

Profitability analysis of a silvo-pastoral system in Colombia: Economic and environmental benefits

Danny Fernando Sandoval; Jesús Fernando Flórez Herrera; Karen Johanna Enciso Valencia; Mauricio Sotelo; Stefan Burkart.
Centro Internacional de Agricultura Tropical (CIAT), Programa de Forrajes Tropicales, Cali, Colombia
Contact: s.burkart@cgiar.org

About our study

Motivation: Beef, dairy, and dual-purpose systems have considerable environmental impacts, such as deforestation and methane (CH₄) emissions by ruminants. To counteract this, technological innovations must focus on economic and environmental sustainability.

Silvo-pastoral systems (SPS) are a valuable option since they offer economic benefits while providing ecosystem services, e.g., CH₄ emission reductions, microclimatic regulation, carbon sequestration, nitrogen fixation, biodiversity, among others.

CIAT, over the past decade, has worked on researching such systems and on supporting their adoption and scaling in tropical cattle systems.

Our experiment: Silvo-pastoral system (SPS) vs. grass monoculture (M). Palmira, Valle del Cauca, Colombia.

Objective: Estimate the economic and environmental value of implementing a SPS instead of a grass monoculture.

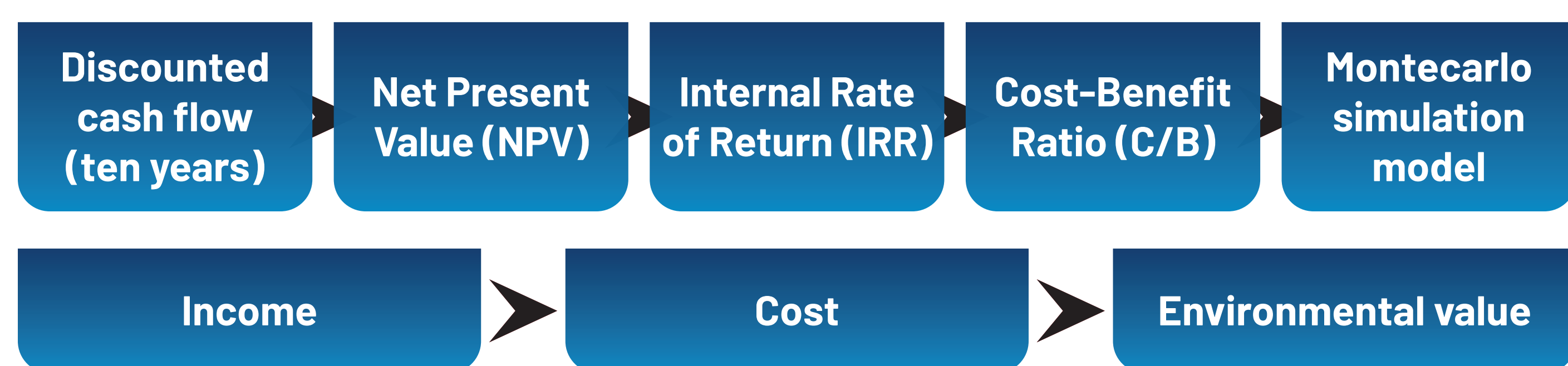
Method: Economic and environmental evaluation.

Table 1. Data and description treatments

Variables	Grass monoculture		Silvo-pastoral system	
	M Toledo	M Cayman	SPS Toledo	SPS Cayman
Land size	1 hectare	1 hectare	1 hectare	1 hectare
Pastures	<i>U. brizantha</i> cv. Toledo	<i>Urochloa</i> hybrid cv. Cayman	<i>U. brizantha</i> cv. Toledo	<i>Urochloa</i> hybrid cv. Cayman
Legumes			<i>Leucaena leucocephala</i>	<i>Leucaena leucocephala</i>
Grass:legume proportion			70:30	70:30
<i>Leucaena</i> trees density			2,000 / hectare 25% for shade 75% for browsing	2,000 / hectare 25% for shade 75% for browsing
Animal stocking rate	3 Brangus animals	3 Brangus animals	4 Brangus animals	4 Brangus animals
Entry age	19.1 months	19.1 months	18.1 months	18.1 months
Entry weight	349 kg	349 kg	345 kg	345 kg
Monitoring time	April 2021-April 2022	April 2021-April 2022	April 2021-April 2022	April 2021-April 2022

Methods

Economic evaluation



Environmental evaluation



Further reading

Sandoval D; Florez JF; Enciso K; Sotelo M; Burkart S. 2022. Economic and environmental evaluation of a silvo-pastoral system in Colombia: An ecosystem service perspective. Policy Brief No. 79. Cali (Colombia): Alliance of Bioversity and CIAT. <https://hdl.handle.net/10568/126338>

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Results

Table 2. Economic evaluation

Indicator	Evaluation criteria	M Toledo	M Cayman	SPS Toledo	SPS Cayman
Economic benefit	NPV mean (US\$)	(268.05)	(527.96)	35.10	(218.49)
	IRR mean (%)	-4.39	-0.06	0.58	-2.39
	Risk (prob NPV<0) (%)	67.16	80.95	48.84	59.56
	B/C ratio	1	0.99	1.03	1.02
Economic benefit + avoided CH ₄ emissions	NPV mean (US\$)	-	-	259.97	6.38
	IRR mean (%)	-	-	3.00	-0.23
	Risk (prob NPV<0) (%)	-	-	39.27	50.07
	B/C ratio	-	-	1.04	1.03
Economic benefit + microclimatic regulation	NPV mean (US\$)	-	-	29,342.24	29,088.65
	IRR mean (%)	-	-	260.42	228.89
	Risk (prob NPV<0) (%)	-	-	0.00	0.00
	B/C ratio	-	-	2.95	2.91

Table 3. Reduced methane emissions

Parameter	M Toledo	SPS Cayman
Emissions per animal (t CO ₂ eq.)	1.739	1.59
Price (US\$)	42.25	42.25
Cost (US\$)	73.47	67.35
Benefit/cattle head (US\$)	0	6.12
Animal stocking rate	3	4
Time needed to reach sales weight (d)	842	310
Total benefit (US\$)	0	24.49
Annual benefit (US\$)	0	28.83
SPS with 1,000 cattle heads		
Emissions (t CO ₂ eq.)	1,739	1,594
Cost (US\$)	73,473	67,347
Benefit (US\$)	0	6,126

Table 4. Microclimatic regulation

Item	Unit value (US\$)	Quantity	3 years value (US\$)	Annual value (US\$)	Annual value/ha (US\$)	Annual value 1,000 ha (US\$)
Shadow mesh (m ²)	0.78	12,082	9,471	3,157	1,578	1,578,425
Poles (units)	5.49	483	2,651	884	442	441,830
Labor (d)	9.24	4	37	12	6	6,159
Total value of ecosystem service (US\$)			12,158	4,053	2,026	2,026,414

Conclusions

- SPS are a valuable option for cattle production. When analyzing the economic results obtained in this study, we find that SPS lead to higher NPV and IRR, as well as lower risks of obtaining economic losses.
- By including the economic value of avoided CH₄ emissions and the microclimatic regulation in the calculation of benefits, the economic indicators further improve considerably.
- Including legume-based diets in SPS has the potential to reduce CH₄ emissions generated by ruminants. Our study shows that CH₄ emissions can be reduced by 8% when compared with diets obtained based on a grass monoculture. This reduction is valued at US\$ 6.12 per cattle head.
- SPS are providers of shade, and thus contribute to microclimatic regulation within the production system. This offers thermal comfort to animals, especially in high-temperature areas, and leads to improvements in meat and milk production both in quantity and quality. Our study shows that the microclimatic regulation generated in a SPS generates an economic value of 2,026 US\$ ha/year.