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Season and Enterprise Effects on Cow Milk Production Indicators in Ciego de Ávila

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ABSTRACT

The effects of season and enterprise on cow milk production indicators between 2008 and 2012 in the province of Ciego de Ávila, Cuba, are presented. Official information of the productive, economic, and financial indicators from the Economic and Production Departments of the enterprises evaluated was used. The mean productivity and efficiency indicators were calculated from the basic information collected. Descriptive statistical analysis and variable comparisons between seasons and enterprises were made. The bio-economic indicators in the rainy season produced the least unfavorable results. More than one milk kg/cow was produced in the rainy season, and yields per area had a mean of 8.2 and 12.9 kg of milk/ha/month in the dry and rainy seasons, respectively. Different results were observed in annual efficiency and production indicators, both primary and secondary. *Ruta Invasora* was the enterprise with the best productive results; whereas *Orlando González* Enterprise had the highest overall yields.

Key words: *productivity, efficiency, cow milk, climate, enterprise*

INTRODUCTION

Productivity of dairy systems based on the use of pastures and forages must be determined with different technological variants, in order to design efficient alternatives, improved strategies, or restructuring of systems with productive limitations (Curbelo *et al*., 2010). However, productivity and efficiency of herds are mainly determined by the use it has been given, including the control over several different factors, such as the level of supplies applied to the soil-plant system, its natural potentialities, animal potential, and the volume of supplements in terms quality and quantity (Guevara *et al.*, 2003); all influenced by the climate and executive decision making factors. Certain barriers that can affect sustainability may be unveiled (Marchand *et al*, 2014), regardless of the tools used to assess a farm.

This paper deals with season effect on cattle milk production indicators in the province of Ciego de Avila, Cuba, in the 2008-2012 period.

MATERIALS AND METHODS

This study included information collected over a five-year period, between January 2008 and December 2012, from every Basic Unit of Cooperated Production (UBPC); and from four state-owned cattle enterprises, Ministry of Agriculture: *Ruta Invasora, Orlando González, Chambas* and *Bolivia*, located in four municipalities of the province of Ciego de Ávila, Cuba.

The climate in the province is humid tropical savannah, with 6-7 month seasonal humidity, and annual mean precipitation values of 1 319 mm; around 80 % of total precipitations occur between May and October; the other 20 % takes place from November to April. The mean temperature values in the period were 27.3° C, ranging between 22.5° C and 24.3° C, during the dry season, and 26.4° C-30.0° C in the rainy season, according to data provided by the Weather Forecast Service in Ciego de Ávila.

Official information of productive, economic, and financial indicators was collected from the Economics and Production Departments at the enterprises assessed. The primary information compiled every month was, area, number of animals per category, number of workers, salaries, milk delivered to industry, milk production per cow per day, fuel purchases (Diesel and gasoline), power consumption, and total solid contents in the milk (monthly reports by the dairy industry in Ciego de Ávila).

The primary information used to calculate mean productivity indicators (Barrios 2008) and efficiency was,

- Milk kg/ha: the mean monthly milk kg is divided by the total hectares of the enterprise.

- Milk kg/total females: the mean monthly milk kg is divided by the mean monthly number of females in reproduction.
- Milk kg/Diesel l: the mean monthly milk kg is divided by the mean monthly volume of Diesel acquired.
- Milk kg/gasoline l: the mean monthly milk kg is divided by the mean monthly volume of gasoline acquired.
- Milk kg/kW: the mean monthly milk production kg is divided by the mean monthly amount of kW consumed.
- Solid kg/ha: the mean monthly total of solid concentration is divided by mean monthly amount of hectares.
- Milk kg/total salary of workers: the mean monthly milk kg is divided by the mean monthly salary paid to all workers.

The season´s features were studied (dry between November and April, and rainy between May and October), and the enterprises, all the indicators, both from official primary information and secondary productivity information, estimated from the former values.

The Kolmogorov-Smirnov test was made to determine normality, and the variables with normal distribution were analyzed by simple variance analysis, using the linear general model. The mean differences were set with the Tukey test ($P \leq 0.05$). Descriptive statistical analysis and comparisons of abnormal variables by the Mann Whitney test, for season; and Kruskal Wallis H, for enterprise, were made. SPSS 15 was used for statistical analysis.

RESULTS AND DISCUSSION

It is well known that dry land pastures are more widespread in the rainy season, sharply shrinking in the dry season, when temperature and solar radiations are lower, and the days are shorter, in comparison to the months in the rainy season.

Significant differences were observed in the milk production per season ($P \leq 0.001$), a mean of 2.85 kg/cow/day in the dry season; whereas in the rainy season it was 3.95 kg/cow/day. Several studies (De Loyola, 2010; Guevara *et al*., 2010 and Soto, 2010), showed that the season effect on milk production is more associated to pasture availability increase, than to lower temperature values during the season, when biomass production decreases.

There are differences in milk production per cow. *Orlando González* enterprise shows the lowest means ranges; the other companies have similar values per cow (Table 1)

Studies conducted in the first decade of the 2000s, in the province of Camagüey, (Andújar, 2006; del Risco *et al*., 2007; De Loyola, 2010; Soto, 2010) reported the effects of season and climatic factors on pasture growth, and their relation with better consumption by animals, leading to increases in production and other bio-economic indicators.

Table 2 shows no significant differences between the seasons, concerning indicators like lactation days and total solids percent in the milk; however, significant differences were observed in milking cows; and highly significant differences were seen in the monthly production and mean salary indicators.

The calving number increased during the rainy season, and in the late dry season, in the province of Havana (Évora *et al*., 2002), and Camagüey (De Loyola, 2010 and Soto, 2010), which also contributed to higher efficiency in production during the rainy season (Guevara *et al*, 2012).

Senra (2007) has stressed on the need to implement alternatives to improve quality and yields of grasslands and soil fertility, as vital elements for milk production at any time of the year. In that sense, season variation would be less striking, as for the case of *Leucaena-graminaneae* associated systems improved for dry lands to stimulate milk production in *Mambí de Cuba* cows (Sánchez, 2007).

Table 3 shows differences milk kg/gasoline liter, and highly significant differences in mid ranges of milk kg/area, milk kg total females, milk kg/Diesel l consumed, milk kg/kW consumed, total solid/hectares, and mean salary/milk produced. Usually, Cuban cattle systems do not include secondary indicators that measure the efficiency of energy sources needed to produce milk.

García and Perón (2000) have claimed that one of the most commonly widespread forms used to measure productivity of dairy cattle is milk kg/cow (kg/c). Additionally, various research papers only measure milking cow yields, regardless of the number of females in reproduction.

Table 4 shows the mean ranges of official variables per enterprise; highly significant differences were observed in indicators like milking cows, lactating days, monthly production, total solids and mean monthly salary. Milking cows, lactation days, and monthly production, are indicators for the system´s productivity, depending on reproduction levels, like natality and annual calving distribution, with a marked influence on annual milk production, income and system efficiency (Évora *et al*, 2002).

Key factors to achieve greater productivity with the cow´s genetic potential are better pasture use (more production and harvest of dry matter/ha), and implementation of more persistent and stable complementing and supplementing strategies to minimize risks, both associated to weather conditions, and the ups and downs of the market (Gallardo, 2012).

Table 5 shows that all indicators for the companies had significant differences. The differences between enterprises were dependent on the kind of production management, supplies for soil-plant, natural potentialities, animal potential and pasture quality, availability and quality, and quantity of supplements (Guevara *et al*., 2003). Another element to consider is the stocking rate, which has been defined by many researchers (Mott, 1960, cited by Guevara *et al*, 2010; Mc Meekan, 1963, cited by Soto 2010) as the main aspect of pasture management, and one of the efficiency indicators in cattle systems. The stocking rate may be different in each of the enterprises studied, but it was not determined in this paper, which solely included the number of animals and the total area, regardless of land use. Further, more specific studies are needed to determine the effect of that indicator on every enterprise. Today, widespread infestation of grasslands with sickle bush (*D. cinerea*) is one of the main causes of increased stocking rates in Cuba.

Enterprises have contrasts in other social and economic aspects that bring about significant differences in the areas used, like total females in reproduction, and breeds, ultimately in productivity indicators, which are critical to achieve proper efficiency (Gallardo, 2012).

Holmes (2001) notes that besides measuring dairy efficiency in kg/cow and kg/ha, it can also be measured from milk solids produced per supplement, per area, per salary, or even solids produces per fuel type consumed.

A more rational use of raw materials and energy sources is currently one of the downsides of milk production systems, because the greater the volume, the lesser efficient and sustainable they turn (Flores and Gómez, 2006).

One vital element for worker motivation and increased performance is income through salary, which contribute to meet personal needs. In that sense, there were inequalities among enterprises, associated with differences in productivity, and diversification, since not in all enterprises income depends on milk sales to the same extent; other agricultural productions and services have a part, too. Furthermore, salaries were considered, whether direct or indirect milk production labor takes place (the main item in dairy systems). In general, the productive results achieved at *Ruta Invasora* Enterprise were better; whereas *Orlando González* had the best performances.

CONCLUSIONS

The bio economic indicators got the least unfavorable results for the rainy season, which is mainly associated with more milk production, due to more pasture and forage availability.

The results of primary and secondary indicators for efficiency and productivity varied from enterprise to enterprise. The best productive results were observed at *Ruta Invasora*; whereas *Orlando González* had, in general terms, the lowest performances.

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Table 1. Individual milk production per cow, per company (kg/vaca/día)

Enterprise	Mean
Ruta Invasora	3.43[a]
Orlando González	3.00[b]
Chambas	3.46[a]
Bolivia	3.41[a]
ES	0.041
Sig.	*

*P ≤ 0.05; different letters in the means indicate significant differences

Table 2. Mean official primary variable ranges by season, according to the Mann Whitney test (means within parenthesis)

Indicators	Mean ranges		Sig.
	Dry	Rainy	
Milking cows, n	344 (99)	376 (111)	*
Lactation days, days	360 (171)	360 (171)	NS
Monthly production, kg/mes	299 (7875)	421 (13208)	***
Total solid in milk, %	350.00 (12.94)	370.9 (13.04)	NS
Mean salary, CUP/month	256.7 (319.28)	464.2 (412.35)	***

*P ≤ 0.05; *** P ≤ 0.001; NS no significant differences CUP (Cuban Peso)

Table 3. Mean ranges of monthly secondary variables by season, according to the Mann Whitney test(means within parenthesis)

Indicators	Mean ranges		Sig.
	Dry	Rainy	
Milk per area, kg/ha/month	308.9 (8.16)	912.1 (12.89)	***
Milk per total females, kg/females/month	278.6 (0.90)	442.4 (1.4)	***
Milk per Diesel, kg/L Diesel/month	312.3 (21.65)	408.7 (11.27)	***
Milk per gasoline, kg/L gasolina	343.7 (21.65)	377.4 (36.85)	*
Milk per kW, kg/kW/month	307.9 (3.56)	413.0 (5.60)	***
Solid/ha, kg/ha/month	308.6 (3.55)	412.9 (5.58)	***
Total salary/month, CUP/kg	331.3 (0.34)	389.7 (0.45)	***

*P ≤ 0.05; *** P ≤ 0.001; NS no significant differences. CUP (Cuban Peso)

Table 4. Mean ranges of official variables by companies, according to the Kruskal-Wallis H test (means within parenthesis)

Indicators	Mean ranges								
	R. Invasora		*O. González*		*Chambas*		*Bolivia*		*Sig.*
Milking cows, n/month	502	(161)	381	(113.5)	283	(90,0)	257	(77.0)	***
Lactation days, Days	323	(169.5)	217	(167.0)	431	(172.0)	328	(170.0)	***
Monthly production, kg/month	468.8	(16017)	340.0	(9775)	307.7	(8411)	287.2	(7160)	***
Total solid, %	488.4	(13.62)	426.3	(13.26)	258.2	(12.70)	327.7	(13.02)	***
Mean salary, CUP/month	301.3	(335.69)	466.2	(488.86)	389.1	(377.62)	354.6	(353.83)	***

Table 5. Mean ranges of secondary variables by company, according to the Kruskal-Wallis H test (means within parenthesis)

Indicators	*R. Invasora*	*O. González*	*Chambas*	*Bolivia*	*Sig.*
Milk per area, kg/ha/month	547 (24.49)	300 (9.2)	277 (8.29)	224 (6.9)	***
Milk per total females, kg/hembras/month	345 (1.0)	386 (1.1)	383 (1.2)	324 (1.0)	*
Milk per Diesel, kg/L Diesel/month	408 (12.73)	258 (5.52)	397 (9.59)	226 (3.90)	***
Milk per gasoline, kg/L gaso-line	554 (353.20)	445 (52.0)	208 (0.000)	253 (3.60)	***
Milk per kW, kg/kW/month	404 (5.2)	231 (3.0)	273 (3.10)	558 (8.6)	***
Solid per area, kg/ha/month	404 (5.16)	231 (2.96)	273 (3.13)	558 (8.62)	***
Total salary per milk kg, CUP/kg	471 (0.58)	109 (0.18)	378 (0.46)	221 (0.23)	***

*P≤0.05; *** P≤0.001. CUP (Cuban Peso)