CGIAR RESEARCH PROGRAM ON Livestock

Bottlenecks and socioeconomic opportunities in the integrated management of pastures

Tropical Pasture Workshop

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Context

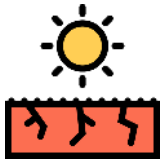
The **forage-based cattle sector plays a key role** in

FOOD
and nutrition security

POVERTY
Alleviation

But it is also associated with **causing negative environmental impacts**:

EMISSIONS
of greenhouse gases



LAND
degradation and deforestation

WATER
pollution and depletion

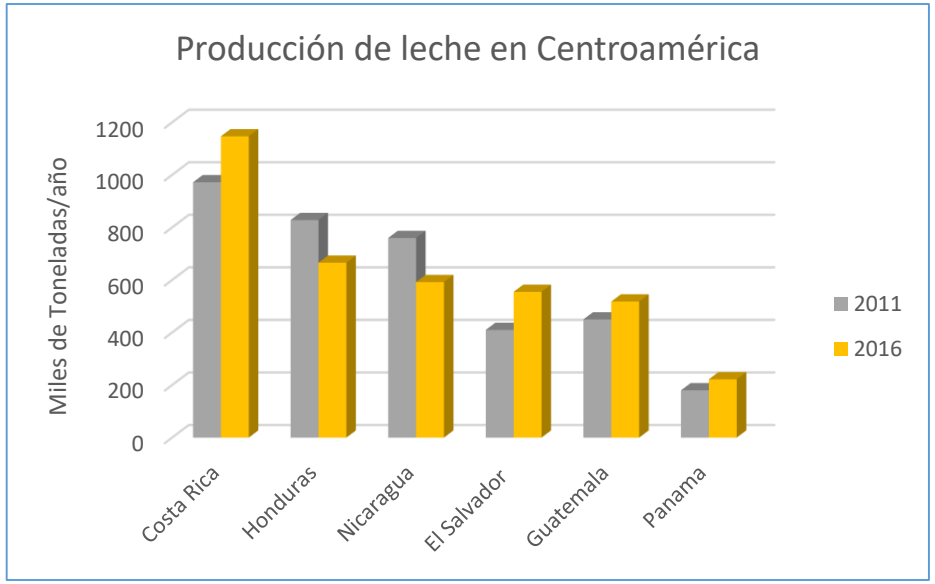
DEFORESTATION

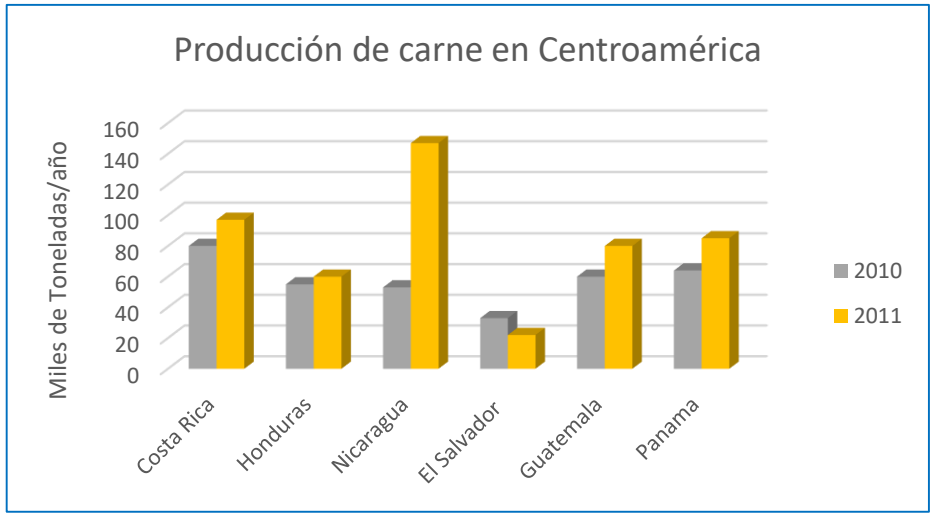
BIODIVERSITY
threatened

- ✓ **Improvements in animal feeding** and **sustainable intensification** are the most promising strategies for mitigating these impacts.
- ✓ The inclusion of **forage legumes in cattle production** systems has the potential to increase yield, efficiency and nutritional value of the forage, with less environmental impact.
- ✓ But **adoption and use by the producers remain limited** due to:
  - Economic factors
  - Lack of knowledge
  - Limited perceived benefits by the producer
  - Risk aversion and uncertainty.

Livestock in Central-America

- Main livelihoods component for hundreds of thousands of rural households
- > 20% of total area for livestock production
- 3.7 millions MT milk (2017), yearly increase 5%
- 492,000 MT meat (2011), 50% in Nicaragua (30%) and Costa Rica (20%)
- Represents 19% of agricultural GNP
- Average anual milk consumption 98 kg per capita (vs 130 and 250 in South and North America, respectively)

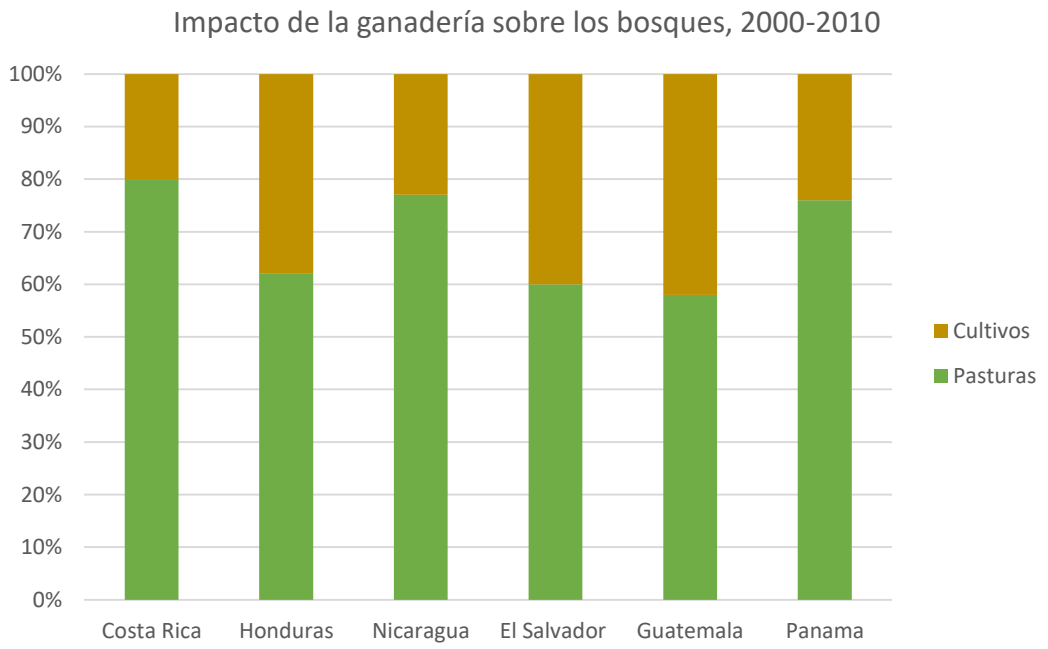




Adapted from: Acosta y Valdés, 2014, y FECALAC, 2018

Livestock in Central America

- Significant production increase last 10 years
- Rather based on increase in livestock numbers and pasture areas than on increase in productivity
- 70-80% of deforested areas for livestock (last 10 years)
- 86% of farms with livestock operated by a family and predominantly reliant on family labour
- Dual-purpose
  - Feeding based on forages
  - Extensive, low investment



Source: FAO/LEAD,2011, en Acosta et al,2014

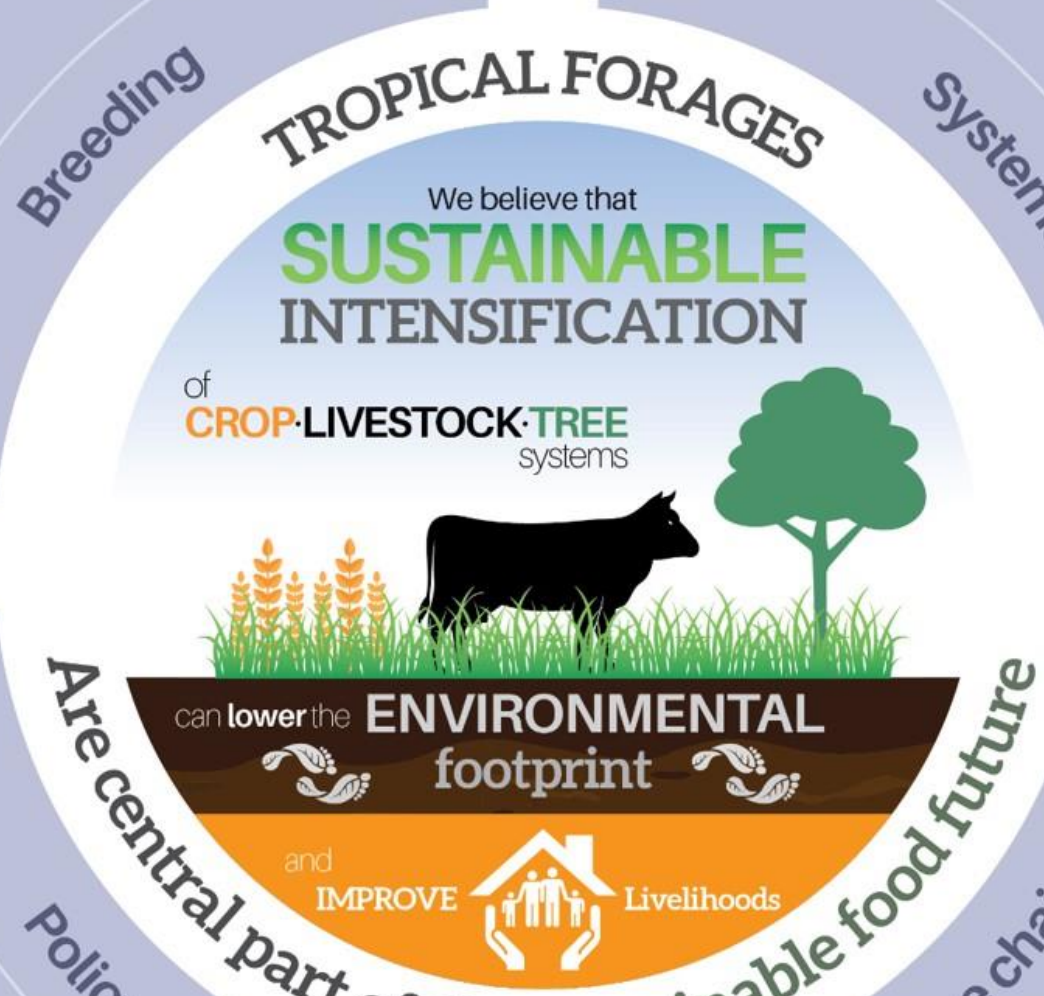
Bottlenecks

Limiting factors for innovations in pasture management

- Limited financial resources farmers
- Difficult access to credits
- Low investments farm level
- Low investment public sector in livestock research
- Limited farmer access to technologies
- Technology transfer lacks effectivity
- Lack of insight in farmers' socio-economic rationality

Farmers adopt improved forages options package - management practices and adequate germplasm – to improve productivity and lower environmental footprint.

Data, tools, approaches and recommendations on efficient and environmentally friendly resource management practices in mixed crop livestock systems.



Recommendations on sustainable intensifications of crop-livestock systems, environmental impacts of livestock production, and on diets: Policy analysis, technical evidence for policy formulation, modeling and foresight.

Innovations for efficient and sustainable value chains (germplasm, data on prices/ supply/ demands/ actors, value chain optimization, management practices, business models, extension approaches and financial mechanisms).

Socio-economic component Tropical Forages Program

To promote sustainable livestock production through socio-economic value chain research generating promotion and adoption strategies for forage-based technologies

- Gender
- Value chains
- Social network studies
- Adoption factors and strategies
- Economic evaluations
- Market studies
- Environmental knowledge studies
- Public policy analysis

LivestockPlus - the sustainable intensification of forage-based systems

Rao et al., 2015. DOI: 10.17138/TGFT(3)59-82

Three innovative/ intensification processes:

GENETIC
Improved yield, quality, stress resistance

ECOLOGICAL
Better management of mixed crop-forage-tree-livestock systems

SOCIOECONOMIC
Better management of mixed crop-forage-tree-livestock systems

Livelihood benefits:

FOOD
and nutrition security

MANURE
Organic fertilizers

ADAPTATION
to climate change

INCOME
Generation

POVERTY
Alleviation

Ecosystem services

- Resource use efficiency
- Restoration of degraded lands
- Reduced per unit animal GHGs
- Mitigation of climate change
- Biodiversity conservation
- Water flows and quality
- Reduced erosion & sedimentation
- Reduce pressure to the forest – Reduce deforestation

Cases

- Financial viability of the improved pastures *Brachiaria humidicola*, *Brachiaria decumbens* (with or without scattered trees) and production system with traditional pastures
- Ex-ante evaluation to compare the potential "yields" of R&D of *Brachiaria brizantha* 26124 and *Brachiaria decumbens / Brachiaria humidicola,* beef system in the Eastern Plains of Colombia
- Profitability of including *Leucaena diversifolia* in Valle de Cauca, Colombia, in comparison with a grass monoculture
- Comparison of intensification scenarios in Central Nicaragua, using CLEANED

Compare the financial viability of the improved pastures *Brachiaria humidicola*, *Brachiaria decumbens* (with or without scattered trees) and production system with traditional pastures

- Colombia, Eastern Plains
- Field measurements, expert consultations, secondary data, literature review
- Economic analysis:
  - Cash-flow model (10 year period), factors associated to benefits and costs
  - Simulation model (@Risk-Decision Tools Suite) to analyze risk factors
  - Estimation of profitability indicators : Net Present Value (NPV), Internal Rate of Return (IRR), Probability of NPV<0

	Improved Pasture[1]	Scattered Trees + Improved Pastures[2]	Native Pasture[3]
Productive parameters ha^{-1} year^{-1}			
Animal stocking rate (AU/ha)	2	2	0.27
Live-weight gain (g/animal/day)	130-445	310-486	77-258
Animal productivity (Kg/ha/year)	294-402	352-480	18-37
Investment and management costs[4]			
Initial investment (US$/ha^{-1}) [5]	1,090	1,187	0
Management costs (US$/ha^{-1} year^{-1}) [6]	179	231	12.7

[1]Species *Brachiaria humidicola, Brachiaria decumbens*; [2]Improved pastures such as *Brachiaria humidicola, Brachiaria decumbens* associated with shadow trees; [3]Native Savanna species such as *Axonopus Purpussi*; [4]Representative Market Exchange Rate for 2016; [5]Pasture establishment and fencing costs (inputs, machinery, labor); [6] Costs for fertilization, weed control, pruning and trimming, fence maintenance and controlled burning (only for native pasture)

	Scenarios	NPV[4]	IRR	Probabiltiy(NPV<0)
Improved Pastures	N[1]	$ 49.78	18%	48,60%
	O[2]	$ 290.3	32%	10,14%
	P[3]	$ 40.1	18%	50,77%
Scattered Trees + Improved Pastures	N[1]	$ -120.6	13%	97,60%
	O[2]	$ 25.17	17%	65,63%
	P[3]	$ -258.86	9%	100,00%
Native Pastures		$ 18.19	--	11,23%

[1]Normal Scenario: A reduction of pasture cover of 45% in the fifth year was assumed; [2]Optimistic Scenario: A reduction of pasture cover of 30% in the fifth year was assumed; [3]Pessimistic Scenario: A reduction of pasture cover of 70% in the fifth year was assumed; [4]Real Discount Rate = 16%

- Results/conclusions
  - Improved pastures increase animal stocking rate by **86%,** animal productivity by **42%**
  - Inclusion of scattered trees increases animal productivity by 15-20%, but not profitable due to high initial investments when only animal productivity is taken into account
  - Profitably highly sensitive to meat prices
  - Need for strategies and / or incentives to reduce the high initial costs of including trees

Ex-ante evaluation to compare the potential "yields" of R&D of *Brachiaria brizantha* 26124 and *Brachiaria decumbens / Brachiaria humidicola,* beef system in the Eastern Plains of Colombia

- *B. brizantha* 26124 increases animal productivity between +15% and +31%
- Adoption allows for:
  - yearly increases of 39% in gross income and 225% in net income,
  - reduction of the risk of economic loss by 80%
- Animal productivity below 280 kg/ha/yr results in negative performance indicators for *B. brizantha* 26124
- Profitability indicators are highly sensitive to meat sales price variations
- The potential success depends mainly on productivity and adoption rate
- Adequate accompanying mechanisms (sound extension strategies and training programs) and seed system essential during the release process

Profitability of including *Leucaena diversifolia*, in comparison with a grass monoculture

Data source: Monthly field measurements in Palmira, Valle del Cauca, Colombia, between August 2014 and August 2015.

Evaluated diets:

T1) *Brachiaria* hybrid cv. CIAT BR 02/1752 (Cayman) monoculture (100%)

T2) Cayman-*L. diversifolia* association in a proportion of 70:30% (2,000 *Leucaena diversifolia* plants/ha)

Animal response data of T1 and T2

Variable	T1		T2	
	(Mean ± SD)	CV (%)	(Mean ± SD)	CV (%)
Carrying capacity (LSU/ha)	3.36		4.04	
Weight gain (g/animal/d)	440 ± 41	9.3	657 ± 73	11.2
Animal productivity (kg/ha/y)	723 ± 68*		1078 ± 120*	
Time to reach sales weight (months)[1]	18		12	

LSU: 450 kg/animal SD: standard deviation.

*Statistically different P<0.01

[1]Period of time required to bring a calf with an average weight of 200 kg to a sales weight of 450 kg

Economic, risk and sensitivity analyses

- Cash flow model for the estimation of financial profitability indicators
- Quantitative risk analysis (Monte Carlo simulation)
- Three pasture persistence scenarios and the following variables were randomly combined:
  - ✓ Live weight gain per animal and year
  - ✓ Investment costs
  - ✓ Maintenance costs
  - ✓ Sales price per kg of live weight
  - ✓ Purchase price per kg of live weight.
- Sensitivity and scenario analyses
- Variables that define profitability : PV, IRR, Benefit/Cost ratio, Payback period “recuperación”

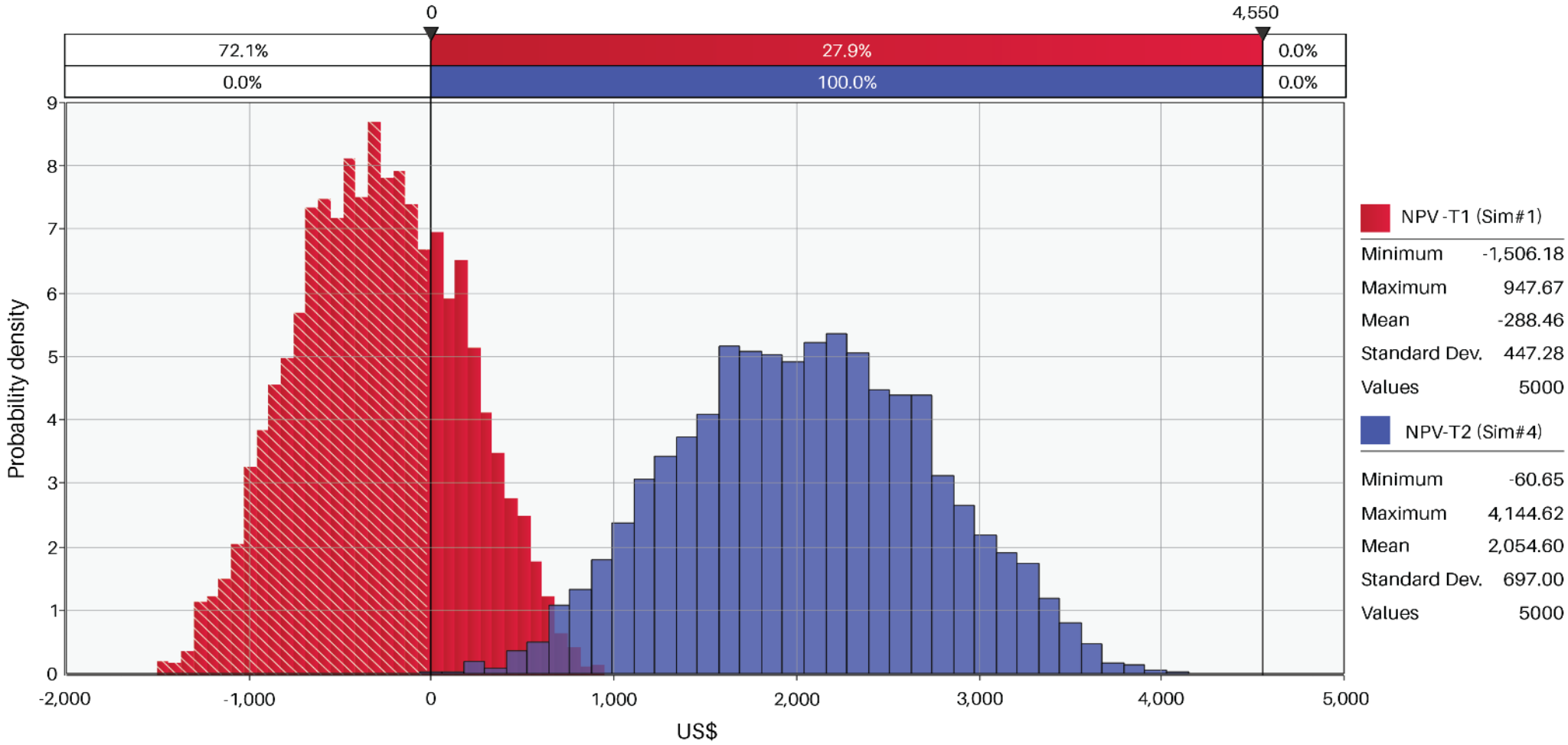


Figure 1: Probability and accumulative density distributions for the NPV for T1 and T2.

For T1, the indicator can have negative values with a probability of 72%. For T2, including the legume reduces the risk of loss to 0.

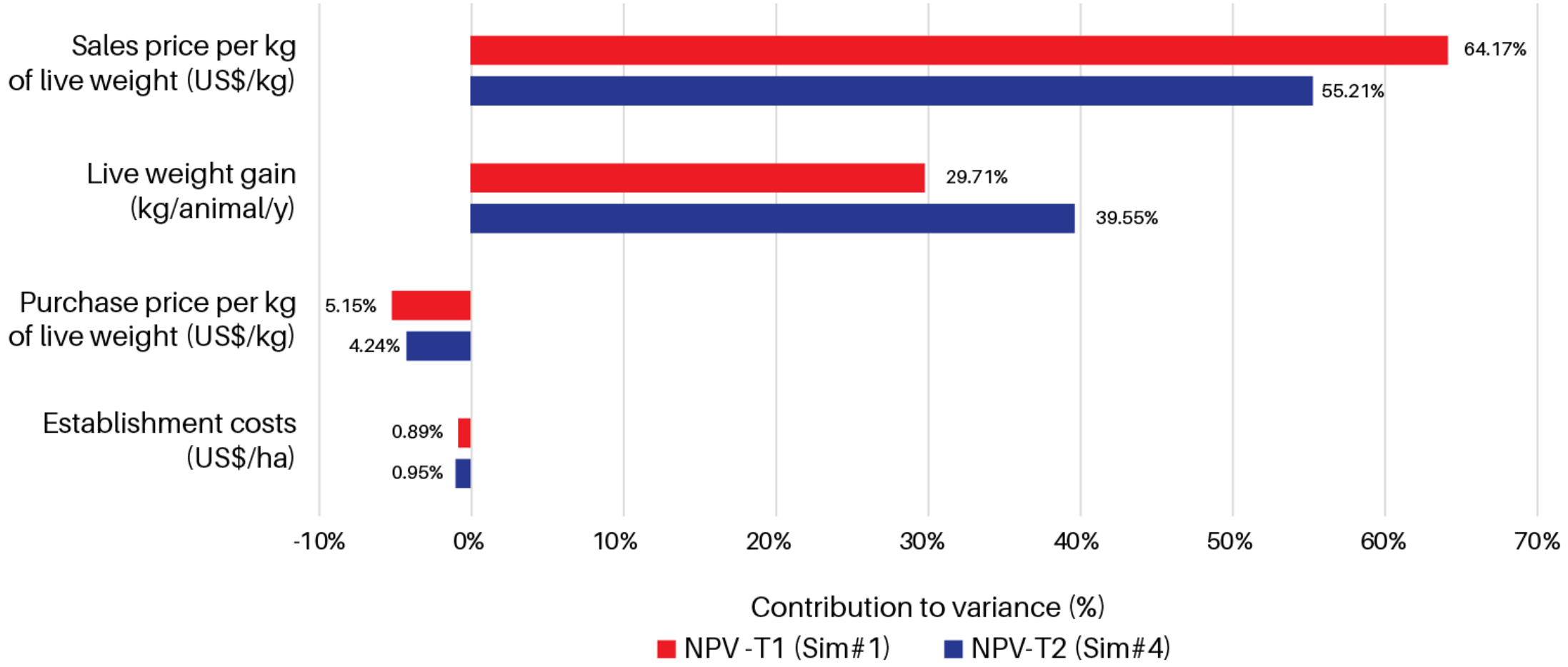


Figure 2. Multiple tornado graph displaying the contributions of random input variables to the variance of the NPV for T1 and T2.

Projection of the area needed to produce 800kg/year

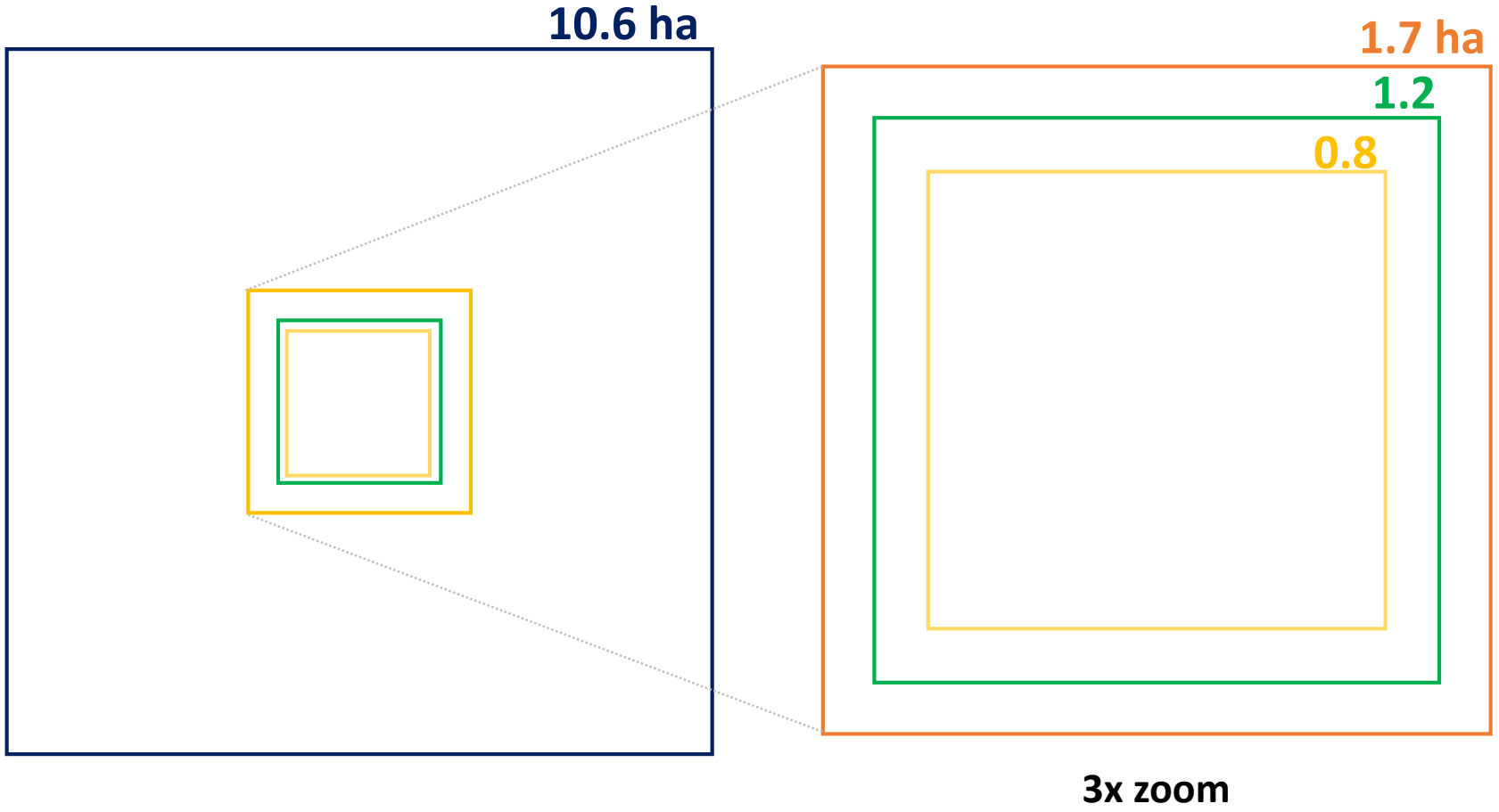
Based on actual stocking rates and live weight gains

Treatment 1
Native pasture

Treatment 2
Brachiaria hybrid cv. Cayman

Treatment 3
Cayman+*Canavalia*

Treatment 4
Cayman+*Canavalia* +*Leucaena*



Conclusions

- *L. diversifolia* in association with Brachiaria hybrid cv. CIAT BR 02/1752 (Cayman) has significant potential to **increase animal productivity and profitability**, under different productivity and market scenarios.
- Profitability mainly affected by animal productivity and meat price.
- Inclusion of *L. diversifolia* reduces **the risk of economic loss**
- Grass-legume associations to be accompanied by **specific training and extension programs to reduce uncertainties** and increase adoption rates
- A**ccess to financial resources** (e.g. credits) to be improved to provide conditions for technology adoption

CLEANED tool: ex-ante environmental impact assessment – livestock systems

- Models (MS-Excel, R) – jointly developed by ILRI and CIAT
- Productivity, **Profitability**, GHG emissions, Carbon accumulation, Water use, Soil erosion, Nitrogen balances
- Scenarios (farm level)
- Data poor
- Workshops with stakeholders for feedback

	nr	milkprod, growth (kg/yr)	exit		Time spent in stable (fraction of day)	Time spent in kraal (fraction of day)	Time spent grazing pasture/fields **on-farm** (fraction of day)	Time spent grazing **off-farm** (fraction of day)		Collection of manure in stable (fraction)	Collection of manure in yard (fraction)	collection of manure in fields/pasture (fraction)		On-farm manure used as fertilizer (fraction of total on-farm manure collecte
Dairy cows - local	0	500.00			0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Dairy cows - improved	15	0.00			0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Adult cattle - male	1	0.00			0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Steers/heifers	0	110.00	0		0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Calves	0	140.00			0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Steers/heifers improved	10	200.00	5		0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Calves improved	13	240.00			0.00	0.65	0.35	0.00		0.00	0.25	0.00		0.90
Sheep	0				0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.90
Goats	0				0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.90
Pigs	0				0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.90
Poultry	0				0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.90
Donkeys/horses	0				0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.90

		Dairy cows local	Dairy cows improved	Bulls/Oxen	Steers/Hei local	Calves local	Steers/Hei improved	Calves improved	Sheep	Goats	Pigs	Poultry	Donk/Hor
Brachiaria brizantha (forage)	WS	70.00%	70.00%	70.00%	70.00%	70.00%	70.00%	70.00%					
	DS	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%					
Hyparrhenia rufa (forage)	WS	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%					
	DS	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%					
Maize (Zea mays) - stover	WS	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
	DS	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%					
Napier grass (Pennisetum purpureum) - forage	WS	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
	DS	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%					
Sorghum (Sorghum bicolor) - forage	WS	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
	DS	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%					

“Sustainable intensification scenarios”

- Improved pastures (e.g., Brachiaria)
- Tree component (legumes)
- Animal genetics
- 200% increase milk production (500 - 1500 kg/year)
- 75-100% increase meat production (LWG, quality - % carcass weight)

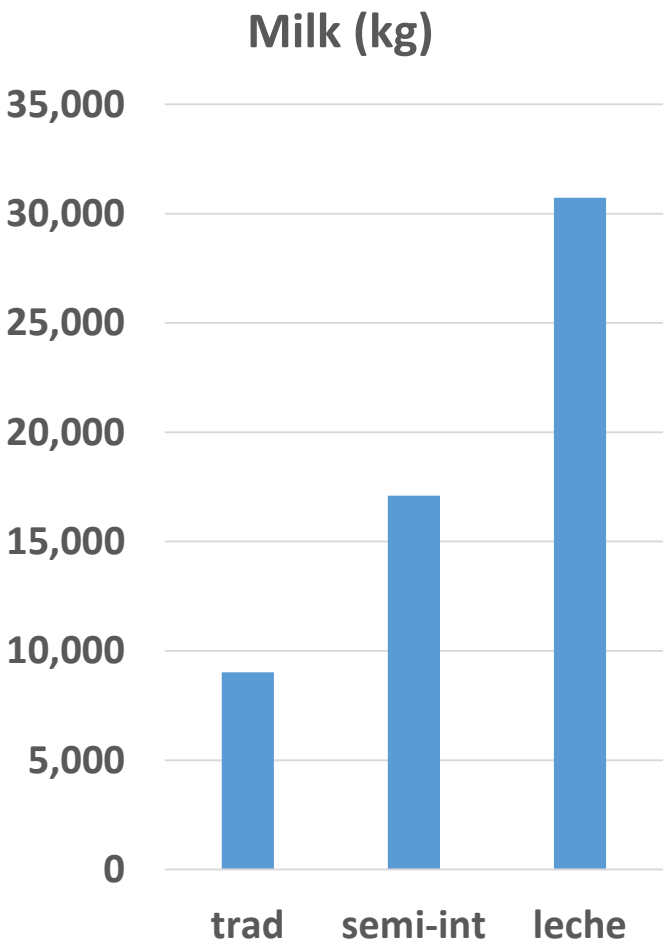
Intervention scenarios

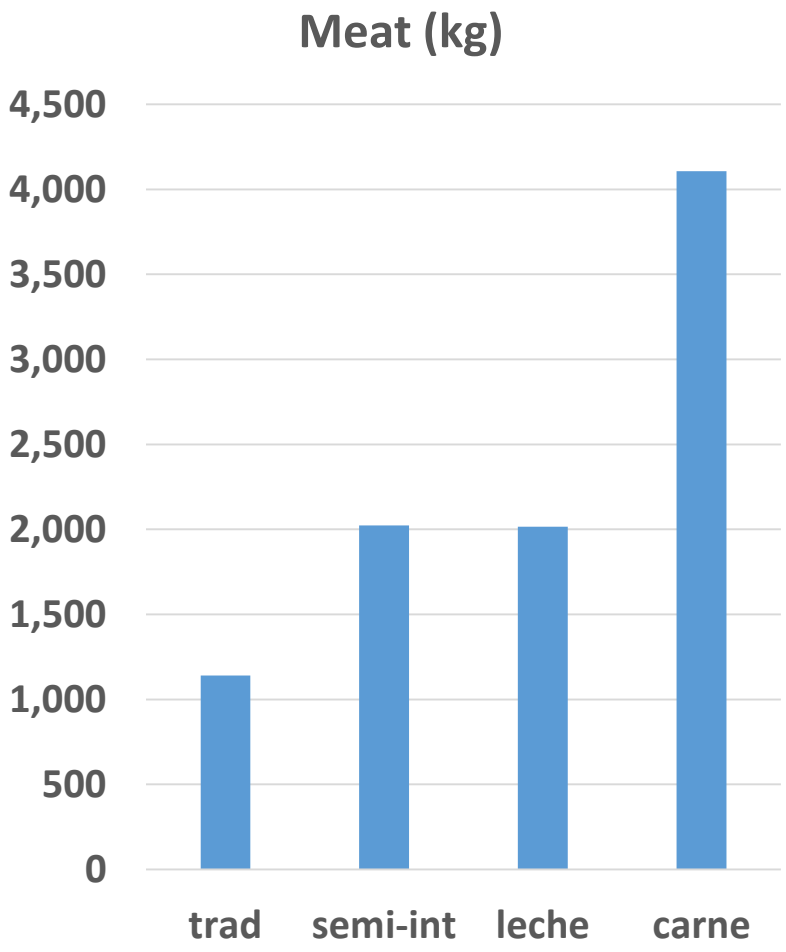
Herd composition and production level								
	Traditional		Semi-intensive		Milk		Meat	
Category	N	Milk/LWG kg/anim/yr	N	Leche/GdP kg/anim/día	N	Leche/GdP kg/anim/día	N	Leche/GdP kg/anim/día
Local cows	15	500	8	500	-	700	-	
Local steers/heifers	8	110	5	110	-	110	-	
Local calves	10	140	6	140	-	140	-	
Improved cows	-	-	8	1500	20	1500	20	-
Improved steers/heifers	-	-	6	160	15	110	15	200
Improved calves	-	-	7	190	17	140	17	240
Adult male cattle	1		1		-		-	

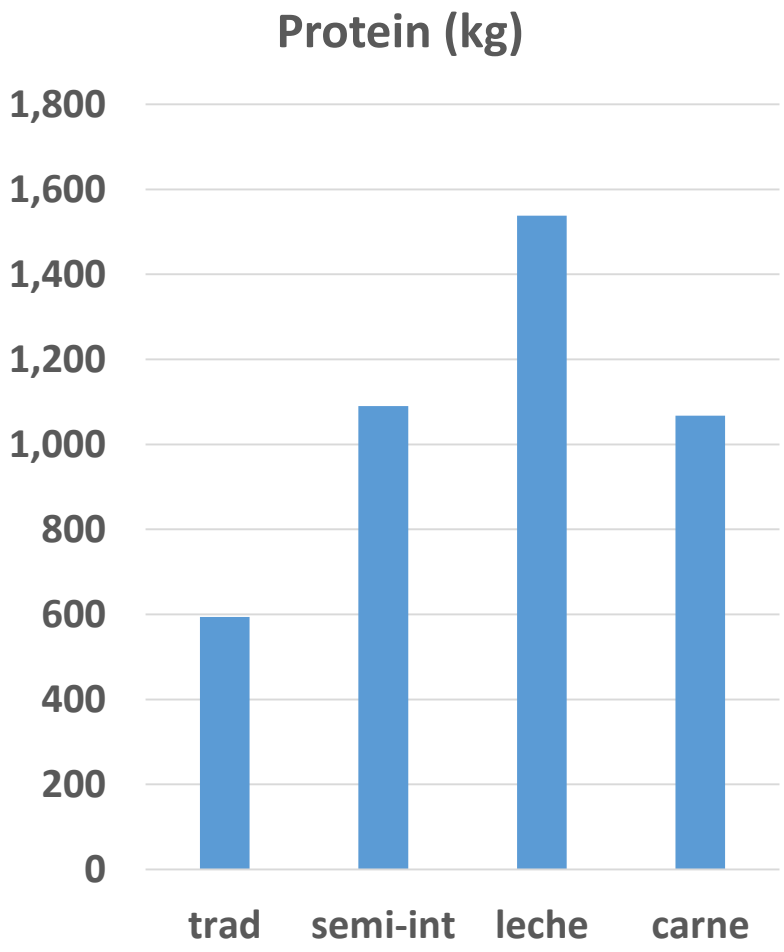
Intervention scenarios

Diet								
	Traditional		Semi-intensive		Milk		Meat	
	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season
Traditional pasture (*H. rufa*)	100%	40%	45%	15%				
Improved pasture (*Brachiaria*)			45%	25%	80%	35%	80%	35%
Crop residues (maize)		15%		5%		5%		5%
Cut-and-carry grass (*Pennisetum* spp)		35%		35%		30%		30%
Sorghum		5%						
Molasses		5%		5%		5%		5%
Tree legume (*Gliricidia sepium*)			10%	15%	20%	25%	20%	25%

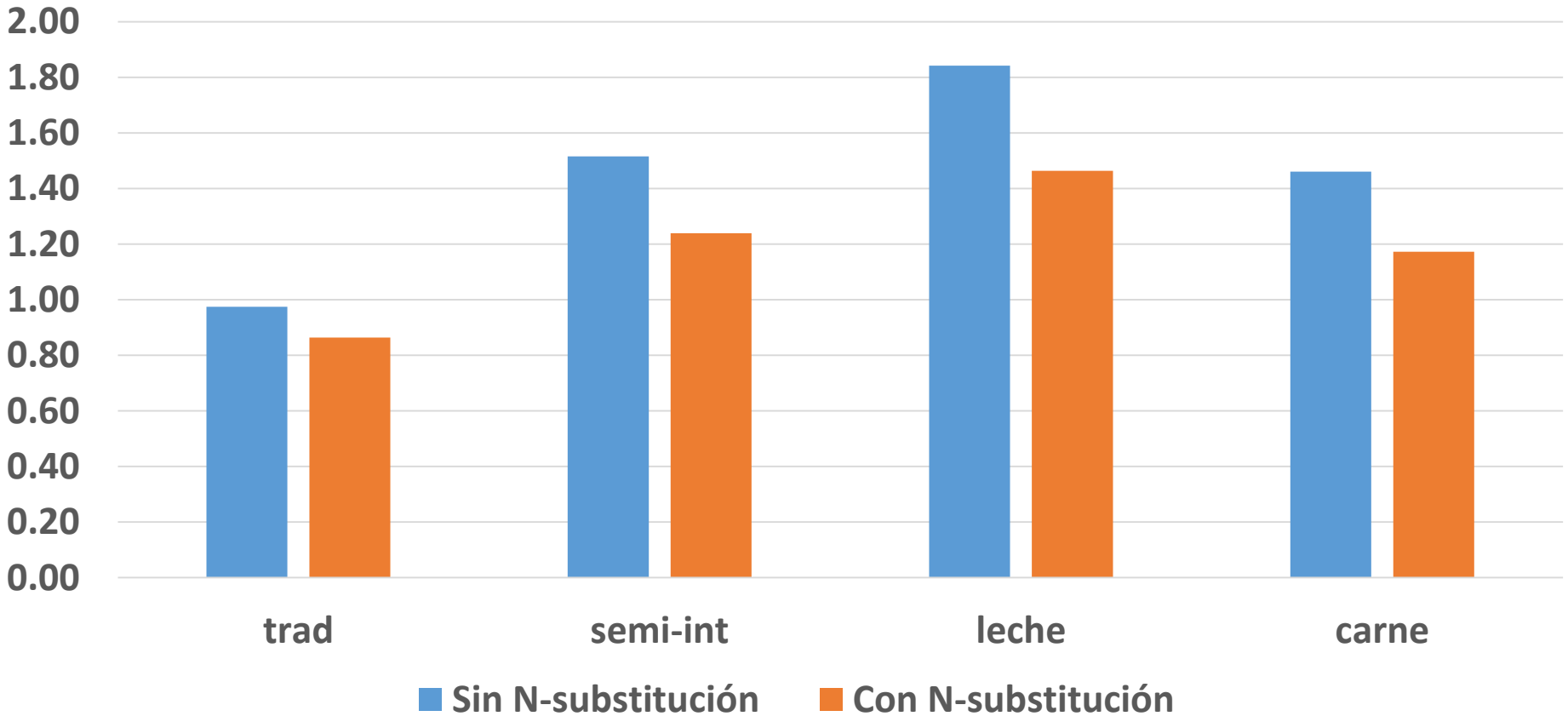
Productivity







Benefit-Cost ratio
(cash-flow, investments not taken into account)



Productividad y Rentabilidad
including investments compared to traditional scenario

	Traditional (baseline)	Semi-intensive	Milk	Meat
Total value of production (USD/year)	6,218	11,301	16,348	12,435
Total value of production (USD/year/ha)	307	667	967	751
NPV (USD) 10 years		43,283	67,220	-53,573
Payback period (years)		3.76	4.63	>10

General conclusions

- Integrated pasture management shows potential to improve productivity, profitability, and reduce environmental and climate impacts

- Proven innovations (“proof of concept”) do not reach end-users (farmers)

- More emphasis needed on economic analysis of different options to back technology transfer

Thank you!

Acknowledgements

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RESEARCH PROGRAM ON Livestock

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