Policy Brief No. 65

Sorghum Corpoica JJT-18 silage production as a business model in Colombia

Keywords: Livestock, forage conservation, silage, climate change, agribusiness.

Key messages:

- Climate variability phenomena such as intense droughts greatly affect the cattle sector in the Colombian Orinoquía region. One strategy for solving this problem is silage.
- Silage production as a business model is an economically and financially viable practice, thus allowing cattle and forage producers to obtain additional income.
- *Sorghum* Corpoica JJT-18 is a promising variety for cattle feed in the Orinoquía region since its agronomic performance and high quality are superior to those of the crops commonly used for animal feeding in the region.

Introduction

One of the underlying problems of climate change that greatly affect livestock production in tropical countries is seasonality in forage production (Arreaza et al., 2012; Mendieta et al., 2015). Prolonged periods of drought and rain affect the availability and quality of the feed consumed by the animals, leading to both biological and economic losses (Arreaza et al., 2012).

Drought and feed shortages are among the main causes of death in cattle in the Orinoquía region in Colombia (DANE, 2019), which reached their highest value in the first semester of 2019, coinciding with the dry season of the region. Although in the second semester the values decreased considerably, the causes of the registered deaths continue to be drought and feed shortages.

To mitigate this problem, applying a forage conservation strategy becomes crucial. According to Sánchez and Báez (2002), forage conservation seeks to provide good-quality forage throughout the year, especially in critical periods of drought and rain. It also focuses on using the excess forage produced during the rainy season, including agro-industrial by-products in cattle feed, increasing animal carrying capacity, and providing a balanced diet. Forages can be conserved in the form of silage, hay, and haylage. The adoption of these techniques, however, depends on the characteristics of the cattle systems in a particular region. In the Orinoquía region, forage conservation practices are carried out in a generalized way among producers, especially silage, favored by high humidity. Silage is made mainly of maize and grain sorghum (Agrosavia, n.d.).

This study proposes the forage *Sorghum* Corpoica JJT-18 as an option for silage production in the Orinoquía region. According to Bernal et al. (2014), JJT-18 has a high content of soluble carbohydrates, a low buffer capacity, a dry matter content greater than 20%, and a physical structure that favors compaction in the silo. Thus, when compared with maize silage, JJT-18 sorghum silage has advantages related to low production costs, better drought tolerance, and higher dry matter production (Bernal et al., 2014). The objective of this document is to analyze *Sorghum* Corpoica JJT-18 silage as an alternative to develop a business model that allows cattle producers to obtain additional income parallel to conducting their regular cattle activity.

Description of the forage *Sorghum* Corpoica JJT-18

Sorghum Corpoica JJT-18 is a sorghum variety developed by Agrosavia (formerly Corpoica) as an alternative for animal supplementation in cattle systems in the Colombian subregions Altillanura plana, Piedemonte llanero, dry Caribbean, humid Caribbean, and Magdalena River valley (Bernal et al., 2014). It adapts to well-drained soils in regions where rainfall is relatively low (350 mm) and dry seasons are frequent (Bernal et al., 2014). *Sorghum* Corpoica JJT-18 has good agronomic behavior and high biomass production and therefore is an optimal alternative to overcome the forage deficit occurring during the dry season. It has green forage yields in the first cut that range from 39 to 56 tons per hectare. This sorghum variety can be used for the establishment and renovation of pastures and can be harvested 80 days after sowing and subsequently used for silage production (Bernal et al., 2014). Experts recommend establishing *Brachiaria brizantha* cv. CIAT 26110 (Toledo) together with *Sorghum* Corpoica JJT-18, with the purpose of renewing the pastures by using the fertilizer provided by the sorghum. In this way, the costs of establishing Toledo are diminished and the quality of the silage increases because of its protein and dry matter contributions. Table 1 summarizes some important characteristics of *Sorghum* Corpoica JJT-18.

Table 1. Characteristics of the forage *Sorghum* Corpoica JJT-18.

Characteristic	Average value
Time from sowing to forage harvest (days)	100
Plant height ~~(m)~~ **(cm)?**	320
Overturning	Moderate (1%)
Average green forage production (t/ha)	44.6
Crude protein content	6%
Acid detergent fiber content	26%
Neutral detergent fiber content	54%
Degradability	67%

Source: Own elaboration based on Bernal et al. (2014).

Objective

To analyze the use of *Sorghum* Corpoica JJT-18 silage as a possible alternative business model in the Colombian Orinoquía region.

Data collection and methodological approach

The Business Model Canvas was structured based on the methodology developed by Alexander Osterwalder (2004). It was complemented by an economic and financial analysis in which the associated profitability indicators and risk factors were calculated using @Risk software (Palisade Corporation). The data were obtained through interviews with experts from the region of study and the cattle sector.

Results and analysis

Canvas

The Canvas methodology is structured according to nine basic business modules: customer segments, value propositions, distribution channels, customer relationships, key resources, key activities, key partners, revenue streams, and cost structure (Ferreira-Herrera, 2015). Table 2 provides the Canvas for the silage production business model.

The business model defines the customer segment to be cattle producers affected by the dry season and without technological capacity to produce silage. The product supporting the value proposition is bagged silage (50 kg) of a mix of *Sorghum* Corpoica JJT-18 and Toledo. In addition to being a product with superior quality to the one of silage of other crops and/or pastures evaluated in the region (Bernal et al., 2014), the bag packaging decreases losses in the distribution and transportation of the silage. The distribution of the product is organized as delivery to the farm, with the buyer bearing the involved transportation costs. The relationship of silage producers with their customers depends on the frequency of sales, which is seasonal and depends on the dry seasons that occur.

The sale of silage (per kg) is the only source of income in this business model. According to experts, the price of *Sorghum* Corpoica JJT-18 silage is about COP 300 per kg (M. Sotelo, pers. commun., 4 November 2021). As the dry season progresses, however, the price can become much higher. To avoid high prices, buyers usually order silage before the dry season starts (M. Sotelo, op. cit.).

The proper functioning of the business model depends on key resources, such as technical personnel trained in silage production, the machinery and infrastructure required in the production process, and the existence of a continuous cash flow. The key activities are mostly related to the sowing, harvesting, and silage preparation of *Sorghum* Corpoica JJT-18. Because the Orinoquía region is dry, sowing must coincide with the rainy season in April. The harvest is carried out 95 days after sowing (in July and until the beginning of August) and the silage is obtained at the end of September or the beginning of October (M. Sotelo, op. cit.).

The research centers[1] present in the region represent key actors for the execution of the business model, particularly because of their role in technology development and technical assistance. The cost structure includes the establishment of *Sorghum* Corpoica JJT-18 and Toledo, silage making, and grass maintenance (Table 3).

[1]Agrosavia and the Alliance of Bioversity International and CIAT.

Table 2. Canvas business model for *Sorghum* Corpoica JJT-18 silage in the Orinoquía region.

Key partners	Key activities	Value propositions	Customer relationships	Customer segments
*Direct: input suppliers *Indirect: research centers (Agrosavia and the Alliance of Bioversity International and CIAT)	*Sowing depends on the rainy season (April). *Harvest after 95 days (July-August). *Silage making: September-October.	*Silage in bags (50 kg) of *Sorghum* Corpoica JJT-18 and Toledo. *Presentation in bags that decrease losses in silage distribution.	* Communication depends on the frequency of sales.	*Cattle producers affected by the dry seasons in the Colombian Orinoquía. *Cattle producers without technological capacity for silage production.
	Key resources		**Distribution channels**	
	*Human: technical personnel trained in silage production. *Physical: machinery and infrastructure. *Financial: continuous cash flow.		*Delivery. *The buyer bears transportation costs.	
	Cost structure		**Revenue streams**	
	Table 3.		Sales price: COP 300/kg. The price can vary as drought intensifies.	

Source: Own elaboration based on obtained data.

Table 3. Cost structure of *Sorghum* Corpoica JJT-18 and Toledo.[2]

Establishment costs (COP) for JJT-18 (1 ha)			
Description	**Unit**	**Unit value**	**Total value**
Soil analysis	1	114,000	114,000
Machinery	hours		
Fertilizer/seeder	8	112,778	902,224
Harrow	5	61,083	305,415
Disc plow	5	88,000	440,000
Subtotal			1,647,639
Fertilizer	kg		
Urea (46%)	100	2,420	242,000
KCl	50	2,412	120,600
DAP	50	3,116	155,800
Boron, zinc, copper	10	4,043	40,430
Subtotal			558,830
Herbicide	liters		
Atrazina	1.5	29,113	43,670
Basagran 480	2	73,072	146,144
Roundup	2.5	41,414	103,535
Subtotal			293,349

[2]The presented costs are approximations.

Seed	kg		
Sorghum Corpoica JJT-18	7	24,000	168,000
Subtotal			168,000
Soil conditioner	kg		
Dolomite lime	1,000	213	213,000
Subtotal			213,000
Labor	days		
Occasional labor	3	30,000	90,000
Subtotal			90,000
Total establishment			**3,084,818**

Silage making costs for JJT-18 and Toledo (32 t/ha)

Description	Unit	Unit value	Total value
Silage in bags (32 t)	hours		
Harvest and chopping	9	50,000	450,000
Subtotal			450,000
Packaging	no.		
Bags	600	1,500	900,000
Subtotal			900,000
Machinery	days		
Silage bag	2	200,000	400,000
Subtotal			400,000
Additives	liters		
Subtotal			
Labor	days		
Occasional labor	2	30,000	60,000
Subtotal			60,000
Total silage making			**1,810,000**

Initial investment

Description	Unit	Unit value	Total value
Establishment of JJT-18			
Subtotal			3,084,818
Seed	kg		
Toledo	8	50,000	400,000
Subtotal			400,000
Machinery	no.		
Fumigation	1	300,000	300,000
Subtotal			300,000
Total			**3,784,818**

Maintenance

Description	Unit	Unit value	Total value
Fertilizer	kg		

DAP	35	3,116	109,060
Potassium chloride	83	2,412	200,196
Magnesium sulfate	100	1,470	147,000
Subtotal			456,256
Total			**456,256**

Source: Own elaboration based on Bernal et al. (2014) and expert information.

Financial analysis

The financial viability was evaluated using the profitability indicators net present value (NPV), internal rate of return (IRR), and benefit-cost ratio. Three scenarios were evaluated that were determined by the average silage production. For the pessimistic scenario, the average production is 25 tons of silage per ha, for the most likely scenario it is 32 t/ha, and for the optimistic scenario it is 40 t/ha. For each of the scenarios, a time horizon of 8 years[3] and an average discount rate of 10.85%[4] were used.

The profitability indicators show that the project is viable for each of the analyzed scenarios (Table 4). The variables that explain in a greater proportion the changes in the profitability indicators are the sales price of silage and the production of silage (Figure 1). Making the product more expensive can be counterproductive, however, and thus increasing silage production is the best option to obtain higher profits. Figure 2 compares the NPV of the pessimistic and optimistic scenarios. The former has a 0.6% probability of incurring losses, while for the latter it is 0%. The optimistic scenario has an 81.1% probability of obtaining values greater than COP 30,000,000, while the pessimistic scenario has a probability of only 3.9%.

Table 4. Summary of profitability indicators for the analyzed scenarios.

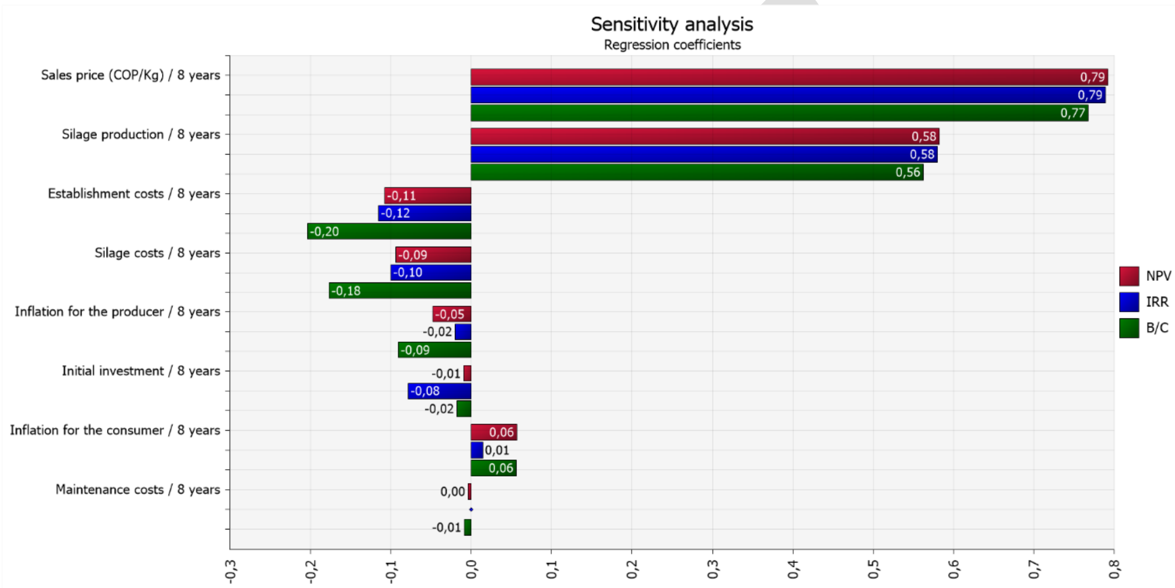
Profitability indicators	Most likely scenario	Pessimistic scenario	Optimistic scenario
Average annual yield (t/ha)	32	25	40
Total gross income (COP/average annual yield/ha)	9,600,000	7,500,000	12,000,000
Total net income (COP/average annual yield/ha)	4,248,926	2,148,926	6,648,926
Total establishment costs (COP/ha)	3,084,818	3,084,818	3,084,818

[3]According to the lifespan of the pasture under good management conditions (Peters et al., 2010).
[4]Based on the Finagro credit line, which is established according to the DTF (fixed-term deposits) + 7% effective annual rate (Finagro, 2021). The DTF was determined based on the projections of Bancolombia 2021-2025 (Bancolombia, 2021). **Is DTF fixed-term deposits? Is further explanation needed here?** **Yes, it is fixed-term deposits. I think we can just add the term like I did above**

Total silage costs (COP/ha)	1,810,000	1,810,000	1,810,000
Total maintenance costs (COP/ha)	456,256	456,256	456,256
NPV (COP/ha)	29,846,709	15,248,946	40,717,384
IRR (%)	151	84	200
C/B ratio	**~~$2~~2.0**	**~~$1,5~~1.5**	**~~$2,3~~2.3**

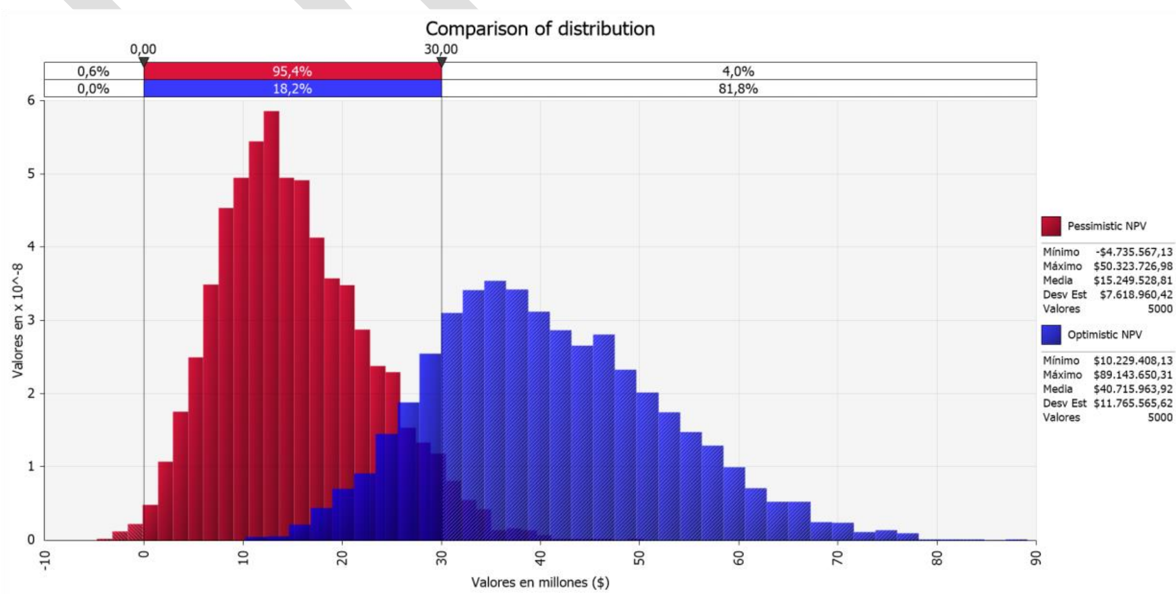
Source: Own elaboration based on obtained data.

Figure 1. Sensitivity analysis of profitability indicators for the most likely scenario.



Source: Own elaboration based on obtained data.

Figure 2. Comparison of the NPV in the pessimistic and optimistic scenarios. **(Words inside figure need to be changed to English: Max., Min., Mean, Values in million COP, etc.)**



Source: Own elaboration based on obtained data.

Conclusions

Silage is an optimal strategy for overcoming the effects of critical factors that affect cattle production, such as feed shortages, losses in production indicators, and, in the worst case, the death of animals. In addition, it allows producers to generate additional income if it is adopted as a business model.

Profitability indicators mainly depend on silage production, making it essential for producers to follow technical recommendations during the whole process, that is, for sowing, harvesting, and silage making. With this, good production rates can be obtained, thus translating into favorable economic results.

The scarcity of statistics related to silage makes it difficult to know the status of adoption of this practice in the country, particularly in the Orinoquía region. Knowing this allows the formulation of research proposals and support policies that help in obtaining support for the modernization and resilience of the cattle sector.

Acknowledgments

This work was carried out as part of the CGIAR Research Program on Livestock. We thank all donors who globally support our work through their contributions to the CGIAR system. The views expressed in this document should not be taken as the official views of these organizations.

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