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Bos indicus and *Bos indicus* x *Bos taurus* heifers performance under two grazing systems in the Arid Chaco of Argentina

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Abstract

The objective of this study was to assess the beef cattle production potential of the Arid Chaco ecosystem through a sylvopastoral system with two different breeds Nelore (*Bos Indicus*) and Braford (*Bos indicus* x *Bos taurus*), and two grazing managements (rotative and alternative) on a Buffel Grass (*Cenchrus ciliaris L.*) var. Nueces pasture. Twenty-eight growing heifers (365-385 days of age), 14 Nelore (*Bos indicus*) and 14 Braford (*Bos indicus* x *Bos taurus*), were randomly assigned into two groups containing seven heifers of each breed. Stocking rates of two heifers/ha were assigned.

The most significant finding in this study was the capacity of the silvopastoral system to support two growing heifers/ha, up to 270 kg live weight gain/ha/year, without any feed supplementation. The kg/ha yield in the silvopastoral system means a great improvement compared to the present yields (4 to10 kg beef/ha/year) obtained at the Arid Chaco with traditional beef cattle production systems. Results indicate the great potential of the silvopastoral system to produce beef cattle on the Arid Chaco, without performing a complete elimination of the natural tree stratus.

Keywords: Braford, Buffel Grass, Cenchrus ciliaris L., Nelore, silvopastoral

Introduction

Argentina is one of the world wide largest food producer and exporter. It is the fifth larger producer of beef cattle, contributing in 2006 with 2.98 million tons (4.9% of world production) (FAO 2008). The 61% of the beef cattle are produced in the humid and sub-humid flat Pampas. The 65% of the farms dedicated to breed and fattening the beef cattle are located there (Rotolo et al 2007).

Last years, due to the high revenue of the food crops, the beef cattle production started to move to the arid and semiarid lands where these crops cannot be produced economically. This fast substitution process could affect beef cattle's industry, as well as the stability of the fragile dry lands environment (Morello and Saravia Toledo 1959; SECYT 1986; Ayerza 1992).

This region is the driest part of the Great South American Chaco plains, with more than 100 millions hectares. It is the second largest South American ecosystem, following the Amazon. Although it shares some characteristics with neighboring phytogeographic regions (Monte Desert and Semi-Arid Chaco), it has features of its own, on account of which it can be treated as a unique ecosystem (Ayerza et al 1988).

The Dry Chaco climate is characterized by having high temperatures in summer and moderate temperatures in winter, with 5 to 15 days/year of frosts. Rainfall is concentrated in the warm season, and 80% of the total occur between November and April. Mean annual rainfall ranges from 500mm in the East to 300mm in the West (SECYT 1986).

The Arid Chaco climax vegetation has been strongly modified by overgrazing and deforestation (SECYT 1986; Ayerza et al 1988). Only traces of the climax plant cover reconstructed by observing the no so altered areas, remain. The predominant vegetation was as follows: A xerophytic tree layer: low (7 to 12m high) and not dense; made up mostly of Aspidosperma quebracho blanco Schltdl, and Prosopis spp. There is no abundant tree species, such as *Ziziphus pistol* Grisea and *Celtis tala* Gill, ex Planch and Scutia. Herbaceous vegetation is dominated by C_4 grasses, mostly species of genus *Chloris, Digitaria, Setaria,* and *Trichloris* (Díaz and Karlin 1984).

The original vegetation changed to a continuous shrub land with isolated trees and small spots dominated by grasses. Most of the new structure is formed by shrubs from the genus *Larrea, Cercidium, Cassia,* and Cactaceae as *Opuntia spp.*, and *Cereus spp.*, and annual grasses of the genus *Aristida*, and *Boutelaua* (Ayerza et al 1988). This bush cover competes strongly with the herbaceous stratus and with second-growth trees, precluding rapid recovery (Karlin and Díaz 1984). Therefore, forage and consequently animal production have decreased dramatically. The present and basic production system are extensive livestock farming (cattle and, to a lesser extent, goats and sheeps), with sporadic extraction of forest products. The real output of the region is low, with 4 to 10kg of live weight gain/ha/year, at stocking rates of 15 to 20ha/cattle head, 40% to 50% calves of 120kg at weaning (Calella1986; Bocco et al 2007; Blanco et al 2008).

However, the beef cattle production potential can be strongly increased in the Arid Chaco through the implementation of systems including species adapted to arid lands, such as Zebu cattle (*Bos indicus*), and Buffel Grass (*Cenchrus ciliaris* L.), as it was reported in a number of papers (Ayerza 1981a, 1982, 1988, 1991; Ferrando et al 1985; Seia 1985). In addition, the use of silvopastoral systems have been reported as an effective means of improving the overall forage quality in a number of arid and semiarid ecosystems (Saravia Toledo 1984, 1989; Le Houérou 1987; Ainalis et al 2006; Tefera et al 2007), maintaining its sustainability (Le Houérou 1993). An abundant tree cover dominates the environment, by modifying sunlight intensity and quality, changing the water balance and the nutrient cycle. Its influence is evidenced by changes in the soil, and in the amount, composition and quality of the species under tree canopies. In a fragile region such as the Dry Chaco, these features, if well managed, can have great relevance in increasing and sustaining productivity (Ayerza et al 1988; Saravia Toledo 1989; Diaz 2003). However, the productivity of Buffel Grass and native trees association system, for animal production in the Arid Chaco, has not been reported. Although this study was carried out in 1993, it was neither published nor presented at any conference. This study could help to understand the potential of this ecosystem for beef cattle production and avoid the indiscriminate deforestation practice as a normal methodology to sow pastures for the former Humid Pampa's cattle, arriving to this region.

The objective of this study was to assess the beef cattle production potential of the Arid Chaco ecosystem with a Buffel Grass and native trees mixed pasture system, two different breeds, and two grazing managements.

Materials and methods

Study site

The research was carried out in the southern portion of the Arid Chaco region, 15km south of Villa Dolores town, Cordoba Province, Argentina. The farm was located at 31° 57' south latitude, and 65° 08' west longitude, and 470m above sea level. Soils are light sandy loam, pH: 7.6, poor in organic matter and nitrogen, and rich in calcium and phosphorus (Ayerza, 1988). Climatic conditions are typical of the Arid Chaco; main climatic characteristics throughout the experimental period are shown in Table 1.

Table 1. Weather conditions at the farm site during the experiment

Variable	**Months**											
°C	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Max T	31.5	29.3	29.3	25.9	21.6	16.5	16.9	20.5	22.9	28.7	29.6	33.7
Min T	18.4	17.3	15.8	13.5	8.5	3.1	3.6	5.7	8.5	14.5	15.3	19.9
Mean T	25.6	23.8	23.5	20.4	15.4	10.0	10.2	13.7	16.8	22.4	23.5	28.5
Max ext T	37.7	38.0	34.0	32.7	27.9	23.3	23.2	29.1	34.7	37.7	38.5	38.4
Min ext T	14.6	12.4	9.6	8.6	-1.8	-3.6	-3.1	-0.6	-2.2	5.6	8.0	13.1
Frost (days)	0	0	0	0	1[1]	6	3	1	2[2]	0	0	0
Rainfall mm	131.1	119.4	30.7	22.4	5.6	1.0	50.3	24.7	17.0	0.1	52.3	48.3

[1] May 5 (first frost); [2] September 8 (last frost)

Lands used were the typical Arid Chaco woodlands, highly eroded due to overgrazing and deforestation practices. In winter time, two years before the trial starts, the lands were shrubs cleaned. About 90% of them were creosote brush (*Larrea divaricata* Cav.). All the trees were kept being the Algarrobo Negro (*Prosopis nigra* Griseb) the largest component, followed by Quebracho Blanco (*Aspidosperma quebracho-blanco* Schltdl), Chañar (*Geoffroea decorticans* Gill ex Hook), and Brea (*Cercidium praecox* Ruiz and Pav), with 85.3, 13.9, 0.6, and 0.2% of the total tree density, respectively. Total tree density was 60 trees/ha, aged 15-30 years old, surviving from the last deforestation due to their young stage at that time.

Pasture and grazing system

Following the shrubs cleaning process, and twelve months before the trial starts, a pasture of

Buffel Grass (*Cenchrus ciliaris* L.) cv. Nueces was established, sowing 3 kg of certificated seed by hectare. Afterwards, the 28 hectares were divided in two same size fields using a conventional fence. North side division was subdivided in seven equally sized fields, and the south side division was subdivided in two equally sized fields using electric fence system inside of both divisions' subplots. The north and south fields were denominated rotational grazing system (RGS) and alternative grazing system (AGS), respectively.

The pasture grazing pressure was 8 and 2 animals/ha, for rotational and alternative grazing system, respectively. Stocking rates of two heifers/ha were assigned, and the minimum stubble height of 10cm of Buffel Grass used to move forward animals in the rotational system, based in previous experiences of trials achieved in adjacent fields of Buffel Grass pastures, but without keeping the natural trees on it (Ayerza 1981a, 1982). Animals were placed into the experimental fields from January 17 until December 28, the same year.

Forage production estimation was done on the original 28 hectares field, three days before the trial started. Thirty samples of one square meter each, selected at random, were cut by hand at 10cm of height. On June 14, analysis for crude protein content was done from an enclosure, ea. 20m x 30m in size. Samples from under tree canopies and samples from the open range were analyzed by separated. The forage samples were transferred in cool packages to the laboratory where fresh weight was determined. Afterwards the samples were chopped and dried at 70°C for 48 hours, and then dry weight was determined (Table 2). Protein determination was done by AOAC method (AOAC 1980).

Table 2. Buffel Grass var. Nueces: dry matter yields, and crude protein content.

Treatment	Dry matter[x]		Crude protein[y]
	kg/ha	%	%[3]
Under tree canopy	2,830[a1]	24.4[a]	8[a]
In the open range	1,325[b]	26.4[a]	5.1[b]
LSD[2]	810.173	3.947	0.817

[x] January 14th; [y] June 14th; [1] means in a line within a group with the same letter are not statistically different (P<0.05); [2] least significant difference for P<0.05; [3] percent of dry matter

Experimental animals

Twenty-eight growing heifers (365-385 days of age), 14 Nelore (*Bos indicus*) and 14 Braford (*Bos indicus* x *Bos taurus*), were randomly assigned into two groups containing seven heifers of each breed, in January 17. Before the experiment started, the Nelore and Braford heifers were inspected and accepted by the Heard Book of the Argentine Nelore Association and Argentina Braford Association, respectively. Both, Nelore and Braford animals were conceived, gestated, born and breed in the same farm, grazing Buffel Grass pastures. Braford heifers were F_1 as a result of a cross between Hereford cows and Nelore bulls. Live weights were recorded initially (January 17), and at day 28 of each month until December 28, included. At the end of the experiment, each cow was palpated to determine sexual maturity by Dr. Vet. Carlos Taboada Candiotti (College of Veterinary, National University of Northeast). The daily gain was calculated by dividing the change in live weight by the number of days between monthly weights. Each grazing system yield was calculated by dividing the total live weight gain/year by the number of hectares of each treatment.

Statistical analysis

The trial was set up as a completely randomized design, with the experimental unit being one heifer. Each variable was compared by analysis of variance. When the F-value was significant ($P<0.05$), means were separated using the Least Significant Difference Test. The statistical program used in the present study was Cohort Stat 6.311(Cohort Stat 2006).

Results and discussion

Pasture production characteristics

As the Buffel Grass is a non frost resistant plant, its growing season length is a frost free period dependent (Pandeya et al 1977). As it was reported, its vegetative growth starts after the last frost occurs; however, growth rates are minimum until rains and high temperatures fulfill species requirements, which in the Arid Chaco in general are set up at the end of January lasting up April or May, depending on the first frost date. Although the Buffel Grass does not have an aggressive growing rate until the rainy season starts, immediately after the frost season ends and an increase in temperatures is evident, Buffel Grass starts to produce new vegetation (Pandeya et al 1977; Ayerza 1981b).

Buffel Grass dry matter production at starting date, and crude protein content on June14, under and out of a tree canopy, are presented in Table 2. Significantly ($P<0.05$) higher dry matter yields and protein content under trees' canopy than that on the open range, agree with early results reported by Diaz and Karlin (1984) for Buffel Grass var. Texas 4464, under and out canopies of Algarrobo Negro (*Prosopis nigra* Griseb) tree, at the same location. However, dry matter yields found in this study were lower than those reported by Diaz and Karlin (1984). Disagreement between experiments could be related to the fact that the Buffel Grass forage quality and quantity of these two growing conditions (under and out of a tree canopy) are affected by the period of time since the grass has been sown, by the climatic conditions of the year, by the Buffel Grass variety, and/or by its interactions (Ayerza and Ortubia 1986; Ayerza et al 1988). Starting forage's dry matter yield availability was coincident with that used by Ferrando et al (1985), as indicator to graze a Buffel Grass pasture in the Arid Chaco.

Protein content obtained herein (Table 2) was in agreement with values reported by Diaz and Karlin (1984), for the Buffel Grass collected in winter, and confirmed the higher protein content of the Buffel Grass forage growing under the Algarrobo Negro canopy, compared with that growing in the open range. The open range value for crude protein was in agreement with that reported for the Buffel Grass var. Nueces, growing in the Arid Chaco in an open range also (Ayerza and Ortubia 1986).

Body live weights: results between breeds

Monthly live body weight for the Nelore and Braford heifers grazing under a rotational system showed significantly (P<0.05) higher body live weight in Braford heifers compared to that from Nelore heifers for all measured dates, including the month one (Figure 1).

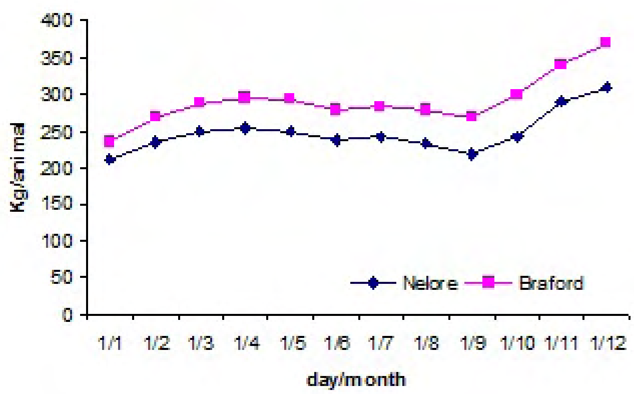

Figure 1. Rotative grazing system: Nelore vs. Braford

Because the weights at starting day had this statistical (P<0.05) difference also, and it was maintained all over the trial, no significant (P<0.05) differences between the breeds could be determined.

However, in the alternative grazing system, where the breeds had no statistical differences in starting body live weights, Braford heifers presented significantly (P<0.05) higher live body weight than that of Nelore heifers at dates F-28, M-28 and D-28 (Figure 2).

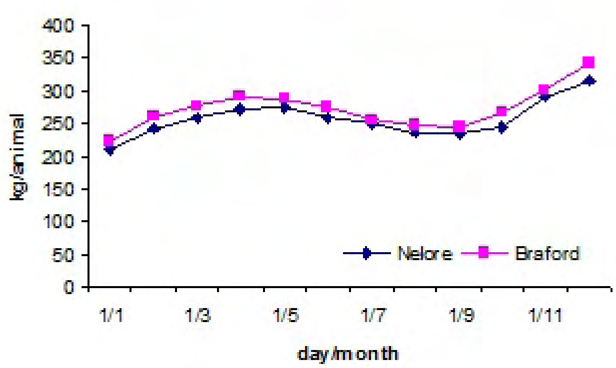

Figure 2. Alternative grazing system: Nelore vs. Braford

This significant (P<0.05) difference agrees with a similar Braford advantage when an early research comparing Nelore and Braford growing calves grazing a Buffel Grass var. Texas 4464 pasture, but free of trees, showed a highly significant (P<0.001) live body weight difference for the Braford heifers (Ayerza 1988).

As in the results between the breeds, overall statistics differences cannot be attributed to a real cause, because the difference was present at the trial starting date, also (Figure 3.)

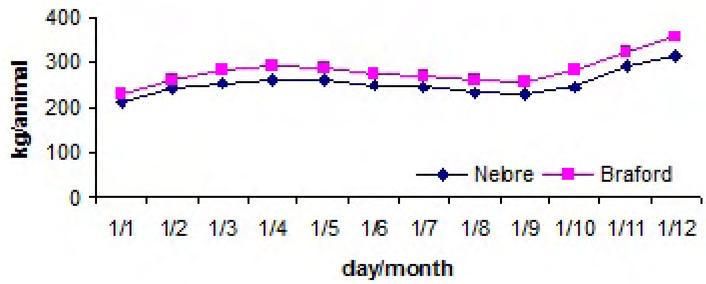

Figure 3 Overall: Nelore vs. Braford

Body live weights: results between grazing systems

No significant (P<0.05) difference in live body weight between grazing systems within Nelore heifers was detected (Figure 4).

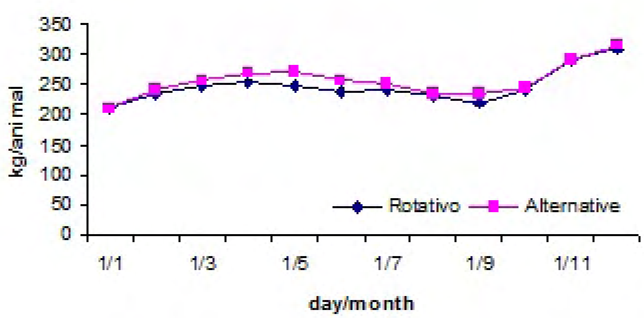

Figure 4. Nelore: alternative vs. rotative grazing system

The statistical (P<0.05) difference between grazing systems, within the Bradford breed, as it was reported for the results between the breeds also, cannot be attributed to a real one because the difference was measured all over the trial since the first weight was performed (Figure 5).

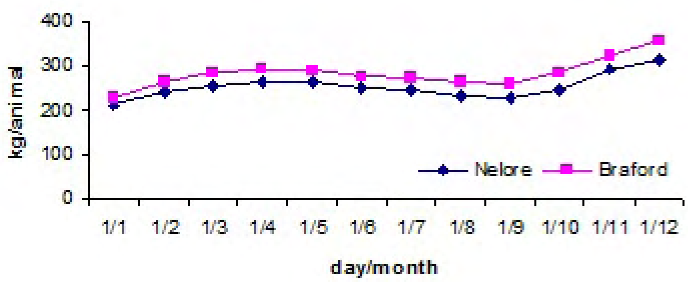

Figure 5. Braford: alternative vs. rotative grazing system

In support of that, when overall results between grazing systems were compared, no significant (P<0.05) differences were detected (Figure 6) at any date.

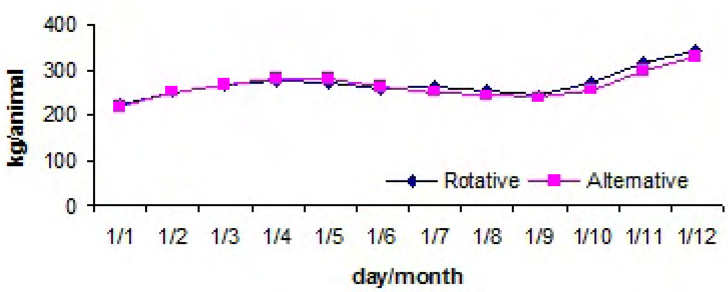

Figure 6. Grazing systems: alternative vs. rotative

Daily weight gains were negative at date M-28, J-28, J-28, A-28, and S-28 (Data not showed). All these months received one or more frosts (Table 1). As the Buffel Grass is a non frost resistant plant, its growing season length is a frost free period dependent. The first frost occurred at the trial on May 5 and the last one on September 8, with a total of 13 days with frosts (Table 1). During that period, Buffel Grass had no green vegetation, showing low levels of crude protein (Table 2).

The weight gains measured after the last frost (October, November, and December) were the highest of the trial (Table 3).

Table 3. Liveweight gains per year

System	Genotype	Liveweight gain/year[1]		
		kg/head	kg/head/day[2]	kg/ha
Rotational	Nelore	98.4[b2]	0.285[b]	196.9[b]
	Braford	135.1[a]	0.392[a]	270.3[a]
	LSD[4]	24.137	0.069	48.279
Alternative	Nelore	106.4[a]	0.308[a]	212.9[a]
	Braford	119[a]	0.345[a]	238[a]
	LSD	21.756	0.063	43.512
Rotational	Nelore	98.4[a]	0.285[a]	196.9[a]
Alternative	Nelore	106.4[a]	0.308[a]	212.9[a]
	LSD	22.741	0.066	45.482
Rotational	Braford	135.1[a]	0.392[a]	270.3[a]
Alternative	Braford	119[a]	0.345[a]	238[a]
	LSD	23.212	0.067	46.424
Overall	Nelore	102.4[b]	0.297[b]	204.9[b]
Overall	Braford	127.07[a]	0.368[a]	234.1[a]
	LSD	15.597	0.452	31.194
Rotational	Overall	116.8[a]	0.339[a]	233.6[a]
Alternative	Overall	112.7[a]	0.327[a]	225.4[a]
	LSD	18.419	0.053	36.838

[1] 346 days; [2]average; [3] means in a column within a group with the same letter are not statistically different (P<0.05); [4] least significant difference for P<0.05;

When they were compared to the first three months (February, March, and April) of the trial as a percentage of the live body weight, results showed an 80% and 70% of higher daily weight (Data not showed) in the last three months than in the first three months, for overall rotational and alternative system, respectively. These comparative higher gains could be explained by a phenomenon known as compensation growing process. This well known effect took place after a period of weight lost, and followed by a period where the animals have availability of good quality and quantity of feed (Lofgreen and Kiesling 1985).

In addition, a temperature increment effect on daily weight gains, between 10°C and 27°C of air temperature, was reported for the Brahman breed (*Bos indicus*) by Johnson (1982). In the present study, the highest daily weight loses (Data not showed) of both breeds was measured in July, which was the month with the lowest mean, minimum mean, minimum extreme temperatures and highest number of days with frost of all trial's months (Table 1). Thus, no just the low quality of the forage, but the environment low temperature as well, could have affected the daily weight gain on both Nelore and Braford heifers.

Farm productivity

The most significant finding of this study was the silvopastoral system capacity of supporting two growing heifers/ha without any feed supplementation, with a live weight gain up to 270kg/ha/year (Table 3). The kg/ha yield in the silvopastoral system means a great improvement compared to the actual yields (4-10 kg/ha/year) obtained at the Arid Chaco with traditional beef cattle production systems (Ayerza et al 1988; Bocco et al 2007; Blanco et al 2008).

In addition, at the end of the trial, heifers were palpated for sexual organs development, and all of them were certified as ready for reproduction (C. Taboada Candiotti 1983, Corrientes, Argentina, personal communication). These determinations mean that heard replace heifers can be growing at the same farm and that they are physiologically ready for reproduction with 24 months old, which is normal for these two breeds (Dias et al 2004).

Conclusions

Results showed that Nelore and Braford heifers are sensitive to the seasonal dynamics of Buffel Grass quality in the Arid Chaco ecosystem. However, although this study provides only limited information on the relations tree-grass-animal and additional studies should be undertaken to fully characterize the productive system, results indicate the great potential that the silvopastoral system has for beef cattle production in the Arid Chaco, without needs of performing a complete elimination of the natural tree stratus.

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