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Effects of Three Calving Patterns upon Dairy Systems Bioeconomic Efficiency During Dry Season

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ABSTRACT

Effects of three calving patterns upon dairy systems bioeconomic efficiency during dry season were evaluated from April 2004 to October 2011. Twelve dairy farms affiliated to the Livestock Center Triángulo 1 in Jimaguayú municipality, Camagüey province, Cuba, were sampled to this purpose. Calvings were distributed into three patterns: PI (55 % calvings during the rainy season and 45 % calving during the dry season), PII (65 % calvings during the rainy season and 35 % calving during the dry season), PIII (75 % calvings during the rainy season and 25 % calvings during the dry season). Every pattern was evaluated taking into account indicators performance with regard to production, feeding efficiency, and financial efficiency. These indicators were also assessed by a simple analysis of variance (ANOVA). Most of the indexes showed a significant difference ($P < 0,005$) markedly higher for productive indicators in PIII. This same pattern exhibited a milk production increase over 65 000 kg milk/year compared to the other patterns, a better grassland utilization, a higher financial efficiency concerning total income and income-expense rates, and a lower production cost for each liter of milk. It is apparent that a higher calving concentration during dry season enhances animal food availability and lowers milk production costs based on pastures.

Key Words: *seasonality, calving patterns, grassland utilization, bioeconomic efficiency*

INTRODUCTION

The more rationally use of pasture is a concerning dairy systems of Camagüey, for pasture is nearly the only feed source available for them (Guevara *et al.*, 2010). Several studies on this topic have proved the feasibility to improve the bio economic indicators when calving increases during the rainy season (Díaz *et al.*, 2009; Curbelo *et al.*, 2010; de Loyola *et al.*, 2010; Soto, 2010). Various analysis by Del Risco, Guevara, Guevara, Curbelo and Soto (2007) compared three patterns of calving characterized by PI (50 % of calving during the rainy season, and 50 % during the dry season), PII (30 % of calving during the rainy season, and 70 % during the dry season), and PIII (80 % of calving during the rainy season, and 20 % during the dry season).

However, other possibilities of comparing patterns, generally characterized by the increasing percentage of calving during the rainy season, have not been evaluated. The objective of this research was to assess the three calving pattern effects during the rainy season on the bio economic efficiency of dairy systems.

MATERIALS AND METHODS

Location, climate and soil

The research was carried out from April 2004 to October 2011, on twelve dairy facilities in the Agricultural Enterprise Triángulo Uno, Municipality of Jimaguayú, Camagüey province, 21° north and 70° west. The soil is agro-productive category 3, according to the data from the Agricultural Enterprise data, provided by the Institute of Soil in Camagüey. The climate is tropical humid of plains, around 1 114 mm^3 of annual rainfall (average rainfall of the season) and 79 % of rains between May and October, which is the spring-summer season.

Characterization of facilities

The Dairy Production Facilities (UPL) cover an area ranging from 95.3 to 130.1 hectares and 106-136 cows. The birth rate percentage reached 46-64 % and the lactation time average was 230 to 245 days.

The resulting animals are a mixed race of Holstein and Cebú, under a diet of rotational pasture, with an average of five enclosures per UPL. The consumption is 87-100 kg of NORGOLD® (dietary supplement) per cow annually, with a nutritional value of 86 % of MS, 24 % of PB and 2.3 Mcal/kg MS of energy that can be metabolized (NRC 2000).

Botanical composition

The distribution of grazing areas, forage, sugar cane used as forage and wood (shrub-like and invasive) per UPL is registered in the agro technical data files for approximately seven years.

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Forage balance for the rainy and dry seasons

The forage balance method used was Guevara´s (1999); the forage needs for the rainy and dry seasons were estimated, considering 155 days for the rainy season, and 210 for the dry season, and 15 kg of MS/UGM per day. The use of 50 % of pasture for both periods and 90 % of forage to harvest were considered (Del Risco, 2007), estimating 10 % of loss in harvesting, carrying and rejection in feeders.

Creation of calving patterns

The calving patterns were created using the information available in the productive entities, in order to evaluate the influence of these patterns in the bioeconomic indicators, referred to as the percentage of calving occurrence (the rainy season was established from April to August). The distribution of the patterns followed the following order:

PI = 55 % rainy season and 45 % dry season (UPL 1; 2; 4; 5 and 12).

PII = 65 % rainy season and 35 % dry season (UPL 4; 6; 7 and 9).

PIII = 75 % rainy season and 25 % dry season (UPL 3; 8; 10 and 11).

Productive indicators

From the information available of each UPL, the production rate was estimated according to Guevara, Guevara and Curbelo (2007).

- Total production/year
- Production/cow/day
- Production per hectare/year
- Work group production (UT)/year, considering five workers per UPL

The indicators estimates reflect: solids, fat, protein, and lactose per animal, using transformation coefficients related to total production. The distribution was 12.1 % of solids; 3.5 % of fat; and 3.2 % of protein, according to Ponce’s criteria (2000) for national breeds; and 4.5 % of lactose according to Webster (1993).

Financial indicators

Derived from the economic fluctuation of calving patterns, financial allocations and enterprise income, and profitability over total gross income per year were estimated according to procedures of the *Management Manual of Dairy Enterprises* (Luening, 1996). These are the total expenses, total income, income-expenses (net income), and costs per milk kilogram.

Statistical analysis

In order to accomplish the statistical analysis, some variance analyses were performed to the economic indicators and the characteristics of the entities, using the Tukey’s algorithm to evaluate pattern contrast. In the case of productive indicators a co-variance analysis was used, by applying the same algorithm to know the differences between patterns. Systat software program, version 7.0 (Wilkinson, 1997) was used.

RESULTS AND DISCUSSION

Physical Indicators of the entity

Table 1 shows the analysis of significant differences ($P < 0.05$) within various calving patterns, related to the total area of entities, PIII as the one with the smaller total area. However, the natural pasture distribution is similar, while to PIII’s chemically treated pasture a smaller area corresponded.

Similar results were achieved by Guevara *et al.* (2005), in research done in the Camagüey-Jimaguayú basin, regarding the total area and the chemically treated pasture land; contrary to the natural pasture land which had lower results.

PI and PIII did not show any significant differences between each other, regarding animal burden; but in comparison to the rest PII was the lowest animal burden pattern, (González, 2004). He said that in this type of operation, the most important producer’s decision is to determine the calving starting date after the animal burden adjustment. Its relevance is related to the effect over the nutritional level at the beginning of the lactation period, which influences its duration and subsequent behavior.

Significant differences ($P < 0.05$) were not observed among the three patterns in the forage balance during the rainy and dry seasons. A similar situation in the three patterns, according to climate and pasture efficiency, occurs during the dry season. The situation has not been reported in the country; neither in research in experimental stations nor in assessment of dairy systems. In experimental trials, García-Trujillo (1988) indicated that since pasture availability is lower in the dry season, a milk production drop is produced, to 76 % of the potential to be achieved. Senra (1982) in ICA; Milera, Iglesias, Remy and Cabrera (1994) in Indio Hatuey stated other results, which indicate that changes in pasture availability during the dry season, can increase milk production if the same happens to energy concentration. Guevara *et al.* (2005), in commercial systems assessed in Camagüey and Bayamo, found a seasonal effect in milk production drop in the dry season. Benítez *et al.* (2003), state the same phenomenon in cattle from commercial enterprises in mountains and hillsides in Granma province. The cows had the same diet during the whole year, in the three patterns; there were no big differences among them as to the amount of feed consumed by each cow. However, in PIII he pasture is available in a greater amount when the animal needs are bigger, a reason why this pattern stands out over the other two.

Behavior of productive indicators

Table 2 shows the behavior of the patterns regarding total milk production, and production per hectare, cow, and work group per year, with significant differences (P < 0.05) among all patterns; PIII was the one with the highest production. These results are positive consequences of the proper usage of the grass growing pattern with a higher number of animals giving birth at the beginning of spring, which is the essence of seasonal pasture to produce milk efficiently. This has been the common feature of most commercial herds in New Zealand, Australian´s temperate south, Ireland, Argentina, Chile, and more recently, The United States of America and Canada (Durán, 2000; Holmes, 2001; Fowley, 2003; Rath, 2003).

In terms of milk production per hectare a year, PIII had a significantly higher performance (P < 0.05) with respect to the other two patterns. Similar results in Cuba were reported by González (2003) from dairy herds in Ciego de Ávila province, where a group of young cows, in which hormones were used, gave birth at the beginning of the rainy season. And unlike the rest of the cattle, they achieved a higher percentage, differing 42.8 %, regarding productions per year and hectare. This behavior is the result of the better use of the growth of pasture, at the beginning of the rainy seasons, by the animals that give birth in that time of the year and have higher nutritional requirements. These requirements are achieved mainly by assigning a higher amount of nutrients per area, which is one of the most important pillars of the nutritional strategies of seasonal systems efficiency success (McMeekan, 1963; López Villalobos, Holmes and Garrick, 2000; Holmes, 2001; González, 2003; Guevara *et al.*, 2005). This corroborates, Del Risco (2007), in the parallelism between lactation and pasture productivity rates, which allows to considerably increase the load and, consequently, not to rely so much on the production per animal but on a more efficient production per hectare.

The daily milk production per cow showed significant differences in favor of PIII, whereas no significant differences were observed between PI and PII. The same results were found by Guevara *et al.* (2007a) that reported dairy farms at the Triángulo 1 Enterprise from March 2001 to April 2004. In group production a year significant differences between PIII and the other patterns (P < 0.05) (with no difference between them so far) were found. According to McMeekan (1963), this indicator is not commonly reported in scientific research, but it is one of great importance, because the countryside-city migration is a vulnerable phenomenon to livestock-farming production systems, since the rates of production per worker are determinant in livestock farming efficiency of the milking systems, because those rates favor economic efficiency, indicate more income and advantages in dairy businesses, and cause producers to strengthen their working abilities and show more dedication towards their labor (Ferry, 1998; Guevara *et al.*, 2007b).

Fluctuation of the milk component

Table 3 shows the advantage of PIII over the other patterns with respect to the production of total solids per cow a year (P < 0.05). This component of milk yield is very important to the effects of the industry because it represents more efficiency values related to the processes that take place in the factory; especially now, when milk has not only become a basic food, but also a raw material, due to the increase of its usage value in various types of food (Griffith, 2000; Holmes, 2006).

In the fluctuation of milk total solids per year, relevant differences were found among the patterns (P < 0.05). PIII was much higher than the other two, which were lower compared to the use of the pasture potential in the more productive season. That was linked to the favorable effects of seasonal production and it is an example of efficiency in this more favorable pattern of calving, reported by González (2003) and Rodríguez

(2003), where the production of solids and milk fat was accomplished. This production was higher in 37 % of the calving patterns at the beginning and middle of the rainy season. In New Zealand in primary productivity conditions, in the area of Waikato, values of 351 and 378 kg were achieved (Kerr, Cowan, and Chaseling, 1994; Howes 1997), and in from 400 to 439 kg per cow were found in Australia; with a high use of pasture for grazing in both places.

In addition, the Plll was the one with a higher volume of fat was produced, as a result of higher dairy production. The annual production of fat per cow also showed significant differences between the patterns. Plll is the one with the highest production per cow, resulting from higher concentration of cows giving birth at the beginning of the season of higher feed availability. The production of milk, as well as its components, will increase, and they are a direct product of the already reported benefits of what happens in the milking systems that keep their calvings for the seasons near the beginning of spring. This procedure is beneficial for the industry and financial balances of raw material (Holmes 2001).

The total lactose variation was similar to fat variation, which was significantly higher in Plll than in the other two patterns. In previous years, lactose, as a dairy component, was thought to be harmful (Griffith, 2000). Nowadays, its value as a nutritional component has increased and it is considered an added value to new food from which milk is a part of.

The annual amount of raw milk in the Plll was also very different from the other two patterns ($P < 0.05$), because Plll was the one with the highest production of raw milk annually. This high production of milk is the positive consequence of the union of several factors, such as weather, proper handling and nutrition. Furthermore, this milk has an added value present in its components; this is an efficiency sign for the industry, according to the favorable processes and statistics of raw materials, nutrients, water, energy, and finances. This matter has been pointed out by experts on this topic, such as Best (2004), for the dairy industries of Chile, Uruguay, Argentina and Brazil (Durán, 2000; Guevara *et al.*, 2005).

Performance of the financial indicators

Table 4 shows the values of economic efficiency obtained by Plll, which showed significant positive differences ($P < 0.05$) compared to the other patterns, though it was the one with the highest total expenses. Nevertheless, higher total income and expense-income (net income) were achieved in Plll, indicating a better financial efficiency; and, even though the operational expenses are higher in PIII, salaries corresponding to workers' labor are also higher. This happens at the same time that exploitation can be intensified and expenses are increased. This is an indicator of bigger financial efficiency, regardless of higher expenses of salaries paid in advance, as indicated by Guevara *et al.* (2005) after they found out that money was mostly spent on salaries, mostly on grass cutting by hand (more than 70 %) and total salaries (more than 85 %), in the dairy facilities of the Camagüey province.

In terms of economic efficiency, similar results have been registered. On this Ferry, (1998) stated that in order to improve their income, milk producers must have more control over their variable expenses, which can become manageable expenses. Sometimes in Cuba, according to the farms incomes salary expenses are highly overstated, and are related to wages paid in advance assigned by the Ministry of Agriculture to cooperatives. The overstated salary expenses are also related to other expenses that sometimes are pro-rated for farms that, according to the Ministry's evaluations, do not need those budgets.

Table 4 also presents the differences among the patterns, as to expenses per milk kilogram, $ 0.79 Cuban pesos per milk kilogram, Plll the one of lower cost, which is a conclusive response to favorable effects in proper pasture usage with the objective of satisfying, in a high percentage, the nutritional requirements of dairy cows grazing, with a minimal dependence on feed not produced on the farms, which reduces the expenses.

Brockington (1992) reported simulated positive responses after causing calving to occur towards the beginning of the period of highest pasture growth, which reduces the cost of the milk kilogram.

In Brazil, Argentina and Uruguay, downfalls in the expenses per milk kilogram in cattle with calving concentration at the beginning of the period of highest pasture growth were also found (González, 2004).

CONCLUSIONS

Plll, with 75 % calving during the rainy season, considerably increased the bioeconomic indicator, resulting in a better usage of pasture in the period of highest growth.

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Table 1. Physical resources of units and nutritional indicators

Variable	Patttern I (55 % ll y 45 % s)	Pattern II (65 % ll y 35 % s)	Pattern III (75 % ll y 25 % s)
Total area (ha)	109.11 a	115.66 b	100.42 c
Native pasture (ha)	63.91 a	65.84 a	62.15 a
Improved pasture (ha)	23.76 a	18.82 ab	13.28 b
Sugarcane (ha)	7.74 ab	6.36 a	9.18 b
Woodytrees (ha)	9.71 a	18.82 b	17.18 b
Animal burden (v/ha)	1.15 a	0.96 b	1.25 a
Forage/rainfall balance (t)	-12.42 a	-26.05 a	-9.73 a
Forage/dry balance (t)	-133.80 a	-124.60 a	-87.33 a
Total feed per cow (t)	3.62 a	3.52 a	4.14 a
Concentrate (t)	3.47 a	3.27 a	2.28 a

Different letters differ significantly ($P < 0.05$). (ll) rainfall and (s) dry

Table 2. Behavior of productive indicators in dairies, in terms of calving per year

Calving patterns (P)	Burden A/ha	Production total/year	Production total/ha	Production cow/year	Production UT/year
PI (55 % ll and 45 % s)	1.15	104 281.39 c	858.66 c	3.64a	17 885.3 c
PII (65 % ll and 35 % s)	0.96	112 465.4 b	1 095.18 b	3.83a	23 472.85 b
PIII (75 % ll and 25 % s)	1.25	175 786 a	1 528.19 a	5.85c	33 985.71 a
Significance (P < 0.05)		*	*	*	*

(UT) working units; (ll) rainfall and (s) dry

Table 3. Behavior of dairy yields per pattern (kg)

Variables	Pattern I (48-56 %)	Pattern II (58-68 %)	Pattern III (69-79 %)
Total solid	10 799.47 a	13 328.14 b	20 510.26 c
Total fat/year	3 614.95 a	3 902.60 a	6 286.98 b
Total lactose/year	4 727.68 a	5 126.34 a	7 957.97 b
Gross protein total/year	3 306.01 a	3 568.7 b	5 658.67 c

*a, b, c for different letters differ significantly (P < 0.05)

Table 4. Behavior of financial efficiency indicators regarding the calving pattern

Indicators ($)	Pattern I	Pattern II	Pattern III
Total expenses	82 379.4 a	85 878.35 a	111 479.4 b
Total income	102 422.4 a	111 786.35 a	181 093. 87 b
Total expenses	20 043 a	25 908 a	65 160.36 b
Cost/kg of milk	0.97 a	0.89 b	0.79 c

*a, b, c. for different letters differ significantly (P < 0.05)