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Productive indicators of a commercial dairy farm in Matanzas province

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ABSTRACT: The study was conducted in order to characterize the productive indicators of a commercial dairy unit, in a livestock production enterprise of the Matanzas province, Cuba. The unit had a total area of 80,83 ha, from which 2,66 ha consisted in sugarcane; 12,6 ha had king grass and 60,04 ha were for grazing. This last one was divided into 49 paddocks (1,6 ha per paddock, approximately) and the real stocking rate was 1,7 LAU/ha. The dry matter availability of the pastures was determined with a monthly frequency, as well as milk production in 100 % of the animals to elaborate the retrospective feeding balances per group. No significant differences were found among the availability values (between 1,6 and 2,5 t DM/ha/rotation). Significant differences were detected (p < 0,001) between the milk production average in July-August and September-October (9,5 and 10,0 kg/animal/day, respectively) with regards to March-April and January-February (6,6 and 7,8 kg/animal/day, respectively). In the other bimesters, the cows showed moderate milk productions, without statistical differences. It is concluded that, although the pasture availability was low throughout the year, the use of concentrate feeds allowed to obtain adequate milk productions, with the best productive responses in September-October and July-August. To make transformations in the feeding basis of the unit is recommended in order to increase the dry matter availability in the pastureland.

Key words: milk production, supplementation, natural pastures

INTRODUCTION

The growing development of livestock production in Cuba was closely related to the progressive increase of cultivated or improved pastures, which can constitute up to 90 % of the DM of the diet of cows and allow their utilization throughout the year. They occupied around 50 % of the grazing area by the end of the 1980's; however, the inadequate management, along with the deficit of resources in livestock production, has propitiated an accelerated deterioration of pasturelands.

As a result, Cuban farmers have to deal with a low DM availability in their pasturelands throughout the year, together with a deficit of crude protein, due to the low content of this indicator in natural pastures (Cáceres and González, 2000); this causes an important decrease in the economic and production results at the enterprises.

In this sense, concentrate feeds are used as short-term strategy; they depend on imported raw materials, with prohibitive prices at the international market, for which their supply is unstable and, in many cases, they compete with human feeding.

Another strategy is the creation of forage areas within the production units, mainly, with diverse sugarcane varieties (*Saccharum* spp.) and king grass (*Pennisetum purpureum*), which makes the farmers less dependent on external inputs and helps to mitigate the nutrient deficit in the dry season.

The inclusion of trees and shrubs in the paddocks (Yamamoto *et al*., 2007) can also significantly influence the productivity of double-purpose herds, because with relatively low stocking rates and with limited quantities of supplementary forage a good productive performance of cattle is obtained.

That is why, in recent years, in cuban milk production farms and livestock enterprises, the *in situ* studies aimed at identifying the cases of low productivity, to propose solutions that allow to reverse this situation with proposals adapted to the current conditions, have become important. In this sense, the objective of this study was to characterize the productive indicators of a dairy unit in a livestock production enterprise of the Matanzas province, Cuba.

MATERIALS AND METHODS

Location and characteristics of the farm. The study was conducted in a dairy unit which is geographically located at 23º North latitude and 80,1º 3' West longitude, 70 m above sea level. The unit has a total area of 80,83 ha, from which 2,66 ha are of sugarcane and 12,6 ha, of king grass, both for forage, and the rest of the area was for grazing. The facility occupies a hectare and has an Alfa Laval milking machine of four units, a cooler milk tank, a waiting room and a block.

Soil and climate characteristics. The soil of the unit is Ferralitic Red (Hernández, 2006), with a slightly undulated relief. The mean annual temperature during the experimental period was 23,79ºC, with a mean of 21,51ºC and 26,07ºC in winter and summer, respectively.

The annual rainfall during the experimental period is shown in table 1. The climate data were compiled at the meteorological station of the Cidra dam, located in the Matanzas province, near the studied livestock production enterprise.

Animals and management. The dairy unit, with capacity for 120 cows, maintained 114 animals as annual average, and in them the crosses of Mambí de Cuba bulls with Holstein x Zebu cows prevailed. The grazing area was divided into 49 paddocks (1,6 ha per paddock, approximately), which allowed a real stocking rate of 1,7 large animal units LAU/ha. The cows were separated by groups (elite, high and low) and they were milked two times per day: at 2:00 a. m. and at 2:00 p. m. The morning grazing occurred from 6:00 a. m. to 10:00 a. m., hour in which they were gathered and taken to the sheds, where they had water, mineral salt and supplementary feedstuffs in correspondence with their availability (tables 2 and 3). Cows were allowed to graze again from 5:00 p. m. to 2:00 a. m.

In grazing the species *Dichanthium caricosum*, *Dichanthium annulatum* and *Paspalum notatum* prevailed, with a population between 52 and 80 %. These natural pastures had a crude protein (CP) percentage below 7 %. On the other hand, the supplied concentrate feeds had different origin and chemical composition (table 4).

Measurements

Pasture availability. The pasture availability was estimated through the alternative method proposed by Martínez *et al*. (1990), in which the mean height of the pastureland was considered. The samplings were performed every month at the entrance of the animals in each paddock, at the beginning of the rotation. Eighty observations were made per paddock.

Retrospective feeding balance. The retrospective feeding balance was made for the cows under production, through the CALRAC program (1996) in its version 1.0 and the DM, CF, Ca and P data obtained in the study were used; while the ME, DPIE and DPIN were estimated from the indicators that appear in the program. Regarding the availability of the pasture DM and the milk production, the values obtained in the study were used and the fat quantity was estimated from the values of the enterprise laboratory.

Milk production. The milk from the 100% of the cows was weighed during two years, with a monthly frequency, to determine the production per milking cow. In addition, the influence of the production bimester, the season, the lactation number and the year, were analyzed.

Mathematical analysis. For the analysis of the milk production results the general linear model (GLM), belonging to the statistical pack SPSS®, version 11.5 for Windows XP®, was used.

The data were adapted to the following equation:

$$Y_{jkl} = \mu+E_j+B_k+A_l+ C_n+D_m+e_{jkl}$$

Where:

Y_{jkl}= log Y_{jkl}
μ = constant common to all the observations
E_j= log E_j, effect of the j-eth production period
B_k= log B_k, effect of the k-eth production bimester
A_l=log A_l, effect of the l-eth year of production
C_n log C_n, effect of the n-eth season of the year
D_m= D_m, effect of the m-eth group
e_{jkl}= log e_{jkl}, normal and independent residual error distributed with zero mean and variance σ^2

Table 1. Rainfall during the experimental stage. (mm)

Season	Year			
	2008	2009	2010	2011
Rainy season	1 293,1	1 106,6	971,5	1 085,3
Dry season	457,2	156,6	378,7	107,0
Total	1750,3	1 261,1	1 350,2	1 192,3

Table 2. Feeding of the elite and high-production groups during the study (kilograms on fresh basis).

Feedstuff	Production bimester					
	JF	MA	MJ	JA	SO	ND
King grass CT-115	20,0	20,0	20,0	20,0	20,0	20,0
Northgold[1]	0,4	0,4	0,4	0,4	0,4	0,4
Mineral salt	*Ad libitum*					
Soybean cake[3]				1,0	1,0	1,0
Mexican concentrate feed[2]			2,4	2,4	2,4	2,4
Creole concentrate feed[3]	1,0	1,0	1,0	1,0	1,0	1,0
Bran			1,0			

[1]From 2 kg of milk; [2]in year 2010; [3]year 2009.

Table 3. Feeding of the low-production group (kilograms on fresh basis).

Feedstuff	Production bimester					
	JF	MA	MJ	JA	SO	ND
King grass CT-115		15,0	15,0	15,0	15,0	15,0
Northgold[1]	0,4	0,4				
Mineral salt	*Ad libitum*					
Mexican concentrate feed[2]				2,4	2,4	2,4
Creole concentrate feed[3]	0,5	0,5	0,5	0,5	0,5	0,5

[1]From 2 kg of milk; [3]year 2009; [2]year 2010.

Table 4. Chemical composition of the feedstuffs. (%).

Feedstuff (%)	DM	CP	CP	Ca	P
Natural pastures	30,9	41,30	5,9	0,52	0,31
King grass CT-115	20,2	35,20	7,1	0,45	0,21
Creole concentrate feed	87,6	25,11	11,0	0,18	0,10
Mexican concentrate feed	90,8	30,26	23,60	1,03	0,25
Soybean cake	90,0	9,87	40,0	0,25	0,55
Northgold	90,0	6,40	30,0	0,04	0,82

RESULTS AND DISCUSSION

Table 5 shows the pasture availability per bimester, season and year. No significant differences were found among the values, which in all cases were between 1,6 and 2,5 t DM/ha/rotation. This result is similar to the report by Lamela *et al*. (1998), who sustain that the production potential of tropical natural pastures for Cuban conditions is 1,0 and 2,2 t of DM/ha/rotation, for the dry and rainy season, respectively.

Iriondo *et al*. (1998) obtained similar results (1,1 t of DM/ha) in non-cultivated pastures during the dry season.

Among the causes that influenced the low pasture availability are the prevailing species in the pastureland (a high percentage of natural pastures), with low yields in general, and the use of a stocking rate higher than the carrying capacity of the pastureland.

The work was carried out with 114 animals as average in the two years, but the real stocking rate

Table 5. Dry matter availability and offer.

Effect		Offer (kg DM/animal/day)	Availability (t DM/ha/rotation)	SE±
Bimester	J-F	13,9	1,6	0,185
	M-A	21,0	2,5	0,495
	M-J	18,8	2,2	0,239
	J-A	15,6	1,8	0,243
	S-O	17,9	2,0	0,087
	N-D	15,5	1,7	0,281
Season	RS	17,5	2,0	0,218
	DS	16,7	1,9	0,117
Year	1	18,4	2,1	0,073
	2	15,8	1,8	0,228

used in the unit was 1,7 LAU/ha, a higher value than the one recommended by García-Trujillo (1983) for systems in which natural pastures prevail, where it is recommended not to exceed 1 LAU/ha.

From the above-presented results, it is derived that it is necessary to decrease the stocking rate in the unit to achieve that the animals have a higher pasture offer, which can favor, in turn, the recovery of the improved species of the pastureland. In this sense, Iraola (2013) referred that the stocking rate is an important variable in the production per animal and per area unit, and it is one of the factors in a management system to increase the efficiency of pasture utilization.

On the other hand, the sowing of cultivated species in the pastureland is necessary to improve its floristic composition and quality, because they show better nutritional value and influence the productive response of the animals.

Regarding the dry matter offer, it was low in all the bimesters (table 5), which limited the possibility of selection by the animals and the satisfaction of their requirements, and it influenced their productive performance. A similar result was found when studying the dry matter offer per year and per season.

According to Stobbs (1978), the daily availability per animal in the tropical pastures should be between 35 and 55 kg DM/animal/day, so that around 40-45 % can be used and milk production does not decrease.

Souza *et al*. (2013), when evaluating *Cynodon dactylon* under continuous grazing and with three DM offers (3,0; 6,0 or 9,0 kg DM/100 kg of live weight), concluded that the productive potential of that grass was low with offers lower than 6 kg DM/100 kg LW (which are slightly higher than the ones in this work), unfavorably influencing the yield of the animals.

Significant differences were found (table 6) in the milk production average of July-August and September-October (9,5 and 10,0 kg/animal/day, respectively) with regards to the one shown by March-April (6,6 kg/animal/day) and January-February (7,8 kg/animal/day).

The influence of pasture availability and its quality was minimal, as it was previously analyzed, for which the difference was ascribed to the fact that in the first two bimesters a better-quality concentrate feed was offered (tables 2 and 3). In this sense, Aguilar-Pérez *et al*. (2009) referred that when there is stability in the quantity and quality of the cereal concentrate feeds no affectations should exist in the energy balance, milk production and reproduction of grazing crossbred cows, for which no differences were found in this indicators between seasons. In the other bimesters the cows had moderate milk productions, without significant differences.

The milk production showed similar values to the ones obtained in an association system of *Panicum maximum* with *Leucaena leucocephala* cv. Cunningham, with Mambí cows, in which there was low utilization of concentrate feed and 10 kg of roughage supplement on humid basis were provided during the dry season (Sánchez, 2007); nevertheless, in this study 20 kg of king grass throughout the year and a supplementation with concentrate feed higher than in the above-mentioned essay were used.

Table 6. Milk production of the cows during the studied period.

Effect		Milk production (kg/animal/day)	SE ±	Sig.
Production bimester	J-F	7,8[c]	0,299	0,001
	M-A	6,6[d]	0,249	
	M-J	8,2[c]	0,327	
	J-A	9,5[ab]	0,228	
	S-O	10,0[a]	0,238	
	N-D	8,9[b]	0,180	
Group	Elite	13,4[a]	0,148	0,001
	High	9,4[b]	0,116	
	Low	5,9[c]	0,079	
Year	2009	9,5	0,176	0,001
	2010	8,5	0,131	
Season	RS	8,9	0,148	NS
	DS	8,9	0,151	

[a, b, c, d] Means with different letter in each effect differ $p < 0,05$ (Duncan, 1955)

The values were also similar to the ones reached by Lamela *et al*. (2010) when evaluating an association of *L. leucoephala*, *Morus alba* and *P. purpureum* CT-115, with irrigation and with medium-potential cows (Holstein x Zebu). These authors obtained a milk production of 10,0 and 9,9 kg/cow/day for the third and fourth lactation, respectively.

When analyzing the milk production per groups, significant differences were found in favor of the elite one ($p < 0,01$), situation that can be explained because the arrangement of the cows within the herd is done by milk production and by lactation days. Starting from there modifications were made in the management and feeding to cover the requirements of the higher-producing animals (Milera *et al*., 2008).

In the case of milk production per season no significant differences were observed, with 8,9 kg/animal/day as average for both seasons. Such results may be related to the biomass availability under grazing conditions, which showed similar values throughout the year (table 1). This production was an expression of the feed offer.

Regarding the performance per year significant differences were observed ($p < 0,001$) between the production of the first and the second year (9,5 and 8,5 kg/animal/day, respectively). Yet, the total biomass availability values under grazing conditions were similar in the two years (2,8 and 2,1 t DM/ha/rotation), for which the differences in milk production were also due, to a great extent, to the offer of concentrate feed the cows received in the different years where the best values in quality and quantity were those of year 1.

Hence it can be stated that the milk production obtained (with acceptable values for the existing feeding and management conditions) was dependent on external inputs, because it greatly varied from one year to the other and there was no sustainability of the productive results in time.

The feeding balance of the milk-producing cows showed that the intake of DM from concentrate feeds represented 29, 18 and 16 % of the diet of the elite, high and low groups, respectively (fig. 1). Emphasis is made on the utilization of concentrate feeds because the roughage was stably supplied in all the groups during the months of the study.

In this sense, lower roughage intakes were observed in the elite group, because it received more concentrate feed –mainly Northgold (dry destilery grains with solvents)– and the intake index of this type of feedstuff is higher than that of roughage supplements (EEPF Indio Hatuey, 2000).

The energy level offered in the diet (fig. 2) satisfied the requirements for the milk production potential of the cows from the elite group, which exceeded 13 kg/cow/day; similar performance was found in the high and low groups. This was given by the supply of concentrate feeds, mainly North-

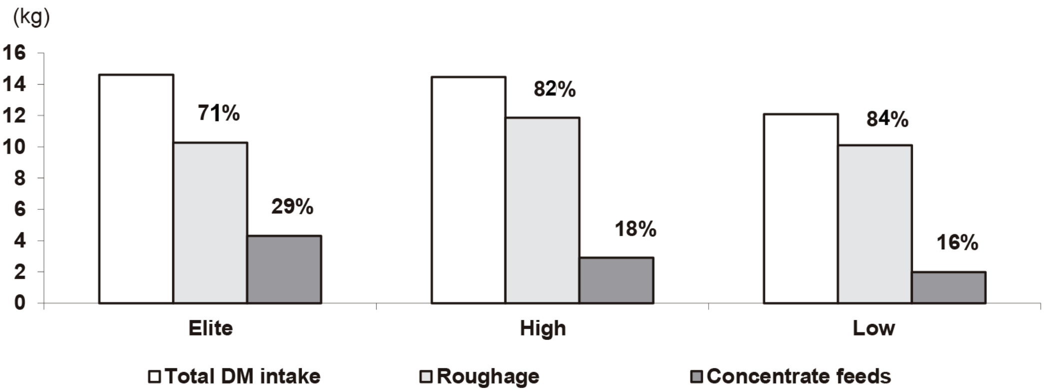

Figure 1. Dry matter intake per production group.

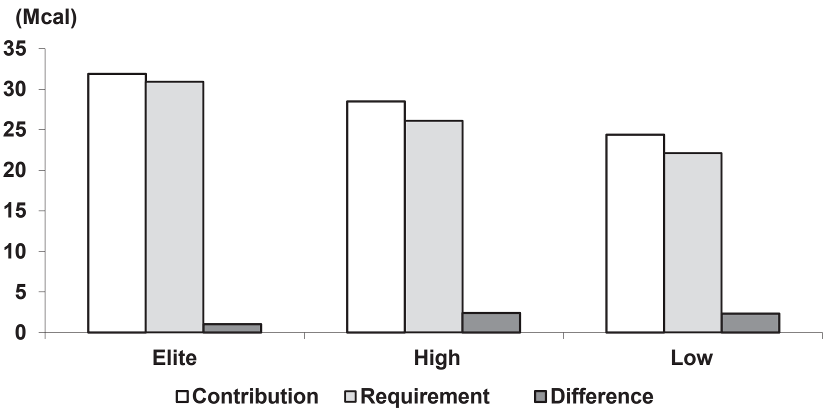

Figure 2. Metabolizable energy offered in the diet.

gold –which was the one with the highest inclusion–, at a rate of 0,4 kg from the second liter of milk. This group was supposed to receive 4,4 kg according to the regulation, but taking into consideration the retrospective balance made, it was proven that it only needed 3,26 kg daily per animal to cover their requirements and not the real quantity offered.

Similar situation was observed in the high group, which received 2,8 kg/animal/day and the balance showed that it needed just 1,34 kg/animal/day to cover its requirements. Hence the importance of using feeding balances as a tool to correct feeding in systems with cattle.

In this sense, through the retrospective feeding balance it was proven that the DPIN and DPIE (fig. 3) and Ca and P (fig. 4) requirements were fully covered for the three production groups. Although the balance showed that the P requirements were fulfilled, attention should be paid to this mineral because of its important role in reproduction and in the metabolic processes of the animal, in addition to constituting the element with the highest deficit in pastures and forages in Cuba, with contents that rarely exceed 0,2 % (EEPF Indio Hatuey, 2000), and it is known that its concentration in the diet of lactating cows should exceed 0,33 % (NRC, 2001).

The highest percentage of milking cows was achieved in the bimesters July-August and September-October (71 and 72 %, respectively), which influenced the milk production during both periods, along with the fact that this coincided with a high supplementation in which northgold, mexican concentrate feed and soybean cake were included. The lowest values were found in January-February and November-December (table 7).

In this sense, Menéndez *et al*. (2004), when quantifying the effect of the percentage of milking cows on the total milk production of the herd of 19 dairy units, through mixed linear models and the

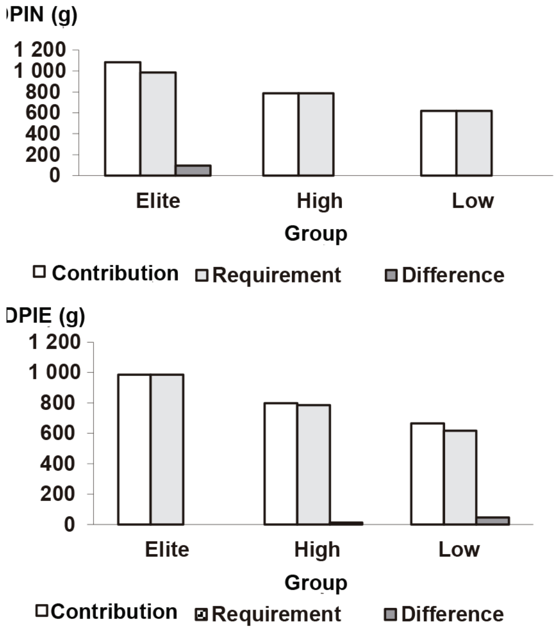

Figure 3. Contribution of DPIN and DPIE of the diet.

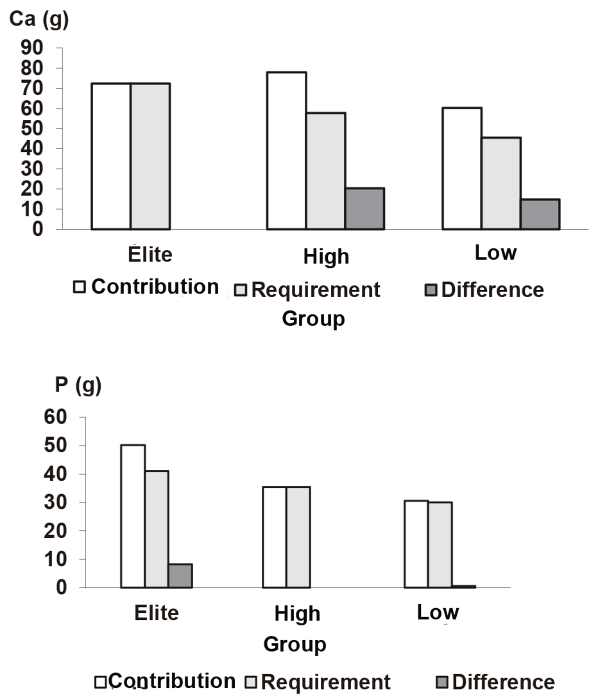

Figure 4. Contribution of calcium and phosphorus in the diet.

use of the dependent variables total monthly milk production (TMMP), total monthly production per hectare (MPMH) and total daily milk production (DMP), found that for each 1 % of increase in the percentage of milking cows the production rose in 138,3; 2,16 and 4,54 kg for TMMP, MPMH and DMP, respectively, which shows the importance of

Table 7. Other productive indicators during the evaluation period.

Indicator (%)	Bimester					
	JF	MA	MJ	JA	SO	ND
Milking cows	68,0	70,0	70,0	71,0	72,0	69,0
Newly-calved cows	17,0	11,0	8,0	17,0	15,0	15,0
Inseminated cows	42,2	40,8	39,2	28,4	36,6	45,5
Pregnant cows	43,3	44,7	48,1	44,1	38,6	34,4

the percentage of milking cows in the productive performance of the herd.

Figure 5 shows that the animals reached the milk production peak on the eighth week after parturition (60 days), which is in correspondence with the productive characteristics of cows with more than three lactations and of the breed used (Andrensen, 2012).

It is concluded that in the studied unit adequate milk productions were obtained, with the best productive responses in the bimesters September-October and July-August, which was closely related to the use of supplementation with concentrate feeds.

The pasture availability was low, without differences among bimesters and between seasons, which suggests making transformations in the paddocks to augment the availability of dry matter and increase the feeding basis of the unit.

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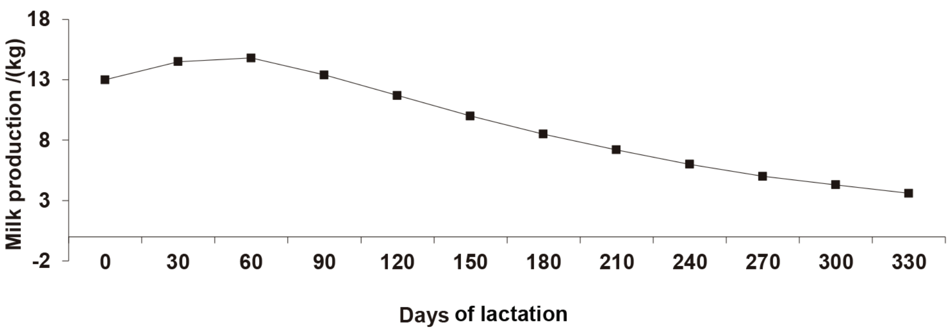

Figure. 5. Lactation curve of producing cows.