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Leucaena leucocephala cv Perú in Association with Graminaceae in Dryland Conditions for Final Bovine Fattening Stage

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Abstract

To evaluate the factors that affect efficiency in a *Leucaena leucocephala* cv Perú association, with pastures for bovine fattening, 22 Zebu fattening cycles were studied on a farm of the Rectangulo Livestock Company, in Camagüey, Cuba, between 2002 and 2012. The local soil is brown without carbonates. The climate is tropical humid, and the annual precipitation average is 1 183mm. The factors evaluated were food balance, duration of the fattening cycle, and quantity of animals/cycle. The daily weight gain and expenses/income per operation were also analyzed. The pasture and *Leucaena* percentages were determined by plant counts. Food balances were estimated. The final value of the population of Leucaena cv Perú was 93% (P <0.05), with an increase in common Bermuda grass and other pastures. Short duration tests showed much higher gains (P <0.05), with values above 1.0 kg/animal/day. The number of animal/cycle (P <0.05) produced higher gains with fewer animals. Forest-grazing in association with *Leucaena leucocephala* cv Perú-graminaceae under dryland conditions produced mean daily gains above 0.800 kg/animal/day in the final stage of fattening bulls, based on food balances with adequate biological and economic results. The best behavior was observed in the shortest cycles, where the highest final weight/animal values were achieved, with fewer expenses and higher income.

Key words: *ruminants, weight gain, grazing, cost-effectiveness, management factors*

Introduction

Livestock systems based on graminaceae and shrub-like leguminosae in association have produced remarkable results in favor of more environmentally friendly livestock raising, with higher incomes and a more heterogeneous rural development (Guevara *et al.*, 2009; Pérez Infante, 2010).

In that context, the renovation of grasslands, and the introduction of tree-like and shrub-like plants in grazing areas for commercial fattening in final stages is one technological alternative to improve production of that bovine category, which has been confirmed by other studies in Cuba. Iglesias (2003) reported final-fattening gains above 550 g/young bulls/day in areas with Leucaena cv Perú associated with pastures, compared to graminaceae alone. Additionally, Cino *et al.* (2011), and Díaz, Martín, Castillo, and Hernández (2012) found the highest incomes per operational fattening area using Leucaena cv Perú, and obtained very high weight gains/day and increased final weights.

In that sense, the aim of this research was to evaluate the effect of factors that may eventually harm the dynamics of productive and economic efficiency indicators based on *Leucaena leucocephala* cv Perú and enhanced and native pasture associations, in the final stage of cattle fattening.

Materials and Methods

This study was conducted in the 2002-2012 period, at Represa No. 1, La Angelita Farm, from Rectangulo Livestock Company, municipality of Guaimaro, Camagüey, Cuba. The local soil is a category III, brown without carbonates. The climate is tropical humid of savannahs (Aw), and the mean annual precipitation is 1 183mm, of which 71% occurs in the rainy season.

Establishment and management of grasslands, and supplementation

The grazing areas were moderately deteriorated when leguminous *Leucaena leucocephala* cv Perú was established, which was made by excessive grazing before harrowing stripes of 2.0 m wide, separated by 3.0 m. Light harrow discs were run twice, then the rows were made, and 6.0 kg/ha of leguminous inoculated seeds were sown, followed by manual closing. The area was cleared from weeds using a hoe during the first 120 days. The criterion for establishment was when the plants reached 1.0-1.2 m high. The area was divided into 20 enclosures. The resting time in the rainy season was 38-57 days, and 57-76 for the dry season, with occupation/enclosure of 2-4 days. Norgold ® was used for supplementation, using 0.4-1.0 kg doses/kg/day, according to the criterion of the farm's specialist. Water was supplied in tanks.

Twenty-two grazing fattening cycles were evaluated during the 2002-2012 period (10 years). The factors considered to cause variations were, duration of fattening cycles, in days and number of animals per cycle. Analyses of daily weight gain, final weight, supplement expenses, and final incomes per operation, were made. The percentages of initial and final population of meadow species was made by the steps method, with 200 observations per enclosure (Corbea and García Trujillo, 1982), and Leucaena, by counting plants per linear meter in 10 rows of 25 m long each, in each enclosure, every year. The initial food balances were estimated without this technology, and then regularly throughout the period after introduction, by the Pérez Infante (1983) technique. The NRC (2001) values were utilized for animal requirements during the final fattening period. The primary data were processed through analysis of variance and the Tukey´s test, using the SYSTAT, 11.0, software.

RESULTS AND DISCUSSION

Leucaena cv Perú reached of 93% of its population in the final count, with significant increases (P< 0.05); it was also observed in common Bermuda grass populations (66%) and other improved pastures (Table 1). In this particular case *Leucaena leucocephala* cv Perú increased 16 percent units in relation to the beginning of the study, which coincided with the effects found by Milera (2008) in tree-like plants associated with graminaceae; and by Iglesias (2003), in forest-grazing of Leucaena and other shrub-like plants for growing-fattening animals. These results represented a tangible benefit of how much the botanical composition of grasslands can be altered by the influence of associated shrub-like leguminosae, which due to certain biological reasons, can determine a decrease in temperatures to bring more comfort to animals. Besides, they recycle nutrients, and improve soil fertility and the nutritional value of graminaceae (Orskov, 2005; Alonso, 2011; Cino *et al.*, 2011; Cino *et al.*, 2014; Díaz, Martín, Castillo and Hernández, 2012; Ku Vera *et al.*, 2014; Makkar, 2014).

Table 2 shows the food balance results without forest-grazing, whereas Table 3 shows the results with the inclusion of forest-grazing, with differences in dry matter contribution for these two very different scenarios, which led to 0.350 kg/animal/day, as reported by the company when forest-grazing was starting. All the evaluation period accounted for 0.885 kg/animal/day.

Weight gains increased under the forest-grazing conditions (Table 3). Although supplementation meant sensitive additions of energy-protein to the system, the contribution of the other components of the technology (increased population and nutritional quality of Leucaena and other leguminosae in association with pastures), was high and produced improvements in terms of biological effectiveness and cost effectiveness, as normally expected for this technology in tropical areas. It was corroborated by very similar results found for the fattening stage in cattle, by several authors in Cuba and Mexico (Iglesias, 2003; Guevara *et al.*, 2009; Simón, 2010; Alonso, 2011; Ku Vera *et al.*, 2014).

Short duration tests (Table 4) showed much higher gains (P <0.05), with values above 1.0 kg/animal/day, which demonstrated that leguminous systems cover previous deficiencies in shorter cycles, and compensate for delivery operations in a more sustainable way. These findings were reported in experiments done by Díaz, Martín, Castillo, and Hernández (2008) for consecutive initial and final fattening in associations of Leucaena cv Perú + graminaceae and herbaceous leguminosae covering 50-100 % of the total areas, for more than 90 days, where crossbred animals reached suitable final weight increases at the end of the experiments, at very low costs. Meantime, Guevara *et al.* (2009) in areas for grazing into final fattening cultivated with Bermuda grass cv common and leguminosae of genera *Calopogoneum, Centrosema, Desmodium, Galactia*, and *Indigofera*, for Zebu animals at the Rectangulo Company, in Camagüey, Cuba, reported mean gains between 0.620 and 0.780 kg/animal/day, and final delivery weights above 432 kg, with little supplementation of Norgold.

The number of animals in the cycle (Table 5) affected live weight gains (P <0.05), in favor of a lower number of animals in the trial, with gains over 1.00 kg/animal/day, though they had a stable supply of quality forage. This was possibly due to competition over food and the dominance animal behavior, according to Ensminger (1995); Pérez, Soca, Díaz, and Corzo (2008), and Elizalde (2015), when they studied the effects of grazing behavior on very large groups of animals, without other restrictions (water, supplements, and stress from heat, persistent heavy rains, etc.). No differences were observed between final weight and supplement expenses; the latter seemed like an indicator of irrational use of foods as part of animal diet management.

The weight gains achieved indicated high stability of the system and its resilience in terms of productivity and nutritional quality, despite the occurrence of drought events along those years (the local precipitation mean was 1 183 and 1 320 mm/year in the province of Camagüey), and variations in the behavior of the association. However, it could compensate the harshest periods thanks to its diversity, based on the differential yields of the different species (leguminosae, herbaceous species, Bermuda grass, other graminaceae and non-graminaceous herbaceous species, Leucaena, etc.). This phenomenon was reported by Simón (2010), Milera (2013) and Ku Vera *et al.* (2014) for grasslands in association with shrub-like leguminous species for bovine nutrition in Cuban interior plains and humid tropical areas in Mexico.

In that regard, the literature reports various studies with very positive biological and financial and economic results, when the technology used has enabled a closer relationship between graminaceae and leguminosae for cattle grazing to produce beef. The weight gains have always been higher than 500 g/animal/day live weight increase and lower costs. Iglesias (2003) and Simón (2010) studied the effects of forest-grazing on growing-fattening animals feeding from Leucaena and pasture associations in Cuba. One important condition was to maintain the stability of these indexes over time, regardless of climatic effects on pasture (long droughts and/or intense summers during the rainy season), pasture diseases, insects, and low supplementation (Milera, 2013).

CONCLUSIONS

Leucaena cv Perú and Bermuda grass cv common improved their persistence and remarkably increased their populations in the grasslands.

Factors like duration cycle (days), and number of animals were observed to have contradictory behaviors per se. The former underwent a reduction in mean daily gain as the number of days increased, regarding the lower range in the latter, which was reduced between 80-120 animals, in relation to 25-69 animals.

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Table 1. Population dynamics of grasslands (%) in time, based on forest-grazing (*Leucaena leucocephala* cv Perú with graminaceae) in dryland conditions, during the final fattening stage

Species	Beginning	Year 2	Year 3	Year 5	Year 7-10
Leucaena cv Perú	77	90	90	92	93
Bermuda grass cv common	18	56	58	60	66
Other graminaceae	53	31	38	27	25
Other Species	18	7	4	13	9
Depletion	11	6	--	--	--

Table 2 Food balance without the inclusion of forest-grazing for bulls with an initial weight of 340 kg, and pasture quality estimates (1) for a 0.350 kg/animal/day (2)

Nutrient contribution	Consumption (kg of LM)	Consumption (kg of DM)	ME (Mcal)	CP (g)
Bermuda grass cv common and other graminaceae	12.0	4.18	7.52	293
Creeping leguminosae	2.3	0.56	0.89	67.2
Norgold	0.400	0.35	0.91	92.0
Total	14.70	5.09	9.32	453
Requirements	-	5.02	8.30	375
Difference	-	-	+1.32	+78

(1) Pérez Infante (1983) technique to estimate the quality of grass for consumption and balance estimation; (2) Values from the NRC (2001) were used to meet the requirements.

Table 3 Food balance with the inclusion of forest-grazing for bulls with an initial weight of 340 kg and pasture quality estimates (1) for a 0.885 kg/animal/day

Nutrient contribution	Consumption (kg of LM)	Consumption (kg of DM)	ME (Mcal)	CP (g)
Bermuda grass cv common	14.7	4.54	9.4	441
Native leguminosae	4.7	1.33	3.1	253
Leucaena cv Perú	7.5	2.33	5.2	477
Norgold	1.00	0.88	2.03	229
Total	27.9	9.09	19.7	1 400
Requirements	-	-	18.5	1 065
Difference	-	-	+1.23	+335

(1) Pérez Infante (1983) technique to estimate the quality of grass for consumption and balance estimation; (2) Values from the NRC (2001) were used to meet the requirements.

Table 4 Influence of fattening cycle (days) on weight gain, final weight, supplement expenses, and final income by operations in cattle fattening systems, based on forest-grazing with *Leucaena leucocephala* cv Perú in association with graminaceae without irrigation

Indicators (1)	60-89 days	97-147 days	152-208 days	S.E.	Sig.	VC (%)
Daily gain, kg	1.126 a	0.722 b	0.871c	0.03	*	17.2
Initial live weight (g)	325	318	321	19.0	NS	14.0
Final live weight (kg)	414	424	428	31.0	NS	14.0
Expenses/supplements ($)	3 041c	6 585 a	5 157 b	106	*	21.4
Income/operations ($)	15 803 a	12 314 b	12 409 b	895	*	23.0

(1) The stocking rates were 1.9-2.1 A/ha, for all the cycles evaluated in the factor, a, b, and, c, unequal super indexes indicate significant differences from (P <0.05), according to Tukey

Table 5. Behavior of weight gain, final weight, supplement expenses, and final income for a single fattening operation on forest-grazing with *Leucaena leucocephala* cv Perú without irrigation, based on the number of animals/fattening cycle

Indicators (1)	47-66 Animals	103-139 Animals	142-206 Animals	SE	Sig.	BF (%)

Daily gain, kg	1.033a	0.757b	0.781b	0.09	*	21.3
Final live weight (kg)	421	429	442	17.0	NS	11.6
Expenses/supplements ($)	2 988	3 076	3 055	139	NS	20.4
Income/operations ($)	14 803a	11 014b	10 146b	972	*	15.0

The animal stocking rates were 1.8-2.1 A/ha for all the cycles evaluated. Unequal letters indicate significant differences (P <0.05), according to the Turkey's test.