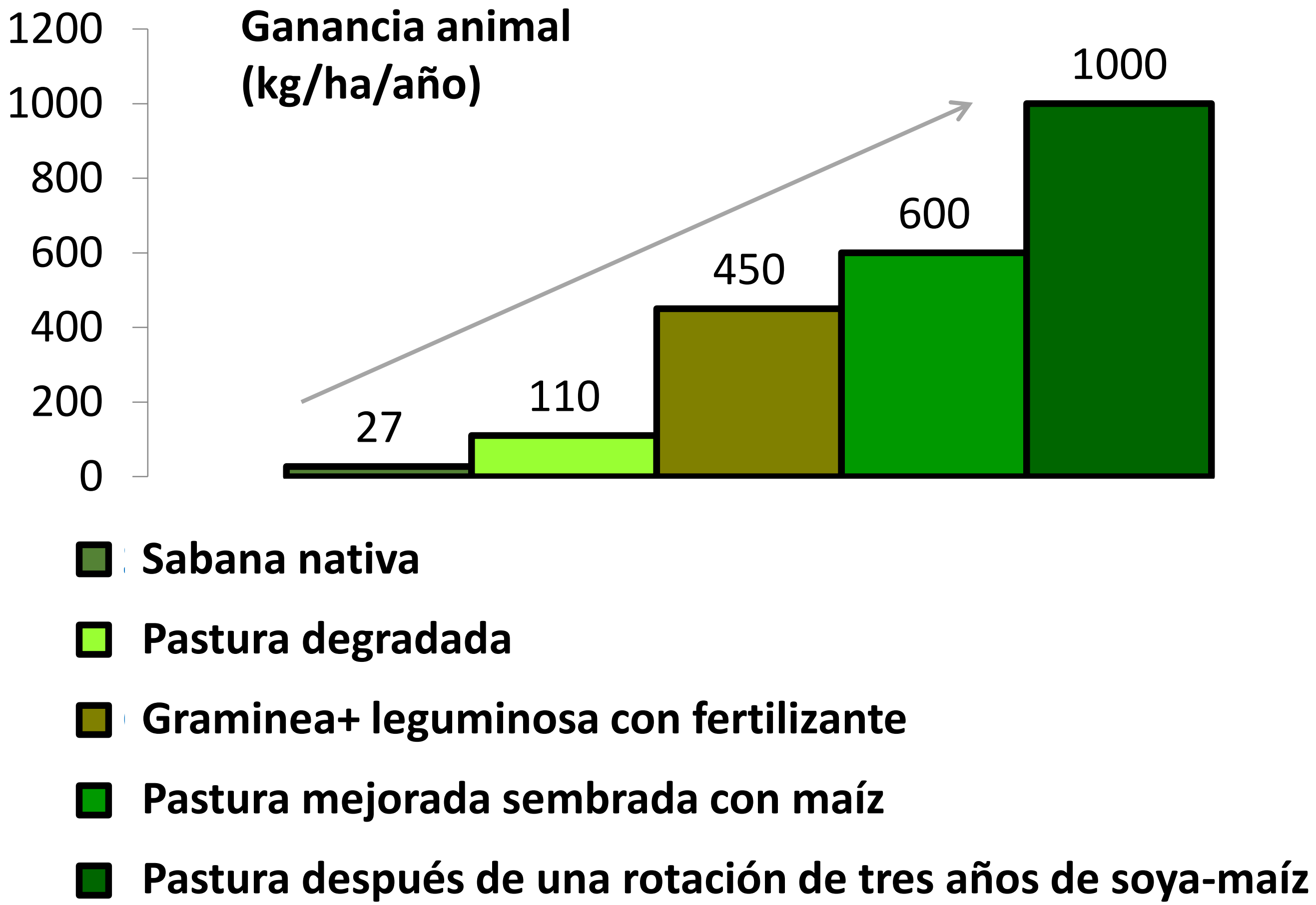
Brachiaria humidícola hybrids for floors with drainage poor and seasonal flooding in Oxisols and Ultisols (Ricci et al., 2011).

Integration of pastures with annual crops

Effect of improved pasture on the cultivation of corn in an oxisol of the eastern plains of Colombia



Effect of rotation with annual crops on animal production in acid soils of the eastern plains of Colombia



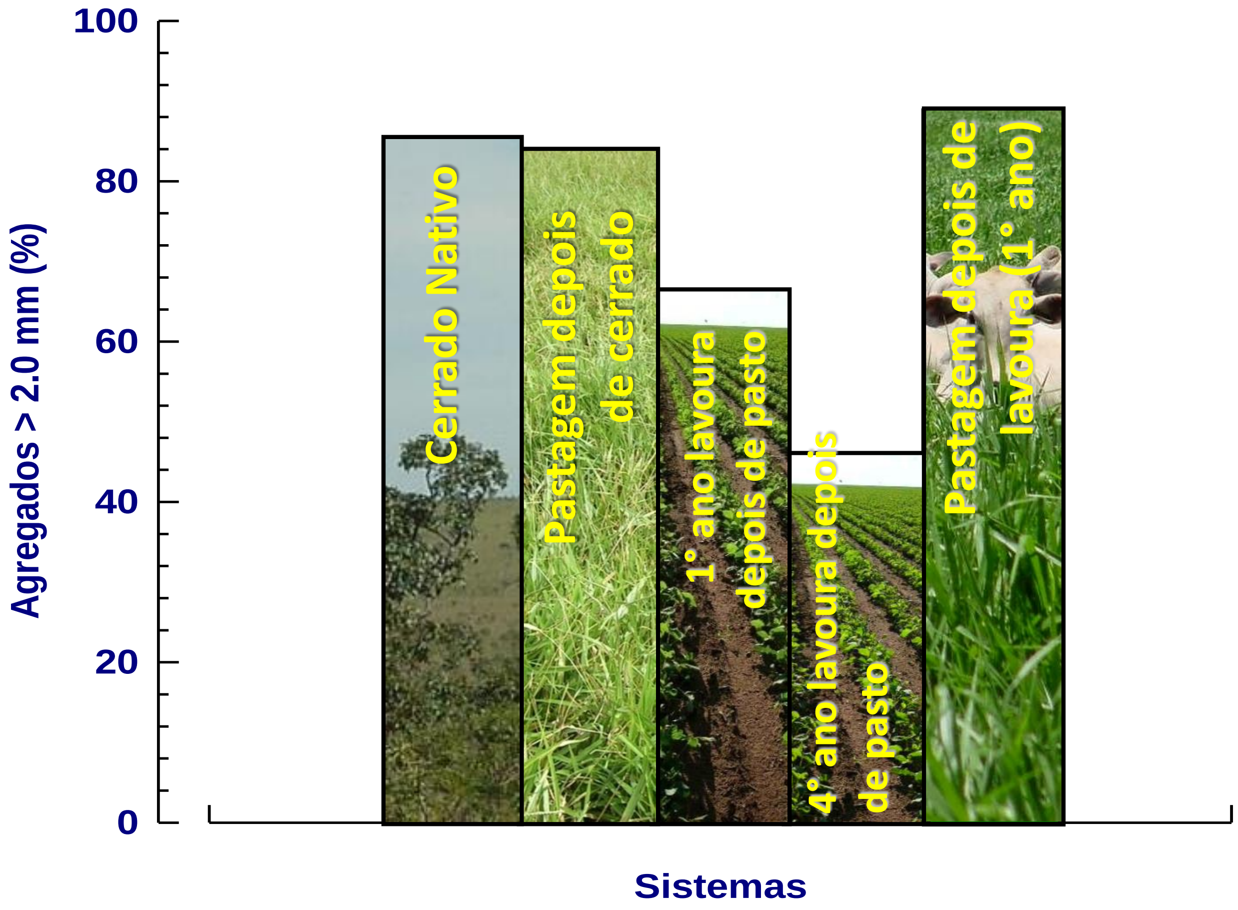
Fuente: Rincón, 2013

Efficiency in the use of phosphorus in a Cerrado floor

Fósforo aplicado	Fósforo recuperado	
	Anuais	Anuais e capim
(kg/ha de P_2O_5)	----------------- %	----------------
100	44	85
200	40	82
400	35	70
800	40	62

Fonte: Sousa et al. 1997

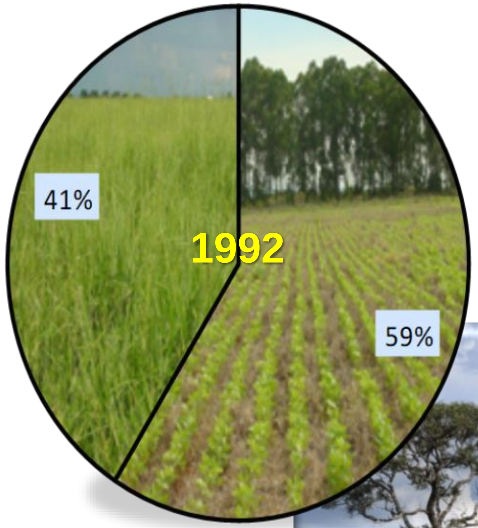
EFFECTS ON SOIL AGGREGATION

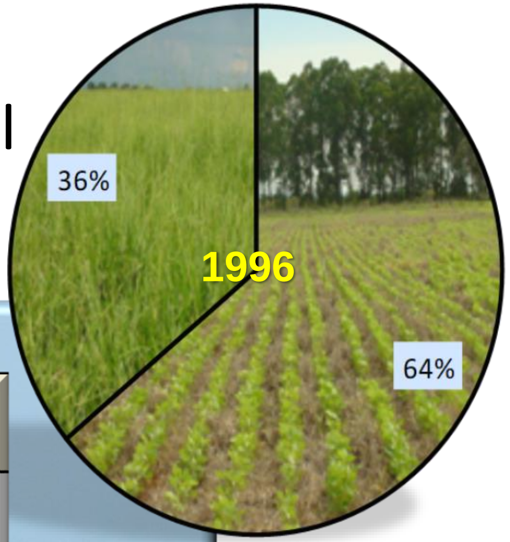


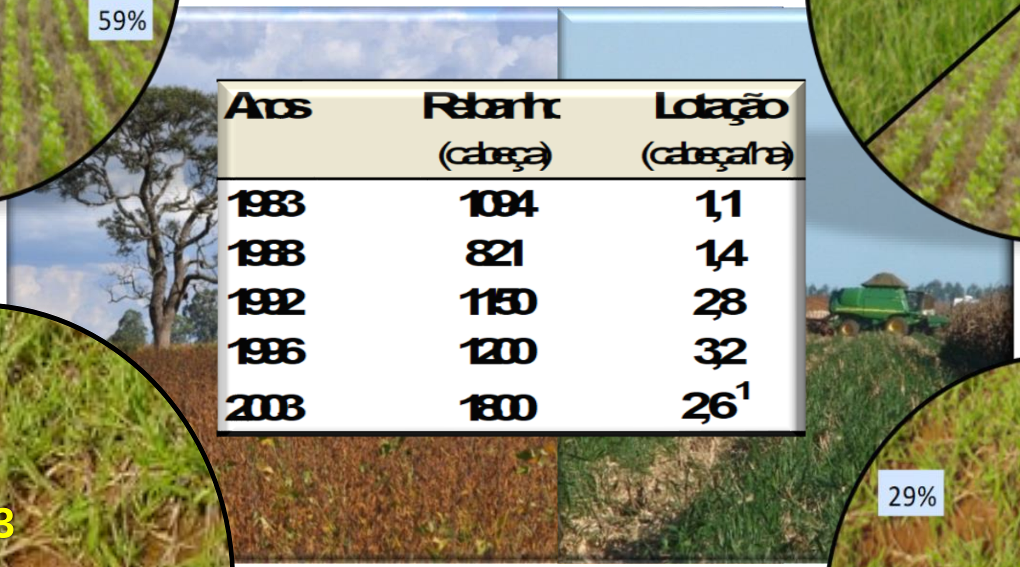
Ayarza et al. 1993

INTENSIFICATION AND DIVERSIFICATION OF THE SYSTEM

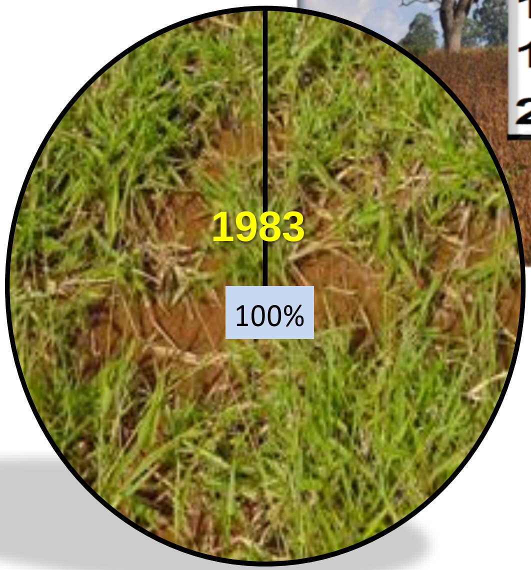
Sta Terezinha Farm,
Uberlândia, MG, Brasil

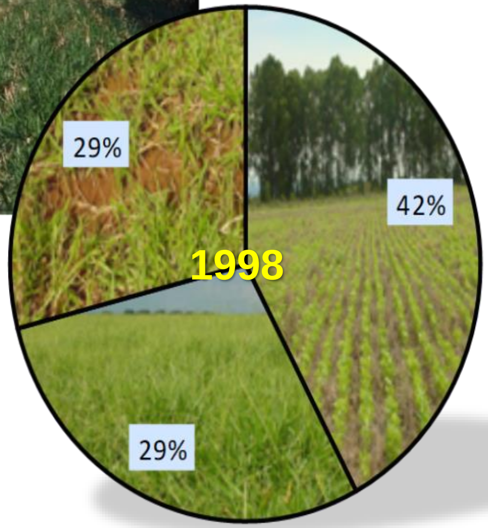






Anos	Rebanho (cabeça)	Lotação (cabeça/ha)
1983	1094	1,1
1988	821	1,4
1992	1150	2,8
1996	1200	3,2
2003	1800	2,6[1]





Ayarza y Vilela, 2005

Integration of pastures with trees in silvopastoral systems

Improves the recycling of nutrients

Competition for water, light and nutrients

Shade reduces forage yield
but it increases N levels in the tissue
of grasses (example Panicum).

The trees increase the M.O

Reduce soil losses due to erosion

Improve the biological activity of the soil

Agroecological intensification models

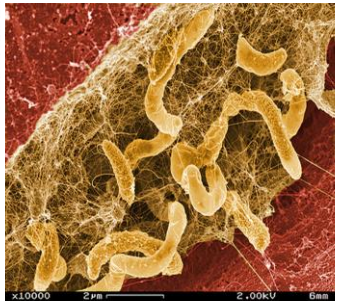
Increase in agricultural production through the use of ecological processes that contribute to preserve / improve the quality of natural resources and the safety of the products generated.

Sources of nutrients

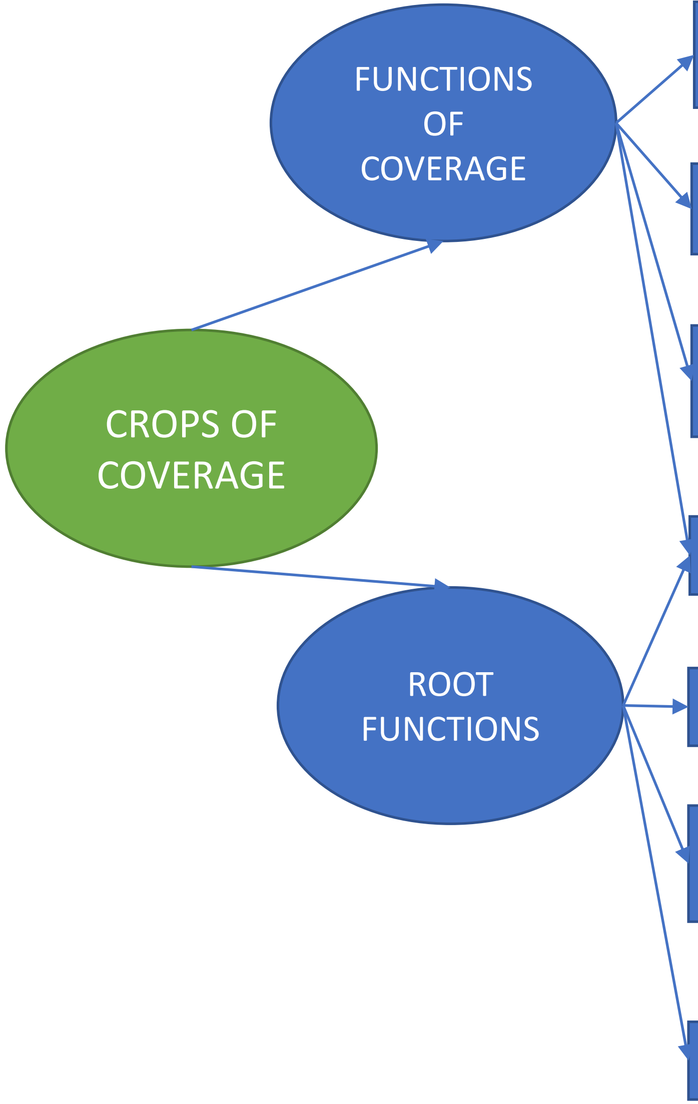
Green fertilizers

Organic wastes

Biofertilizers



Coverage functions



	DIRECT EFFECTS	INDIRECT EFFECTS
BIOMASS PRODUCTION	• Food (+), forage (+), fuel (+) • Soil fertility improver (+) • Protection to the ground	• Increase O.M. (+) • Carbon sequestration (+) • Production costs (+/-)
ACCUMULATION OF NUTRIENTS	• Nutrient supply	• Production of the crop (+) • Nutrient leaching (-) • Loss of nutrients (-)
SOIL COVERAGE	• Weed control (+) • Wind and water erosion (-) • Runoff (-) • Soil temperature (-) • Soil moisture (+)	• O.M. (+) • Efficient use of water (+) • Production of the crop (+) • Loss of sediment (-) • Nutrient leaching (-)
ECOLOGICAL FUNCTIONS	• Biodiversity (+) • Habitat (+) • Dispersion of pests (-)	• Beneficial microorganisms (+) • Pests (- / +) • Production of the crop (+/-)
SOIL AND NUTRIENT RETENTION	• Wind and water erosion (-) • Nutrient retention (+)	• O.M. (+) • Production of the crop (+) • Environmental impact (-)
RADICULAR GROWTH AND EXUDADS	• Water infiltration (+) • Water retention (+) • Soil compaction (-) • Runoff (-) • Availability of nutrients (+) • Weed control (	• O.M. (+) • Production of the crop (+) • Flood (-) • Aquifer recharge (+) • Environmental impact (-)
SYMBIOSIS	• Nitrogen fixation (+) • Association with Micorrizas (+)	• Imbalance of nutrients (-) • O.M. (+) • Production of the crop (+)

Fuente: Scholberg et al, 2010)

Effect of the integration of green fertilizers in dual purpose systems

Biomass of the incorporated legume and production of the indicator crop (maize)

(Castro et al, 2017)

treatment	Legume incorporated kg MS ha^{-1}	Corn fodder kg MS ha^{-1}
Removal 0%	3.742	12.601 a[1]
Removal 25%	3.386	11.676 a
Removal 50%	**1.704**	**11.283 a**
Removal 75%	1.051	8.908 b
Removal 100%	0	8.584 b
Average		10610

(P <0.05), according to Tukey's test.

The legume *C. brasiliencies* made a contribution of N equivalent to 75-100 Kg N / ha and improved the levels of organic C and NO3 in the soil

Effect of the use of animal waste

Composition of the manure of some animals (Bernal, 2003)

Species	Humidity	N (%)	P	K	S	Ca	Mg	F
	%		Kg/t					
Dairy cattle	79	5.1	0.9	4.5	0.5	2.5	1.0	0.03
Beef cattle	80	6.4	1.8	4.1	0.8	1.1	0.9	0.03
Pork	75	4.5	1.3	3.5	1.2	5.2	0.8	0.25
Horses	60	6.3	0.9	5.5	0.6	7.1	1.3	0.12
Sheep	65	12.7	1.9	9.1	0.8	5.3	1.7	0.15

Variable composition depending on the type of animal, manure management and subject to N losses

Advantages and disadvantages of animal waste (slurry)

Advantages

❖High availability in some regions.

❖Improves M.O, soil fertility and physical and biological properties.

❖Promotes the cycling of C and nutrients, especially N

Disadvantages

❖Problems of water pollution and water tables and GHG emissions

❖May cause nutritional imbalances in the forage and soil

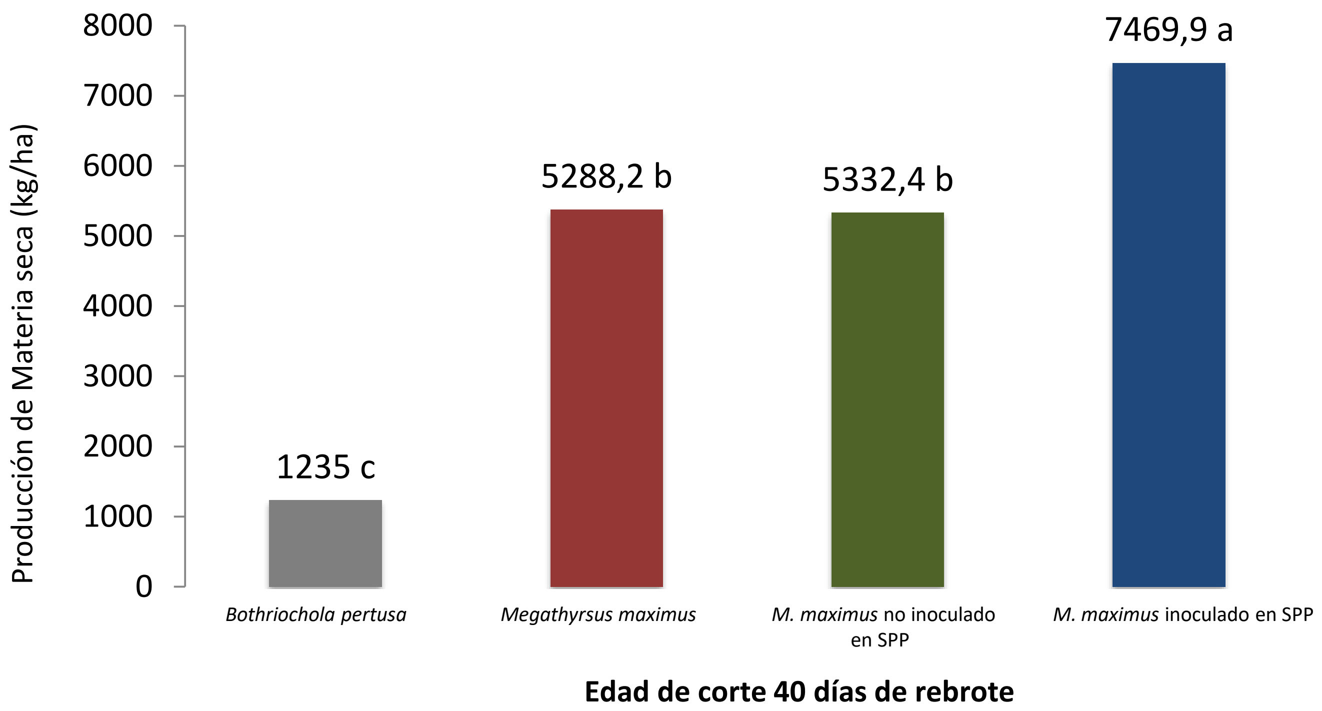
Use of biofertilizers or bio-inoculants

A BIOFERTILIZER IS A PREPARATION THAT CONTAINS LIVING OR LATENT CELLS FROM EFFICIENT STRAINS OF BACTERIA, FUNGI, ACTINOMYCETES AND ALGAE THAT ACCELERATE SOIL MICROBIAL PROCESSES BY IMPROVING THE ASSIMILATION OF NUTRIENTS BY PLANTS.

THE MOST COMMONLY USED MICROBIAL INOCULANTS IN THE COMPOSITIONS ARE BACTERIA OF THE GENERA BACILLUS, AZOTOBACTER, PSEUDOMONAS AND AZOSPIRILLUM; AS FOR THE ACTINOMYCETES STREPTOMYCES STAND OUT. AS REGARDS MUSHROOMS, THE MOST IMPORTANT ARE MYCORRHIZAE.

THE TENDENCY IS TO USE THEM TO COMPLEMENT / SUBSTITUTE THE USE OF INORGANIC FERTILIZERS

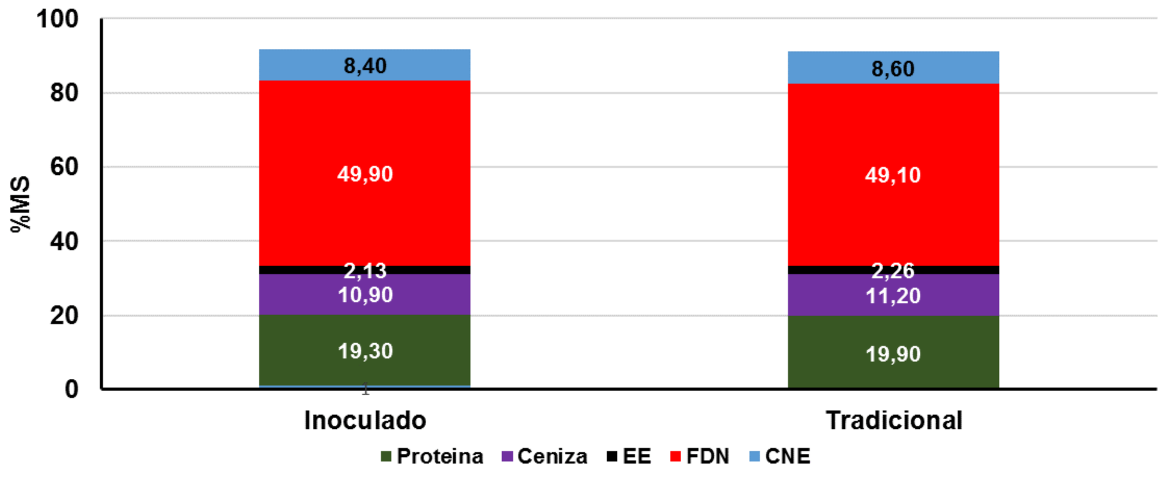
Effect of the application of *Azotobacter* in silvopastoral systems and gramineous monocultures in a region of the Colombian Caribbean



The use of biofertilizers allows to obtain higher quality and quantity of forage, applying 50% of the recommended dose of nitrogen.

Effect of the application of a P solubilizer

	Biomasa (Ton ha^{-1})	P (g kg^{-1})	K (g kg^{-1})	Ca (g kg^{-1})
Inoculado	25	4,1	35,6	5,4
Tradicional	21	4,2	35,2	5,6



The use of biofertilizers allows to obtain the same yields and quality of the meadow applying 50% of the recommended dose of phosphorus.

Gaps of knowledge and strengthening

1. Synergies and antagonisms in the use of water, light and nutrients between components of agrosilvopastoral systems.
2. Strategies to exploit and scale the role of microorganisms to complement / optimize the use of nutrients in livestock systems.
3. Optimize the efficient use of slurry nutrients and determine their residual effect on different types of soil and management systems.
4. Explore the role of microorganisms in the solubilization of nutrients and detoxification of organic waste.
5. Strengthen transdisciplinary research networks in soil fertility management in livestock systems.
6. Policies to support the incorporation of scientific knowledge in the generation of sustainable soil intensification policies

THANKS