Ex-ante evaluation of the economic impact of adopting improved forages in the Colombian Eastern Plains

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Introduction

» Forage-based cattle systems play a key role in rural economies of developing countries in terms of food security and poverty alleviation.

» However, they are often related to being a major cause of negative environmental impacts by contributing to increased greenhouse gas (GHG) emissions, land degradation, and reduction of biodiversity.

» Large amounts of resources have been allocated to research and development (R&D) for forage material improvement and a broad range of improved materials were released showing superior characteristics in terms of productivity and environmental impacts.

» However, data are still scarce on both the economic and environmental "yields" of these investments.

Objective

Through an ex-ante evaluation, this study aims at estimating the potential "yields" of the investment in R&D of the improved forage variety *Brachiaria brizantha* 26124 in the Eastern Plains region of Colombia.

Methodology

Figure 1: Eastern Plains of Colombia.

Location: Eastern Plains of Colombia.

Technology to be evaluated: *B. brizantha* 26124. Identified as promising material given its adaptation to acid soils, high forage production and high palatability. This technology was compared to a base scenario with *Brachiaria decumbens* and *Brachiaria humidicola* in a bovine meat production system.

Data sources: Field measurements; expert consultations; secondary data and literature review

The analysis used two evaluation methodologies:

1. To determine the impact on a productive unit

A discounted free cash flow model and a Monte Carlo simulation were carried out with the simulation software @Risk.

- 5.000 simulations and confidence level 95%
- Random variables: live weight gain per animal and year, investment costs, maintenance costs, purchase price per kg of live weight, and sales price per kg of live weight.

2. To determine the potential social benefits of the evaluated technology and their distribution among producers and consumers

An economic surplus model was developed and a sensitivity analysis was carried out, considering changes in adoption rates and productivity levels.

- *B. brizantha* 26124 allows changes per hectare in animal productivity between +15% and +31% compared to the base scenario (live weight gains per animal: 332 kg/ha/y versus 274 kg/ha/y).
- The maximum expected adoption rate for the base scenario was **2.22%** at regional and **2.8%** at national level.
- Elasticity of supply and demand: **0.7** and **1.17**, respectively.
- Estimated R&D costs: **US$ 412,409.**
- Discount rate: **12%.**
- R&D period: **2011–2015**, as part of a project financed by the Colombian Ministry of Agriculture and Rural Development (MADR) and executed by AGROSAVIA and CIAT (see acknowledgements).
- Year of variety release: **2019.**

Results

1. Private investor economic evaluation

Compared to the base scenario, the adoption of the variety allows for:

- Avg. yearly increases of 39% in gross income and 225% in net income.
- Reducing the risk of economic loss by 80%

Table 1: Performance indicators of the economic evaluation

Decision criteria	Indicator	*B. brizantha* 26124	Base scenario
NPV	Mean[1]	US$334	(US$231)
	SD[2]	US194	US$140
	CI (95%)[3]	(US$192)–US$859	(US$231)–US$153
	Prob. NPV<0[4]	10.61%	54.7%
IRR	Mean	23%	15%
	CI (95%)	12%–30%	5%–24%
Cost/Benefit ratio[5]	Mean	1.07	0.95
	CI (95%)	0.96–1.16	0.87–1.03

[1]Mean value of the NPV obtained through the simulation (5,000 repetitions); [2]Standard Deviation with regard to the NPV mean value; [3]Minimum and maximum values for a confidence interval of 95%; [4]Probability of the NPV being below 0 (with regard to the NPV mean value); [5]Quotient between the benefits and discounted costs.

- At the individual investment level of the primary producer and under specific management assumptions in terms of rotation and fertilization, the adoption of *B. brizantha* 26124 would have positive impacts on the profitability indicators and risk levels.
- An animal productivity below 280 kg/ha/y results in negative performance indicators for *B. brizantha* 26124.
- Profitability indicators are highly sensitive to meat sales price variations.

2. Economic surplus model

Table 2: Results of the economic surplus model (US$ in thousands)

Indicator	Regional level	National level
Base scenario[1]		
NPV	2,319	15,694
IRR	26%	39%
Optimistic scenario[2]		
NPV	6,986	42,775
IRR	33%	48%
Pessimistic scenario[3]		
NPV	521	3,196
IRR	18%	28%

[1]A maximum adoption rate of 2.22% at regional and 2.8% at national level is assumed and at both levels a probability of success of 80% and an increase in productivity of 21%; [2]A maximum adoption rate of 3.3 % at regional and 4.2% at national level is assumed and at both levels a probability of success of 100% and an increase in productivity of 31%; [3]A maximum adoption rate of 1.1% at regional and 1.4% at national level is assumed and at both levels a probability of success of 50% and an increase in productivity of 15%.

- Composition of the total surplus: 63% producer and 37% consumer

Figure 2: Heat map for the sensitivity the IRR (total surplus basis) with respect to changes in the adoption rate and productivity level.

Change in productivity	Adoption rate (Regional level) 0	1%	2%	3%	4%	5%	Adoption rate (National level) 1%	2%	3%	4%	5%
	10%	0.15	0.19	0.22	0.23	0.25	0.25	0.29	0.32	0.34	0.36
	15%	0.18	0.22	0.24	0.26	0.27	0.27	0.32	0.35	0.37	0.39
	20%	0.19	0.23	0.26	0.28	0.29	0.29	0.34	0.37	0.39	0.41
	25%	0.21	0.25	0.27	0.29	0.31	0.31	0.36	0.39	0.41	0.43
	30%	0.22	0.26	0.29	0.31	0.32	0.32	0.37	0.40	0.43	0.45

- Increases of 1% in the max. adoption rate and 5% in productivity with respect to the baseline scenario, result in increases of the profitability indicators of more than 10% and 8%, respectively.

Conclusions

» *B. brizantha* 26124 proved to be an alternative to improve production efficiency and profitability of livestock farms.

» From a social point of view, it was found that if adopted, the increase in productivity of *B. brizantha* 26124 could generate a displacement in the meat supply, which would be associated with important economic benefits at the regional and national levels.

» The potential success of the technology depends mainly on productivity and adoption rate. It is therefore key to develop an adequate accompanying mechanism during the release process, in order to provide cattle producers with sound extension strategies and training programs that focus e.g. on pasture sowing and maintenance. It is also key that adequate dissemination mechanisms are being established through a well-functioning seed system.

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