INITIATIVE ON
Livestock and Climate

POLICY BRIEF

Economic evaluation of an intensive silvo-pastoral system for the province of San Martín, Peru

John Jairo Junca Paredes[1]; Sandra Durango Morales[2]; Stefan Burkart[1]
[1]International Center for Tropical Agriculture, Tropical Forages Program
[2]International Center for Tropical Agriculture, Multifunctional landscapes

KEY MESSAGES

- Sustainable cattle practices are essential for improving the livelihoods and environmental sustainability of small-scale cattle farmers. Intensive silvo-pastoral systems (SPSi) can contribute to this purpose since they are more productive and efficient, restoring soils and reducing greenhouse gas emissions.
- Estimates show that SPSi significantly increase profitability. The rise in milk productivity, animal stocking rate, and wood sales generate higher income for the system. Likewise, management with organic fertilizers reduces production costs.
- It is important to strengthen the dissemination of SPSi. Traditional systems, such as monocultures, are deeply rooted among small-scale producers. Therefore, successful cases should be promoted to build confidence in these new technologies.
- The adoption of SPSi is an effective alternative to boost the economy in northern Peru. The study of a representative case at the regional level provides evidence to support this. In the most likely scenario, the net present value (NPV) significantly increased and the internal rate of return (IRR) was above 30%.

INTRODUCTION

In the regions of San Martín and Amazonas, cattle systems typically have an area of less than 10 hectares (ha) (Alegre et al., 2019; Pizarro et al., 2020). Regarding forage conditions, more than 70% of the secondary forests in the Peruvian Amazon are native grasslands with low productivity or improved but degraded grasses at various stages of recovery. This has resulted from poor technical management, inadequate stocking rates, and overgrazing (Alegre et al., 2017; Echevarría et al., 2019). Additionally, from an economic perspective, the cattle sector is relatively small compared to poultry industry, which in Peru contributes with 42.5% to the livestock sector's economic value, whereas beef and dairy cattle only contribute with 4 and 4.5%, respectively (MIDAGRI, 2023). Hence, there is growth potential for the sector. However, projects that focus on both economic and environmental sustainability are needed for this purpose. SPSi meet these criteria, since they are technologies that combine grasses, legumes, shrubs, and trees, allowing for the intensification of production and the mitigation of the environmental impact of cattle farming (Chará et al., 2018).

This document presents the results of an economic evaluation for a SPSi in northern Peru. The comparison technology is a monoculture with *Urochloa brizantha* (syn. *Brachiaria brizantha*) cv. Marandú, predominant in the cattle production systems of the region. The promotion of SPSi is one of the strategic pillars of the Peru-Hub initiative, which is the result of a partnership between national and international research institutions.

DESCRIPTION OF THE TECHNOLOGIES

The analysis involved comparing the traditional productive system of the region against an SPSi with organic fertilization. Each experiment was conducted in an area of 2.5 hectares, with dual-purpose Girolando cattle, at the Universidad Nacional Agraria La Molina (UNALM) campus in Tarapoto, San Martín province, within the framework of the Peru-Hub project. The traditional system is a monoculture dual-purpose system with *Urochloa brizantha* cv. Marandú. This material has been widely disseminated in the American tropics, is resistant to spittlebug, performs well in soils with intermediate to high fertility, but does not respond well to waterlogging (Cook et al., 2020). In Peru, this grass has performed well and is the most widely used forage in this region of the country (Perulactea, 2015). The improved technology is an SPSi with *Urochloa brizantha* cv. Marandú, the legume *Centrosema macrocarpum*, the shrub *Tithonia diversifolia*, and timber trees. *Centrosema macrocarpum* has high nutritional value, tolerates drought well, and is resistant to the main diseases of *Centrosema* spp. (Cook et al., 2020). Perennial legumes fix nitrogen, contributing to productivity (Lagrange et al., 2021). *Tithonia diversifolia* (Sunflower tree) is a perennial or annual shrub with good nutritional value, which can grow between 2 to 5 meters in height (Cook et al., 2020). It adapts to different climates and soils and has a positive impact on animal productivity (Cook et al., 2020). Finally, a wide range of timber trees were included in the SPSi, including *Cordia gerascanthus* (8-15 years), *Brosimum alicastrum* (8 years), and *Guazuma Crinita* (5-8 years). It was assumed that the SPSi provides shade over 15% to 20% of the 2.5-hectare area through trees and shrubs, contributing to microclimatic regulation of the animals and thus, reducing heat stress.

Final animal response data are not yet available. To address this, consultation with experts from the Universidad Nacional Agraria La Molina (UNALM) was conducted, and appropriate productive assumptions were established. It is assumed that compared to the traditional technology, the animal stocking rate (SR) increases from 1 to 2 or 3 Livestock Units (LU) per hectare with the SPSi. On the other hand, milk productivity (MP) would increase from 5 l/day/cow to 6.5 l/day/cow. Finally, the weaned calf selling frequency would decrease from 2 to 1 year.

METHODOLOGY

We used a discounted cash flow model, which consolidates the net benefit per period. With this, four profitability indicators were calculated: Net Present Value (NPV), Internal Rate of Return (IRR), benefit-cost ratio (BC), and payback period (PP). A positive NPV and an IRR greater than the discount rate indicate profitability. Subsequently, the indicators of the evaluated technologies were analyzed and compared to determine which is the best. The analysis continued with a probabilistic approach using Monte Carlo simulation with the software @ Risk, providing more robust estimates of NPV, probabilities of economic loss, and a sensitivity analysis. It also helps identify which variables have a greater impact on profitability. The modeling was applied for the traditional approach and three silvo-pastoral scenarios: pessimistic (SPSiP), moderate (SPSiM), and optimistic (SPSiO). These scenarios were obtained by modifying the values of relevant parameters, as shown in Table 1.

Data on investments, costs, and market prices were available to feed the model. Both the traditional monoculture and the SPSi do not incur renewal costs. The analysis period was set from 2023 to 2030 (8 years), with a discount rate of 8%. Only the SPSi uses organic fertilizers. The beef price was estimated at US$1.96/kg, and the milk price at US$0.34/l. The exchange rate used was 3.83 Soles per US$, corresponding to the average of 2022.

Table 1. Parameter values for the evaluated SPSi scenarios.

Scenario	Stocking rate LU/2.5 ha	Weaned calf selling frequency (years)
SPSiP	3	2
SPSiM	5	1
SPSiO	7	1

Table 2. Profitability indicators for the evaluated technologies

Indicator	Tradicional	SPSiP	SPSiM	SPSiO
NPV (US$)	610	6,962	13,213	19,464
IRR (%)	9.69	24.81	29.31	31.61
BC	1.06	1.46	1.56	1.6
PP (years)	7.83	5.08	4.33	4

RESULTS

According to Table 2, all evaluated technologies are profitable. They have a positive NPV and an IRR higher than the discount rate (8%). However, the results for SPSi were better. For instance, the IRR is significantly higher in the pessimistic (24.81%), moderate (29.31%), and optimistic (31.61%) scenarios compared to the traditional system (9.69%). The BC ratio increases from 1.06 to values between 1.46 and 1.60. Finally, the PP of the investment decreases from 7 years and 10 months to a range between 4 and 5 years in the SPSi.

Moving on to the probabilistic component, Figure 1 presents the probability distributions for the NPV. The traditional scenario (in red) shows profitability with no probability of economic loss. This is not surprising, as the monoculture system with cv. Marandú performs well in the region, becoming the most widely used forage (Perulactea, 2015). In all SPSi scenarios, the probability distributions of NPV shift to the right, making the increase in economic benefit evident. The average NPV grows from US$580 in the traditional scenario to US$13,213 in the moderate SPSi scenario.

Regarding the sensitivity analysis, Figure 2 shows the variables with the greatest influence on the NPV or profitability for both the traditional and SPSiM scenarios. The other scenarios follow similar trends. It can be observed that milk productivity (MP) explains 73.2% and 65.9% of the profitability, while the animal stocking rate (SR) explains 26.8% and 34.1% in these two scenarios. Therefore, improvement in these productive parameters will contribute to increasing profitability.

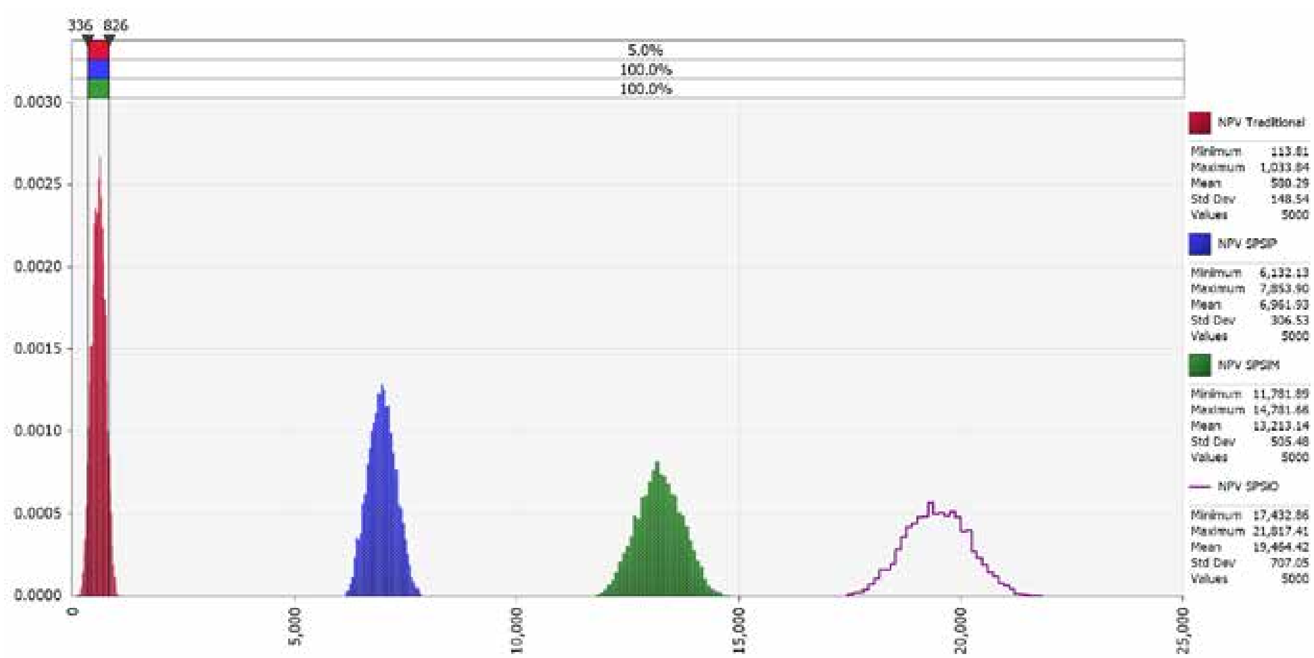

Figure 1. Structure of the Action Plan for the LPGBS.

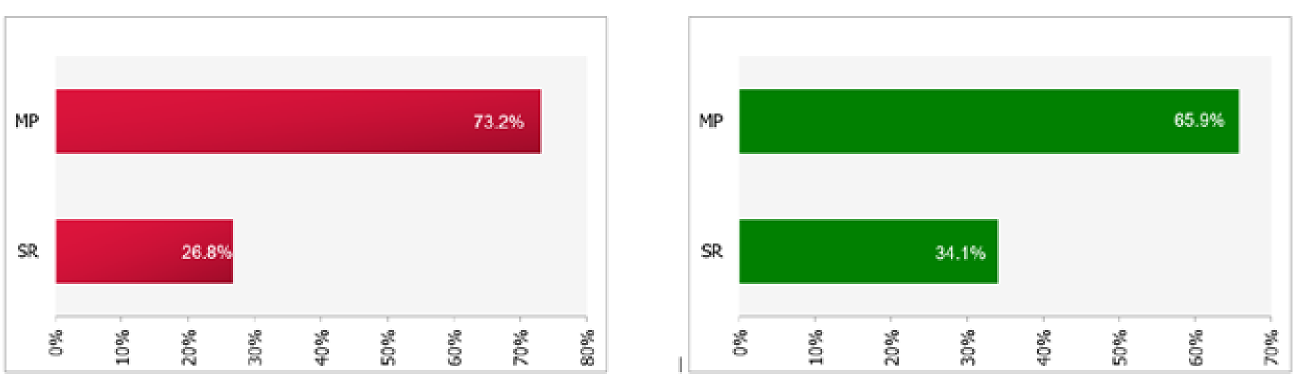

Figure 2. Tornado graphs - contribution to the variance

CONCLUSIONS

The Amazon region of Peru has been affected by extensive cattle practices. In response to this, SPSi, with the combination of various species, provide the opportunity to boost productivity, efficiency, and environmental sustainability in cattle farming systems. While the traditional monoculture system is profitable, the results of SPSi are significantly better. Effectively disseminating these findings is crucial to encourage the adoption of the new technology in the region. In the regional context, producers do not have influence over prices. Therefore, the sensitivity analysis highlighted milk productivity and animal stocking rate as the determinants of profitability.

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ABOUT THE AUTHORS

Jhon J. Junca Paredes Economist. j.junca@cgiar.org

Sandra Durango M. Postdoctoral Fellow. s.durango@cgiar.org

Dr. Stefan Burkart Economist. s.burkart@cgiar.org

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Adriana Varón/ CIAT

CONTACT

Stefan Burkart
s.burkart@cgiar.org

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alliancebioversityciat.org

cgiar.org

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