Beef case study in the Dry Chaco of Paraguay (integrating crops + beef finishing)

WWF – SuLu Project (BMU / IKI)

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Table of contents

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1 Executive summary

Beef production in Paraguay has been growing during the last years, mainly due to the availability of natural resources, to the deforestation of forest areas and other interventions. The expansion has mainly taken place in the Chaco region, where predominantly extensive grazing systems have dominated land use. Neither the growth nor the associated pressure on natural resources has slowed down. Cropland and ranches have gradually replaced the Chaco over the last few decades, it has been disappearing even faster in recent years and, if practices do not change or diversify, the Chaco is projected to lose additional millions of hectares of native vegetation. Current land use in the region has started to compete with crops like soybean and in some cases, both soybean and beef production are being operated simultaneously (integration). According to regional experts, this integration has become a tendency in recent years, in a few regions of Paraguay.
The Dry Chaco is located west of the Pantanal with dry and closed xerophytic forest. The flooded savannas of the Pantanal and the Dry Chaco are closely linked as they share production channels: a considerable number of calves from the flooded savannas are taken to the Dry Chaco to be fattened there.

Paraguay's forest law allows the habilitation (deforestation) of native forest for land use change throughout the Chaco region and obliges producers to maintain 25% of the total area of the property as a forest reserve and 100-meter wide windbreaks totaling about 45% of the total area with native forest cover.

A particularity of the region is that it is strongly influenced by the Mennonite colonies arriving there at the end of the 1920s. The production is characterized by being more technical than in other regions of the Chaco and normal development occurs when the area authorized by law is deforested and a species of pasture is planted: the Gatton Panic (*Panicum maximum)*. A case study was carried out of the Dry Chaco region that was mainly aimed at improving the knowledge of the regional production systems and their economic implications when adopting interventions such as the integration of beef production and crops. A Baseline for beef production (complete cycle - cow-calf and beef finishing) was defined in terms of land use, animal performance and economic results. In order to cover the possible dynamics of the future land use, an additional scenario was modelled: integrating beef and crop (soybean) enterprises (Integration Beef and Crops – IBC).

The Baseline for beef production is characterised by the adoption of paddock subdivision, water management programs, fertility improvement schemes, and a high level of managerial skills, which are required for the implementation of such measures. The result is a relatively high level of productivity, but production is still achieved through deforestation. In the short and medium term, beef production is a profitable activity. However, in the long term, rising opportunity costs, mainly for land, could result in diminishing profitability, if the system remains unchanged. One aim of this study and the analysis of the improved scenarios was to demonstrate that the system can also be productive without deforestation of new pastures.

Compared with the Baseline of beef production only, integrating the production of crops and beef improves profitability, in spite of it not being profitable either when you take the opportunity costs into ac-

count. During the first two years of implementation, careful financial planning is required due to a reduction in profit the cash flow.

Land use options such as IBC are growing in the region and open up a space for additional long-term analysis and perspective. Preliminary results show that it is possible to produce more beef and be more profitable on less land. This option, accompanied by appropriate policy in terms of regulatory schemes and legal frameworks to incentivise production models conserving natural habitats, could result in less deforestation, using less land for beef and crop production. Additional and more detailed studies will be required exploring these options.

In general terms, when comparing profit and opportunity cost for land, it seems that there is an imbalanced situation because opportunity costs for land are higher than profit per ha, showing that the current land use does not reflect its real value. The high level of opportunity costs can result from a) more competitive land use options and/or b) speculation on increasing land values as a result of future improved infrastructure or c) the fact that land investment takes place with motivations not directly related to the agricultural production and its potential output. In many cases, this situation is also important, taking into account generational changes in landholders as well as real estate speculations that can result in the sale of the property to new investors.

This publication is one of the results of the IKI project “Land Use Change in Savannahs and Grasslands – Approaches by Policy Engagement, Land Use Planning and Best Management Practices” briefly “Sulu” (for sustainable land use). It aims at strengthening land use planning and management in the Paraguayan Pantanal and Dry Chaco region with climate criteria, as well as with the conservation and maintenance of carbon stocks, biodiversity and hydrological regimes, and at contributing to a more sustainable agro-industrial production.

Improving the profitability of livestock and crop production through the implementation of a range of practices and approaches could reduce the risk of land use change and the corresponding negative impacts on biodiversity and the environment. The potential of the above-mentioned practices was analyzed in close cooperation with producers and regional experts. This economic analysis is accompanied by other research and publications aimed at strengthening sustainable management practices while avoiding deforestation and the conversion of natural areas.

2 Introduction

Beef production in Paraguay has been growing during the last years, mainly based on the availability of natural resources and the intervention of forest areas. The expansion mainly took place in the Chaco region and in terms of grazing systems with low stocking rates. In the same period, Paraguay has become the ninth exporter of beef globally, which has gone in line with an increase in land productivity, as well as the deforestation of additional forest areas. The increase in land productivity was achieved by using introduced pastures with higher yields per ha, genetic improvement and applying better management programs (e.g. fertility, paddock subdivision, feeding, water supply, etc.). This growth has not stopped and

consequently neither has the pressure on natural resources. In recent years, the current land use in the region is also experimenting competitively with crops such as soybean and in some cases, implementing both enterprises: soybean and beef production simultaneously.

Beef production in the Dry Chaco region is characterised by large farm sizes with grazing areas using improved pastures, paddock subdivision, mineral supplementation, genetic improvement, and water management programs. This land pressure has promoted forest clearing with higher levels of deforestation and all effects associated with such intervention and, on the other hand, it has opened the door to potential competition with crops such as soybean.

The region is still lacking road infrastructure (for transporting grains and oilseeds) and electricity (for milling) and during the wet season, some roads are impassable. These features currently make the expansion of beef and crop production difficult and delay both expansion and introduction.

A case study has been carried out with the aim of setting up the basis for a deeper analysis of the current land use dynamic. On the one hand, the study illustrates a more intensive approach of production factors for beef production, and on the other hand, the integration of crop production (soybean) for market sales with beef production using the crops as feed.

This option of integration will possibly improve productivity and profitability of current land use through the implementation of an integration with crops (Integration Beef and Crops – IBC). The main idea is to show that the system can be productive on existing land without deforestation for new pastures, and thus provide an opportunity to "release" land that can then be used for biodiversity purposes and carbon sinks.

3 Activities, workflow and methods

During a visit to the Alto Chaco region, WWF and Thünen staff jointly decided to analyse additional cattle ranching systems in the region. This decision was inspired by in-depth discussions that had taken place at a workshop with key stakeholders (local producers, investors, and beef production and processing cooperatives), about the future of the region in terms of land use and possible crop scenarios, such as soybean and beef production integration with crops.

The positive interaction with stakeholders, as well as the national sectorial interest to characterise these production systems, facilitated the implementation of this complex study.

Five workshops and parallel field visits took place in the region (Filadelfia Fernheim Cooperative headquarters, Alto Chaco region - Estancia Faro Norte and Asuncion). WWF staff from Paraguay, national and regional experts and advisors, and local producers participated in the visits. The following activities were carried out:

July 26, 2017: Field visit to Estancia Faro Norte (workshop with producers from Alto Paraguay)

March 13, 2018: Discussion of Baseline (workshop with technical group of Fernheim Cooperative and technical advisors

March 14, 2018: Field visit to Estancia Faro Norte (discussion of preliminary results with producers and technical advisors)

March 15, 2018: Discussion of preliminary results (workshop with technical group of Fernheim and Neuland Cooperatives, producers from Alto Paraguay and technical advisors)

November 28, 2018: Discussion of final results (workshop with technical group of Fernheim Cooperative and technical advisors)

November 29, 2018: Discussion of final results (workshop with producers from Alto Paraguay)

agri benchmark methods and tools were made available for analysing and modelling the data (see Deblitz, 2018).

Data collection

The main source of data was farm level information. The information was gathered during field visits to the project region. A group of expert technicians and advisors came together to discuss and complement the data supplied by local producers. Studies covering the project region were also consulted and discussed.

Data processing and analysis

The *agri benchmark* Network's TIPI-CAL model was used to simulate the 10-year period of IBC introduction. TIPI-CAL is a production and accounting model and assessment tool. It has a 10-year dynamic-recursive structure and produces a profit and loss account, a balance sheet, a cash flow for the whole farm and all enterprises considered for each of the 10-year simulation. It further provides very detailed information on activity levels, performance and productivity of the enterprises, such as herd size, reproductive performance, milk yields, weight of animals, feed rations, mortality, weight gains etc. For this project and in line with the standard operating procedure to define typical farms (Deblitz, 2018), real farms were taken as a basis and then 'typified', i.e. individual particularities were replaced by regionally typical data.

Assumptions for the calculations

With respect to data availability and quality, we found several situations; these observations can be summarised as follows:

- When discussing main Baseline components, it was assumed that the Baseline is already characterised by a relatively high 'intensity' level. It means that paddock subdivision, improved pastures, genetic improvement and fertility management programs were already in place as in some top leading farms in the region.

- For modelling forage production, animal requirements were used as a basis, and according to the number of animals in each age group, the total requirements were calculated.
- For modelling the alternative scenario, all investment requirements were reflected, assuming commercial credit conditions available in the region. The analysis does not include the farm owner's money requirements to cover living expenses.
- Input and output prices were taken from the year 2016, assuming average annual prices and a "normal" year (avoiding special conditions like drought, extraordinary diseases etc.).
- For modelling the introduction of the IBC, a stepwise approach was selected, assuming periods of usually 1-2 years from implementation of the strategy to first results. The reason being the multi-annual character of beef production where today's interventions only show results (= finished cattle) more than a year later.
- Most of the calculations were based on two sources of information: real farm data from technical regional advisors, and databases from professional advisory services implementing contract services, outsourcing all the crop activities (seeding, cropping, harvesting).

This case study can serve as an illustration of the potential land use tendency in the region, implementing beef production programs with a high level of investment and management. The study cannot provide a quantification of regional or national land use optimization.

Figure 1 Participants of the Dry Chaco workshops

Source: Martín Mongelós / WWF Paraguay

4 Main results

One Baseline (business as usual) and one alternative scenario are presented in this report: a Baseline for cow-calf and beef finishing (complete cycle) in the Dry Chaco region, and the scenario of Integration of cow-calf and beef finishing with crop production – IBC (in this case soybean, and its rotational options, maize and sorghum) in the same farm/region. The adoption period (transition) of integrating crops into beef production is also illustrated. Thus, all results show the evolution during this transition period from the Baseline to the full implementation of the IBC.

4.1 Baseline

The Baseline is the reference system for the analysis. Synonyms would be 'status quo' or 'business as usual'. The Baseline selected for this study reflects a land use system currently adopted in the region: the production of beef by deforestation and the introduction of new pasture varieties, paddock subdivision, genetic improvements and herd fertility programs. These kinds of programs require high level of management as well as investments. Beef production under this system comprises cow-calf and beef finishing (complete cycle). The expansion of cattle ranches and cropland led to a replacement of native forest over the last decades. If practices are not changing or diversifying, the Chaco is projected to lose millions of hectares of native vegetation.

Figures 2 and 3 provide a visual impression of the Baseline and Tables 1 and 2 provide an overview of the most important system characteristics.

Figure 2 Beef production in the Dry Chaco region (complete cycle on improved pastures)

Source: Martín Mongelós / WWF Paraguay

Figure 3 Beef production in the Dry Chaco region (complete cycle on improved pastures)

Source: Martín Mongelós / WWF Paraguay

Table 1 Production system description
– Baseline Cow-calf with finishing on improved pastures

Year of analysis	2016	
Production system	Cow-Calf and finishing on improved pastures	
Land availability and use (number of hectares)	21.000 ha, of which: 10450 ha are improved/planted pastures and 10550 ha are native forest	
Labour	2 Managers 4 Foremen 4 Cowboys 12 Cattlemen 3 Cooks	
Financial policy	No credits	
Feeding system	Grazing on planted pastures, rotating paddocks	
Supplementation strategy	Minerals	
Technical advisory service	Not available	
Cow-calf enterprise		
Number of cows	4.500	
Age at first calving (months)	31	
Weaning rate (No. of calves per 100 cows and year) *	68.5%	
Number of weaners per year	3086	
Weaning age female / male (days)	240/240	
Weaning weight female / male (kg LW)	220/234	
Weaners:		
Males sold (%)	0%	
Males transfered to finishing (%)	100%	
Females sold (%)	0%	
Females kept (%)	68%	
Females transfered to finishing (%)	32%	
Cows mortality rate (%)	2%	
Weaners mortality rate (%)	2%	
Finishing enterprise		
	Female	*Male*
Number of weaners transferred to finishing	491	1.543
Age at start of finishing (days)	240	
Age at end of finishing (months)	23.3	
Period of finshing (months)	15.3	
Weight at start of finishing female / male (kg LW)	220	234
Weight at end of finishing female / male (kg LW)	450	420
Weight gained female / male (kg)	230	186
Daily weight gain female / male (grams per day)	500	404

* Weaning rate is a measure of the physical productivity of the farm. It is calculated as the number of calves weaned per 100 cows and year. It summarises in one indicator pregnancy rate, birth rate and calf mortality rate.

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

- The Baseline farm type comprises 4,500 cows producing 3,086 weaner calves every year. The weaning rate of the farm is 68.5%. All male calves and some of the female calves are transferred after weaning to the finishing enterprise. 68% of the females are kept for replacement.
- This farm has a total area of 21,000 ha of which approximately 50% of the land area is used for grazing on improved pastures and the remaining 50% is native forest. This ratio is based on the Paraguayan regulation on intervention in forests: 25% of the total surface must be left as a forest reserve. In addition, the maximum paddock size must be 100 ha and each of these paddocks must have natural "wind-barriers" 100 meters wide. Taking these requirements into account, the total area of the natural forest remaining represents about 50% of the total property.
- The Baseline farm sells 2,000 finished animals per year. Calves are weaned at 8 months with an average weight of 230 kg. Finishing animals are sold with an average weight of 430 kg. The finishing period lasts 15.3 months with a daily weight gain of 400 – 500 g per day.
- The farm labour structure comprises 25 staff members, made up of 2 managers, 4 foremen, 4 cowboys, 12 cattlemen and 3 meal providers.
- The Baseline works with improved pastures of mainly Gatton panic (*Panicum maximum cv Gatton Panic*), and Buffel grass (*Pennisetum ciliare*); some other grasses such as Tanzania (*Panicum maximum cv. Tanzania*) and Sudan (*Sorghum Sudanese*) are also used. Both cows and finishing animals graze on paddocks of improved pastures practising rotations to better use the pasture supply. All animals receive mineral supplementation.

Table 2 shows the profit and loss account of the Baseline on the whole-farm level (USD per farm) and on a per ha basis (USD per ha).

- The profit and loss account reflects all returns and all costs except opportunity costs. Opportunity costs on these farms are land only because the owner does not work on the farm in person and all labour is hired. Thus, land costs are not included in this statement, as the producer owns all land. The profit is the difference between the total returns and the costs stated and can be view as medium-term profitability.
- Total farm returns are around 123 USD/ha. Total farm costs are 71 USD/ha. Main costs on this exercise refer to the purchased feed costs (cows and beef finishing animals). Other costs such as labour and depreciation are also important components of the total costs.
- The medium-term profit (calculated as total returns – expenses – depreciation) per farm is USD 1,106,000 (USD 52.7 per ha). The profit margin (profit divided by returns) is 43 percent.

Table 2 Profit and Loss Account of the Baseline
(USD total values and per hectare and year 2016)

	Baseline - year 0	
	USD per farm	**USD per ha**
1 Total returns		
1.1 Market receipts of the enterprises		
Crop and Forage market receipts		
Cow-calf market receipts	1.233.619	58,7
Beef finishing market receipts	1.325.908	63,1
Total market receipts	2.559.527	121,9
1.2 Other returns		
Interest on savings	30.751	1,5
Sum other returns	30.751	1,5
1.3 Total farm returns	2.590.278	123,3
2 Total input		
2.1 Total variable costs crop and forage	73.568	3,5
2.2 Cow-calf		
Animals	10.560	0,5
Purchase feed costs	216.551	10,3
Other fixed and var. costs	19.800	0,9
Total expenses cow calf	246.911	11,8
2.3 Beef finishing		
Animals	644.371	30,7
Purchase feed costs	49.269	2,3
Other fixed and var. costs	7.996	0,4
Total expenses beef finishing	701.636	33,4
2.4 Total fixed expenses	116.424	5,5
2.5 Total labour expenses	143.524	6,8
2.6 Total interest on liabilities		
2.7 Depreciation		
Machinery econ. accounting	14.115	0,7
Buildings econ. accounting	188.379	9,0
Total farm depreciation	202.494	9,6
2.8 Total farm input	1.484.558	70,7
3 Farm profit	1.105.720	52,7

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

For a long-term consideration of profitability, the opportunity costs for own production factors (family labour, own land and capital / equity) must be considered (see Table 3).

- It reflects the fact that family labour could earn a salary outside of the farm, own land could be rented out to other producers or investors and instead of investing in equipment; the capital could be taken to a bank to earn interest. In the case studies analysed, opportunity costs for labour are zero (only employed, paid labour).
- The main opportunity cost of the Baseline is land, followed by capital. The opportunity cost for land was valued by the producer and expert groups with an average (for productive and non-productive land) rental price of USD 53 per ha for the Baseline. Multiplied by the 21,000 ha, the total opportunity cost for land adds up to USD 1,103,500 per year. The opportunity cost for capital reaches USD 220,000 per year (USD 10 per ha) and represents approximately one tenth of the opportunity cost for land. The total opportunity cost for the Baseline is then USD 1,323,000 (USD 63 per ha).
- The return to management is calculated by deducting the opportunity costs from the medium-term profit. The return to management for the farm owner is negative USD -217,000 (USD -10 per ha). This means that from a long-term perspective, the business is not profitable. However, in this context some aspects should be mentioned. The producers do not usually take a long-term view and it is not an exception that the return to management can be negative when compared with other farms, even on global level. In the long-term, however, low profitability creates an incentive to change land use to a more profitable option – if available – for example crop production. On the other hand, but following a similar line of argumentation, when generational succession occurs, these points can be taken into careful consideration by the next generation.

Table 3 Opportunity cost, medium and long-term profit Baseline (USD/year and USD/ha)

	USD / year	USD / ha
Medium term profit	1.105.720	53
Opportunity cost		
Labour	0	0
Land	1.103.520	53
Capital	219.519	10
Total	1.323.039	63
Long term profit	-217.318	-10

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

4.2 Integration of Beef and Crop production (IBC)

As it has been observed in the Baseline analysis of this study, land opportunity costs for beef production are higher than profit, illustrating that other options of land use should be explored in order to secure profitability in the long term. In recent years, according to regional experts, farms producing beef and crops simultaneously became popular in some regions in Paraguay. The term 'Integration Beef and Crop' (**IBC**) comprises two enterprises: beef production (cow-calf plus beef finishing) as well as crop production (soybean and rotations with maize and sorghum). Crop production in this study is an option adopted by the farm, intervening in 15% of the grazing areas over a period of approximately 3 years (establishing crop production). The main objective of the crop enterprise is a) selling to (external) markets as a cash crop and b) transferring part of the crop production as feed to the beef finishing units. The IBC scenario involves important changes in management, investments, inputs, grass varieties, and consequently, high levels of investments. The IBC scenario has been identified, specified, quantified and validated jointly between local producers and experts, the WWF team, and *agri benchmark* staff.

Table 4 shows a list of the elements identified for the IBC scenario. The interventions to the Baseline are significant and comprise the following elements:

- Establishment of crops on 15% of the improved pasture area. The crops chosen are soybean for sale and sorghum and maize silage for own consumption in the finishing enterprise.
- Beef production involves the following changes: cow-calf production stays in the grazing areas (improved pastures) and the finishing animals that shared the grazing areas with the cows in the Baseline are now transferred to a new semi-confined area (feedlot unit).
- Feedlot installations and pens are built to hold the finishing animals, there they are fed with the crops produced on farm.
- The number of cows is increased, and the productivity parameters improve, due to better feeding conditions (increased amounts of better quality forage are produced).
- Specialised advisory services accompany and assist the interventions and certain crop production operations (seeding, planting, harvesting, etc.) are outsourced to contractors.

Table 4 also shows that the elements are introduced step by step and not all in one go. The reasons are a) management capacity limitations, b) restrictions on capital and loan availability and c) not all elements are required immediately and at the same time.

Table 4 Elements of the 10-year IBC scenario

Strategy	2017	2018	2019	2020	2021	2022	2023	2024	2025
Information management system	XX	XX	XX	XX	XX	XX	XX	XX	XX
Technical advisory service + (information system, grassland and crop management)	XX	XX	XX	XX	XX	XX	XX	XX	XX
Supplementing programs (nutritional blocks only for young heifers finishing cattle)		X	X	X	X	X	X	X	X
Crop production on 15% of existing pastures	XX	XX	XX	XX	XX	XX	XX	XX	XX
Finishing in feedlot (animal and feed management)	X	XX	XX	XX	XX	XX	XX	XX	XX

Note: The number of ‚x' indicates an increasing level of the intervention
Source: Local expert groups

A total of approximately USD 845,000 in investments (slightly more than USD 40 per ha) is needed. The total investment is made in the first year of implementation. It is financed through credits with a nominal interest rate of 9 percent. Table A.1 in the Annex shows the amounts and the timing of the required investments. The past investments required for the implementation of the improved pastures are also listed in Table A.1.

Figures 5 and 6 show some of the elements introduced.

Figure 5: Crops (Sorghum) for IBC

Source: Martín Mongelós / WWF Paraguay

Figure 6: Infrastructure for cattle feed: paddock subdivisions and drinking points

Source: Martín Mongelós / WWF Paraguay

Table 5 illustrates the changes to all performance and technical parameters from the calculations during the IBC implementation phase. Tables 6 and 7 show the economic results for the implementation period in total USD per farm and per ha. The following key issues can be highlighted:

- The *additional labour* requirement for the beef enterprises is fulfilled by employing three additional cattlemen in the year 2017, while the crop activities are outsourced to a contractor.
- The improvement of herd management gradually leads to a productivity increase from 69 to 74 percent weaned calves in the last year of implementation. This increase is achieved through the improvement of cow fertility, improvement of the forage quantity and quality (the introduction of crop feeding for the finishing animals allows a more efficient use of grassland by the cows), and the introduction of protein cubes for the replacement heifers, all of which is accompanied by a technical advisory service.
- The combined effect of the above measures allows an increase of 30 percent in the number of weaners produced per year from 3,090 to 4,040.
- The finishing enterprise shows a significant increase of sold animals per year from 1,980 to 2,660 (34% more). Due to the heifer requirement for the growth in number of cows, the number of females available for finishing during the implementation of the new system is lower than in the Baseline. Once the cowherd reaches the maximum number of cows the numbers stabilise and the production of finished animals is constant (1,970 males and 690 females).
- The new feeding system allows a better daily weight gain with constant final weights, which allows a reduction of the finishing period.

Table 5 Technical results of the IBC implementation (from Baseline/year 0 to year 9 of implementation)

Technical and managerial details	Integration cattle - crops									
Year of analysis	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Year of implementation	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Production system	Cow-calf and finishing									
Labour										
Manager	2	2	2	2	2	2	2	2	2	2
Foreman	4	4	4	4	4	4	4	4	4	4
Cowboy	4	4	4	4	4	4	4	4	4	4
Cattlemen	12	15	15	15	15	15	15	15	15	15
Cook	3	3	3	3	3	3	3	3	3	3
Financial policy / credits										
Credit amount taken in the year	no	704.000	no	no	no	no	no	no	no	no
Technical advisory service	no	yes								
Cow-calf										
Feeding system	Rotational grazing improved pastures									
Supplementation strategy	Minerals		Protein core (for replacement heifers younger than 1 year)							
Number of cows	4.500	4.500	4.500	4.750	5.000	5.250	5.500	5.500	5.500	5.500
Age at first calving (months)	31	31	31	27	27	27	27	27	27	27
Weaning rate (No. of calves per 100 cows and year)	0,70	0,70	0,73	0,75	0,75	0,75	0,75	0,75	0,75	0,75
Number of calves born alive per cow and year	3.150	3.150	3.285	3.563	3.750	3.938	4.125	4.125	4.125	4.125
Number of weaners weaned per cow and year	3.086	3.086	3.219	3.491	3.674	3.860	4.043	4.043	4.043	4.043
Weaning age - male / female (days)	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240
Weaning weight - male / female (kg)	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220
Male weaners sold (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Males transfered to backgrounding (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Females sold (%)	32%	32%	0%	18%	16%	18%	35%	35%	35%	35%
Females kept (%)	68%	68%	100%	82%	85%	82%	65%	65%	65%	65%
Cows mortality rate (%)	2%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Weaners mortality rate (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Finishing										
Feeding system	Rotational grazing improved pastures									
			Own forage feeding (maize and sorghum silage and sorghum)							
Supplementation strategy	Minerals		Mineral and protein core							
Weaners transferred to finishing (No.)	2034	2034	1543	1900	2016	2175	2606	2729	2729	2729
Age at start of finishing - male / female (days)	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240	240 / 240
Age at end of finishing - male / female (days)	700 / 700	700 / 700	540 / 540	540 / 540	540 / 540	540 / 540	540 / 540	540 / 540	540 / 540	540 / 540
Period of finishing - male / female (months)	15,3 / 15,3	15,3 / 15,3	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10
Weight at start of finishing - male / female (kg LW)	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220	234 / 220
Weight at end of finishing - male / female (kg LW)	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450	420 / 450
Weight gained - male / female (kg)	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230	186 / 230
Daily weight gain - male / female (grams per day)	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500	404 / 500

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

Table 6 Profit and Loss Account during the IBC implementation period (USD total values)

Integration cattle - crops	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 Total Returns										
Crop returns			839.685	856.448	987.923	905.534	734.304	662.834	662.834	662.834
Cow calf market receipts	1.233.619	1.233.619	1.078.070	1.438.589	1.259.597	1.342.229	1.510.450	1.596.197	1.588.066	1.596.197
Beef finishing market receipts	1.325.908	1.325.908	988.574	1.231.257	1.303.936	1.409.620	1.701.131	1.780.757	1.780.757	1.780.757
1.3 Total Farm Returns	2.590.278	2.614.836	3.000.410	3.579.425	3.701.582	3.810.741	4.050.418	4.060.445	4.060.566	4.065.098
2 Total Input										
2.1 Total variable costs crop and forage	73.568	62.304	645.493	645.493	645.493	645.493	645.493	645.493	645.493	645.493
2.2 Total expenses cow calf	246.911	246.911	267.603	263.564	277.291	289.512	291.314	291.451	291.920	291.920
2.3 Total expenses beef finishing	701.636	9.352	647.591	797.342	846.083	912.817	1.093.661	1.145.345	1.145.345	1.145.345
2.4 Total fixed expenses	116.424	159.016	159.016	159.016	159.016	159.016	159.016	159.016	159.016	159.016
2.5 Total labour expenses	143.524	158.836	158.836	158.836	158.836	158.836	158.836	158.836	158.836	158.836
2.6 Total interest on liabilities		84.480	85.899	65.011	53.440	37.848	21.761	4.135	4.368	4.283
2.7 Total farm depreciation	202.494	237.694	237.694	237.694	237.694	237.694	237.694	237.694	237.694	237.694
2.8 Total Farm Input	1.484.558	958.594	2.202.133	2.326.956	2.377.854	2.441.217	2.607.776	2.641.970	2.642.673	2.642.588
3 Farm profit	1.105.720	1.656.242	798.278	1.252.469	1.323.728	1.369.525	1.442.642	1.418.475	1.417.892	1.422.509

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

Table 7 Profit and Loss Account during the IBC implementation period (USD / ha)

Integration cattle - crops	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 Total returns										
Crop returns			40	41	47	43	35	32	32	32
Cow-calf market receipts	59	59	51	69	60	64	72	76	76	76
Beef finishing market receipts	63	63	47	59	62	67	81	85	85	85
1.3 Total farm returns	123	125	143	170	176	181	193	193	193	194
2 Total input										
2.1 Total variable costs crop and forage	4	3	31	31	31	31	31	31	31	31
2.2 Total expenses cow-calf	12	12	13	13	13	14	14	14	14	14
2.3 Total expenses beef finishing	33	0	31	38	40	43	52	55	55	55
2.4 Total fixed expenses	6	8	8	8	8	8	8	8	8	8
2.5 Total labour expenses	7	8	8	8	8	8	8	8	8	8
2.6 Total interest on liabilities		4	4	3	3	2	1	0	0	0
2.7 Total farm depreciation	10	11	11	11	11	11	11	11	11	11
2.8 Total farm input	71	46	105	111	113	116	124	126	126	126
3 Farm profit	53	79	38	60	63	65	69	68	68	68

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

- Regarding medium-term economic performance, IBC allows better profits (tables 6 and 7). Compared with the Baseline, the profit in the IBC scenario increases by 29 percent (from USD 53 to USD 68 per ha).
- From 2018 onwards, crops (mainly soybean) are being sold and on the last year of analysis crop market sales represent 16 percent of the total returns. The implementation of IBC increases the total farm returns compared to the Baseline by 56 percent (from USD 2,590,278 to 4,065,098).
- Regarding the crop variable costs in the last year, they account for USD 645,493 per year. As beef finishing is an enterprise that is growing throughout the period of analysis, variable costs of the enterprise have increased by approximately 63%. Their main component is the animal purchase by the finishing enterprise from the cow-calf enterprise (internal transfers).
- Total interests on liabilities appear from 2017 onwards due the bank loan for establishing the crop enterprise. Comparing Baseline with last year of analysis, total costs (total farm input) have increased by 78% while profits have gone up by 28%.

The long-term profitability was also explored (see Table 8):

- Since labour continues to be provided by employed workers, no opportunity costs for labour have been considered.
- The opportunity cost of land is valued by the producer and expert groups at an average (for productive and non-productive land) rental price of USD 62 per ha for the IBC. Multiplied by the 21,000 ha, the total opportunity cost for land adds up to USD 1,305,500 per year. The opportunity cost for capital reaches USD 203,000 per year (USD 10 per ha). The total opportunity cost for the IBC is then USD 1,508,000 (USD 72 per ha).
- Deducting the opportunity costs from the medium-term profit results is the return to management. The return to management for the farm owner is negative with USD -85,500 (USD -4 per ha). This means that from an exclusively economic point of view, the business in the long term is not profitable. However, the economic performance of the IBC is better than the one of the Baseline.

Table 8 Opportunity cost, medium and long term profit IBC (USD/year and USD/ha)

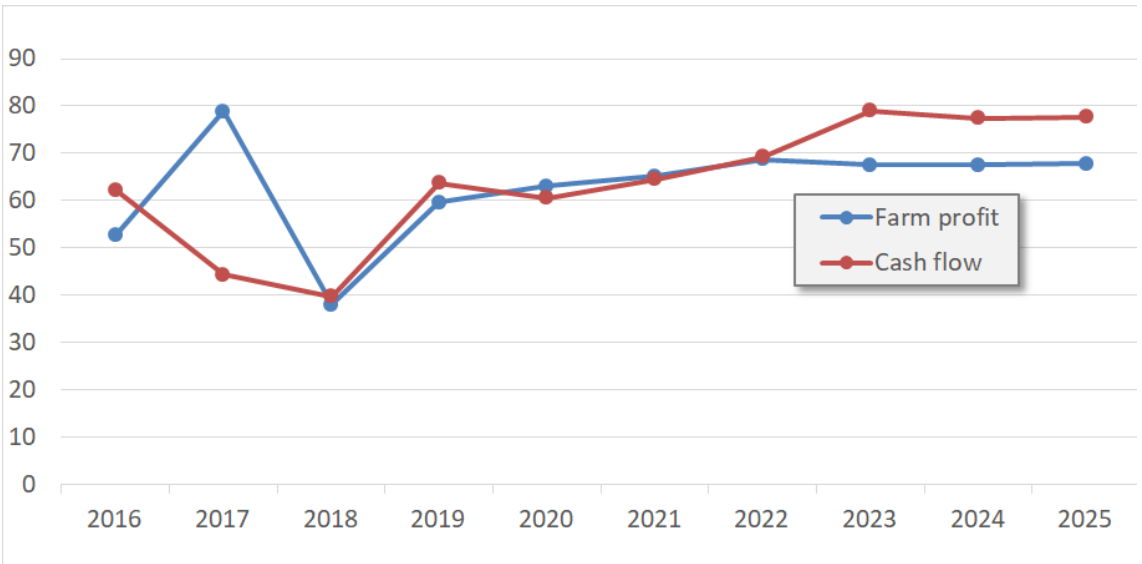
	USD / year	USD / ha
Medium term profit	1.422.509	68
Opportunity cost		
Labour	0	0
Land	1.305.427	62
Capital	202.542	10
Total	1.507.969	72
Long term profit	-85.460	-4

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

Figure 7 shows the farm profit as well as the cash flow during the implementation period.

- The **cash flow** decreases in the first two years. The first and larger reduction (in the first implementation year) is mainly due to the investments required for implementing the IBC. The second reduction occurs in the second implementation year and is the consequence of a combination of 1) higher costs derived mainly from the crops, 2) crops still not fully producing, having diminished returns, and 3) a reduction in the returns of the finishing enterprise, coming from the reduced number of female weaners caused by the cowherd growth.
- In the third year, a marked increase of the **cash flow** takes place, due to a significant increase of the returns: gradually more weaners (especially males) enter the finishing enterprise from the growing cowherd and the maximum crop yields are reached. Later, the cash flow continues increasing but not as sharply as in the third year: the number of finished animals increases and the feed requirements balance the supply, the sold surplus of feeding crops decreases, and the crop returns reduce. From the seventh year on the system is balanced and the cash flow stabilises at a level which is 25 percent higher than the Baseline.
- The sharp increase (50%) of **farm profit** in the first implementation year is due to the fact that on that very first year the animals already in the system are sold but no new animals enter the finishing enterprise to allow crop planting. Thus, the farm has the returns from the sold animals but no costs for new animals. After the third year, the farm profit increases and stabilises on the sixth. Final values after implementing IBC (year 2025) are higher than the Baseline (around 29%). The risk level implied in adopting the IBC is relatively low as the cash flow and profit values never go into negative figures. This situation is mainly due to a) a comparably profitable situation in the Baseline and b) a relatively low level of investments required for IBC.

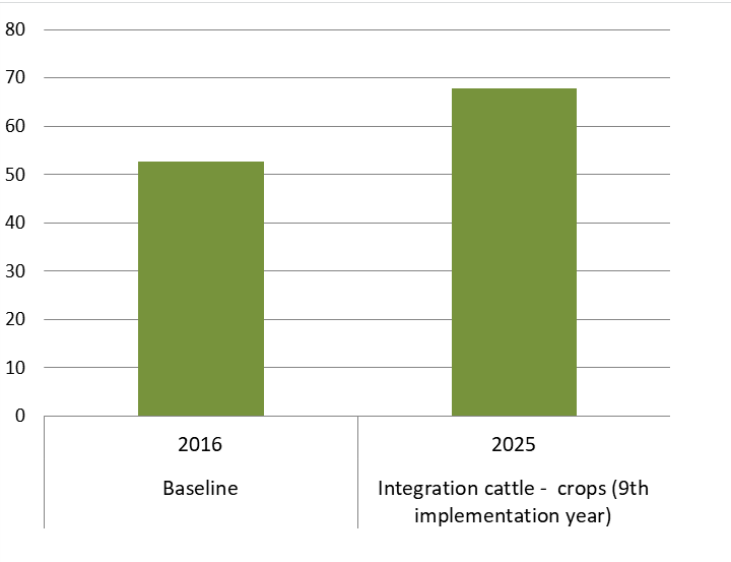
Figure 7: Medium-term profit and cash flow during the IBC implementation period
Cow-Calf only (USD per ha)



Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

Figure 8 compares profit per ha between Baseline and last year of analysis after implementing IBC; results show in increment of 29% (USD 68 vs. 53 per ha).

Figure 8 Comparing Baseline and IBC's profits (USD per ha)



Source Local expert focus groups and own calculations using the *agri benchmark* tools.

5 Conclusions and recommendations

This case study provides a clear analysis of one of the land use options that are currently being taken into consideration in the region: integrating beef production and crops. Beyond the case study level, the following remarks can be made.

Beef production Baseline (business as usual)

- Beef is produced in the region by forest clearing. Both forage and animal production are achieving medium to high performance levels, mainly due to the implementation of management practices that are already above average.
- This type of production is implemented with a relatively high level of capital investment, forcing the producer to achieve better returns on land compared to previous uses (extensive grazing).
- Beef production in the short and medium-term is profitable (considering cash-costs and depreciation). However, in the long term, increasing opportunity costs, mainly for land and stemming from increasing crop profitability, could play an important role for changing land uses to other options (e.g. crops).
- In the region, some crops like soybean have been explored in conjunction with beef production as a land use option.

Integration Beef and Crop Production (IBC)

- Integrating crop and beef production produces better profits compared with the Baseline. Returns from crops are complemented by selling soybean to external markets. Under the integration scheme, 30% more weaners are produced and, consequently, 34% more animals can be sold at the end of the beef finishing phase. Crop rotation provides improved feed quantity and quality that allows the herd to grow and hence increases the number of weaners available.
- Integration schemes require changes in the management of beef production. Semi-confined areas are required offering additional forage to weaners and all cropping activities are managed by outsourcing important operations to contractors.
- When implementing the IBC (in the first two years of implementation) the cash flow, as well as the profit (in year 3) decrease. This aspect has to be taken into consideration when planning this option, especially if profitable situations could turn into losses.
- Compared to the Baseline, IBC shows better economic results (profit increase by 29%). In general, the IBC is more profitable than the Baseline. However, in the long term, incorporating the land opportunity cost in the analysis, the option has difficulty competing with crop-only systems.
- For the cow-calf and beef finishing on cleared forest (Baseline and IBC scenarios), the productivity analysis implemented does not reflect the improvement of soil quality over time (after a long period of monoculture using introduced pastures). The resulting effect is reflected neither in animal productivity nor in profitability. This information was not available in the project. Future studies should consider this aspect when comparing enterprises for land competition over a period of time.

- Advisory services are an important factor accompanying the adoption of BMPs. Supporting and funding advisory services is certainly a role for governments and public institutions (capacity building). They should have an integrated approach in terms of sustainability and production system economics and the ability to link all the production system factors to this vision.

Actions and policy programs are needed to incentivize conservation and the adoption of BMPs setting up financial programs for the facilitation of the adoption process.

Opportunities, potential threats and land competition

- This study shows that it is possible to produce more beef and to be more profitable in the same area by adopting other production systems and thus avoiding further deforestation.
- Preliminary results of additional calculations as shown in Table 9 are an attempt to quantify the amount of land, which could remain in its natural state (native forest)[1].

- The study shows that changing the system to an IBC allows a) for more animals to be kept, b) more meat to be produced, c) animal and land productivity to increase and d) thus for profitability to increase. For the same increases to be achieved with the production system in the Baseline, an additional 2,900 ha would be needed.

Table 9 Comparing land use and beef production under IBC programs

Cow-calf	Baseline	IBC	Difference
Number of cows	4.500	5.500	1.000
Finishing			
Weaners transferred to finishing (No.)	2.034	2.729	695
Number of finished animals	1.983	2.669	686
Total	**8.517**	**10.898**	**2.381**
Stock (heads/ha)	0,82	1,04	0,23
Area needed to increase 2.381 heads unit with the baseline stock (0,82)	2.904	ha	

Source: Own calculations

- Other land use options (i.e. IBC) are gaining importance in the region and open a space for additional long-term analysis and perspective. This option, accompanied by regulatory schemes and frameworks, could lead to a reduction in new interventions, using less land for beef and crop production. Additional and more detailed studies will be required to explore these options.
- In general terms, when comparing profit and opportunity cost for land, it seems that there is an imbalanced situation (opportunity costs higher than profit per ha. The high level of opportunity costs can result from a) more competitive land use options and/or b) speculation on increasing land values because of improved infrastructure or lack of alternative investments or c) the fact that land investment takes place with motivations not directly related to agricultural production and its potential output.

- When comparing Baseline with IBC, there is a clear difference in terms of profit and this difference could lead to a competition for land access. This competition is probably reflected in the current opportunity costs for land (greater than profit).
- The calculation of profit, opportunity costs for land, and investments required for the Baseline and IBC scenario has taken into account the current limiting factors such as road and electrical infrastructure. Those aspects may change substantially, if these limiting factors could be overcome. Then, it is likely that beef production would be replaced by crop production, particularly soybean and maize, especially on former forestland.
- It is important that future studies can represent profit margins for long-term periods, considering soil quality and its associated productivity (possible land degradation).
- In the future, one of the constraints for farmers to adopt best management practices, is the risk implied (mainly climatic conditions) during the adoption period. As this region has recently suffered extreme climatic conditions, possible programs should consider insurance schemes that could cover the critical period of BMP implementation (first 3-4 years).
-

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Annex 1

Table A.1 BMP strategy – Investments required for implementing BMP (USD total values)

Previous investments specific for the finishing and suckler cow activities				
Original buildings (house + shed)	2010	-6	26.399	26.399
Artesian wells	2010	-6	26.399	26.399
Cattle yards 1&2	2010	-6	70.398	
Cattle yards 3&4	2014	-2	70.398	140.795
Establishment of pastures (2090ha) + water supply (2 turkey nests and solar pumps)	2010	-6	1.082.717	
Establishment of pastures (2090ha) + water supply (2 turkey nests and solar pumps)	2011	-5	1.082.717	
Establishment of pastures (2090ha) + water supply (2 turkey nests and solar pumps)	2012	-4	1.082.717	
Establishment of pastures (2090ha) + water supply (2 turkey nests and solar pumps)	2013	-3	1.082.717	
Establishment of pastures (2090ha) + water supply (1 turkey nest and solar pumps)	2014	-2	1.056.318	5.387.188
Van 1	2010	-6	17.599	
Van 2	2012	-4	17.599	
Van 3	2014	-2	17.599	52.798
Tractor 1	2010	-6	26.399	
Tractor 2	2013	-3	26.399	52.798
Electric generator (2)	2010	-6	8.800	8.800
Motorbike 1 & 2	2010	-6	1.760	
Motorbike 3 & 4	2013	-3	1.760	3.520
Weeding machines (4)	2010	-6	1.408	1.408
Chainsaw (4)	2010	-6	1.408	1.408
Horses (10 heads)	2010	-6	8.800	
Horses (10 heads)	2012	-4	8.800	
Horses (10 heads)	2014	-2	8.800	
Horses (10 heads)	2016	0	8.800	35.199
Total previous investment				**5.736.712**

Source: Local expert focus groups and own calculations using the *agri benchmark* tools.

Annex 2

Table A.2 Participants list in the workshops

	Name	Affiliation	Participation dates			
			Jul-17	Mar-18	Nov-18	other
1	Alejandro Serrati	Producer				
2	Alexander Laratro	Producer				
3	Amalio Ríos	Producer				
4	Carlos Passeriu	Producer				
5	Celso Muxfeldt	Producer				
6	Daniel Ríos	Producer				
7	Diego Ramírez	Producer				
8	Egon Neufeld	Producer				
9	Fernando García	Producer				
10	Gabriela Leguizamón	Producer				
11	Guido Ferreira	Producer				
12	Jaime Athorpe	Producer				
13	Jazmín Rivarola	Producer				
14	Jose Estigarribia	Producer				
15	José Renato Saalfeld	Producer				
16	Josue García	Producer				
17	Julio Ávila	Producer				
18	Marcelo Balmelli	Producer				
19	Mateo Felipe Bravo	Producer				
20	Maurizio Scavonne	Producer				
21	Paul Martínez	Producer				
22	Philipp Reimer	Producer				
23	Raúl Rivarola	Producer				
24	Ricardo Mongelós	Producer				
25	Rosalia Goerzen	Producer				
26	Sebastian Boldt	Producer				
27	Willy Franz	Producer				

Source: Own compilation