Husbandry and Nutrition

Review

Strategic Utilization of Forage in Seasonal Production of Cattle Milk in Mid-Eastern Cuba

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ABSTRACT

Background: Several studies have been done in the mid-eastern region of Cuba, to address the problem of forage availability and inappropriate handling, two critical factors in the determination of productive results and system sustainability. **Aim:** To consider changes in forage management strategies, based on a dairy production model implemented in the mid-eastern region of Cuba.

Development: Various important arguments on previous studies of the advantages provided by a change implemented in grazing management perspectives are presented. Accordingly, a more efficient use of large biomass production can be achieved, coinciding with milk production peaks, particularly in the April-August period. Different scenarios and production forms were considered, which coincided with minimum resource utilization. The main perspective of the study is to improve utilization and rational use of natural and local resources.

Conclusions: Considering the real possibilities of cattle systems in mid-eastern Cuba, the implementation of a seasonal strategy might increase the bio-economic efficiency of dairy production, with limited dependency on external supplies.

Key words: season, pasture, animal production, efficiency (Source: *AIMS*)

INTRODUCTION

In Latin America, cattle grazing systems are more predominant, milk production from cows in tropical countries plays an important economic role in the production chain of small and mid-sized farmers. However, there are various challenges that should be addressed by these farmers to

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improve the productive and reproductive efficiency of herds. One of the most important factors is the nutrition of dairy cows living under high temperature, sun radiation, and humidity (De Almeida, 2018).

Grazing poses several challenges, including variable and unpredictable growth of pasture, lower daily grass ingestion, less production per animal, less nitrogen use efficiency, and inefficient grazing management. Several opportunities are available to develop novel approaches for grazing management to meet the above challenges, including the application of automated techniques to monitor the behavior of grazing, and distribution of pasture, run by remote sensors, and hyper-spectral images to integrate animal performance to pasture allocation. Advances in plant improvements also offer potential routes to enhance animal yields, by aligning animal requisites with the nutritional contents of forage. The advantages of milk quality (health and naturalness) attributed to pasture-based systems are acknowledged by demanding consumers, and are being used by groups of farmers and supermarket chains (Wilkinson *et al.,* 2020).

According to Hernández-Castellano *et al.* (2018), further research in dairy cattle physiology in tropical areas should be focused on (1) sub products for animal nutrition to save the land for human nutrition, (2) new alternative foods resistant to droughts and high temperatures, (3) methane emissions, (4) heat stress, and (5) metabolic disorders, and immunological condition.

Several studies have been done in the mid-eastern region of Cuba, including provinces Camagüey and Ciego de Avila, to address the deficit of forage availability and inappropriate handling, since they are pivotal in the determination of productive results and system sustainability. The first studies of seasonal dairy system feasibility in the mid-eastern region of Cuba, were conducted by a group of researchers of the Faculty of Agricultural Sciences at the University of Camagüey, Cuba, which was a starting point of a larger number of studies in different rural areas, and using various modes of production, which are common in Cuba.

The seasonal alternative of dairy production relying on timely and rational use of pastures and forage at their peak productivity, in the summer, is a feasible way to achieve these goals in the low tropic and mountain ranges, as shown in different field trials in commercial systems with such calving trends (Guevara *et al*., 2013). Most of this research considered the spontaneous occurrence of parturitions in different months, comparing the cases with the highest seasonality to others produced anarchically, showing promising results in different forms of production, namely, state-owned, cooperative or private.

The aim of this review is to consider changes in the management strategies of forage, according to a dairy production model in the mid-eastern region of Cuba.

DEVELOPMENT

Key arguments for seasonal management of bulky feeds

Availability and utilization of dry matter can be determining to make decisions in management strategies, and possibly the implementation of new technologies.

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In Camagüey, a marked difference leaning to greater production in the rainy season (May-October) has been observed, which is almost a pattern of the type of behavior of systems, due to the high effect of precipitations on pastures and forages, even on total consumption of water and feed (Guevara *et al*., 2004).

In that sense, the behavior of the distribution curve of the monthly average grass production in the Jimaguayu basin (Figure 1), where four different important moments can be suggested, in terms of grass growth and productivity, in the year: April-June (beginning of the maximum grass growing period); July-September (maximum yielding period); October-December (quick descend of grass growth, and final moment of maximum growth); and January-March (minimum grass growth) (Soto, 2010).

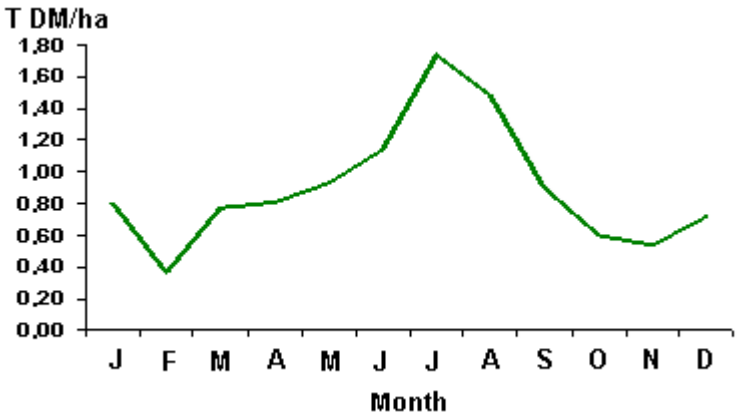

Figure 1. Monthly average productivity curve of grass in the Jimaguayu area (Soto, 2010)

The idea of a seasonal alternative for milk production is based on timely and rational utilization of the highest productivity peak of pasture and forage during the spring-summer period (Guevara *et al*., 2013). Studies done in Camagüey and Ciego de Avila (Guevara *et al.*, 2013; Pedraza, and López, 2015), demonstrated that the effect of season on dairy production is more associated to an increase of pasture availability than a lower temperature in the dry season, when biomass production decreases.

The growing interest in grazing due to the easiness of establishment, and minor requirements of capital infrastructure, low operational costs per milk kilogram, and potential access to high value markets because of perceived benefits to animal welfare, has led to a variety of grazing systems worldwide. However, the modern archetype of grazing is associated to New Zealand, Australia, and Western Europe (for instance, France, Ireland, and the United Kingdom), all of which share a broad history in agriculture that contributed to the development and improvement of a very efficient system throughout the last century (Roche *et al.,* 2017).

Several authors have recommended the application of technological alternatives to increase sustainability and efficiency of cattle raising (Senra, Soto, and Guevara, 2010). Some of them refer to the implementation of a more adequate strategy to recover degraded grasslands, give priority to diagnostic for technology selection in cattle raising areas, and apply the most appropriate one according to the climatic and socio-economic conditions, ensure that the basic diet of bovine production systems, in Cuban conditions, are based on pastures and forages. Additionally, better strategic management should be provided to increase the efficiency in calving synchronization to the period with the highest pasture and forage production peaks.

The main opportunities to increase *per capita* production in grazing are, (a) proper pasture handling to ensure adequate supply of high quality pasture, and (b) strategic supplementation with low-cost, high energetic feeds. High quality pasture supply during lactation may withstand high production levels of milk per cow (Wilkinson *et al.,* 2020).

Strategy for the utilization of forage using the seasonal dairy production model

Various research done in Camagüey (Spencer *et al.,* 2012; Guevara *et al.,* 2013), and Ciego de Avila (Uña *et al.,* 2014; Pedraza, and López 2015; Soto, Uña and Machado, 2018), have demonstrated the effect of season on a more efficient use of pasture and forage when naturally occurring parturitions are concentrated. Generally, these results indicate that the greatest availability, despite the predominance of low and mid-quality species, is more influential than temperature, among other factors, on the bio-economic results of the herd.

On farms in Camagüey, several studies (Guevara *et al.*, 2005a; Guevara *et al.*, 2005b; Guevara *et al.*, 2006; Spencer *et al.,* 2012; Guevara *et al.,* 2013; Pedraza and López, 2015; Soto, Uña, and Machado, 2018), determined negative forage balances in the two seasons of the year. Besides, they found seasonal patterns in empty cows, with increases between June and July, higher values of gestating animals in January, and birth peaks from March to July, with lower values between March and October. This situation favors systematic adjustment of seasonal calvings, depending on milk production.

An analysis performed to ten farms in the municipality of Jimaguayu, in the same province, showed promising results when parturitions were concentrated in the April-August period of up to 79%, compared to the concentration values (57%) in the same period. In that sense, the percent

results of bio-economic indicators were observed when parturitions were concentrated: annual/hectare milk production was increased (44.2%), daily/cow mean production increased as well (37.8%), and the total consumed feed conversion into milk (43.7%). The production costs were reduced (22.7%), accordingly (Soto, 2010).

In different scenarios of Camagüey, where real cases of simulated validation process were used, studies found that the increases in calving concentration between April and August accounted for 81 and 86%, with 78 and 82% intensity, including a rise in the nutritional levels. Milk production was observed to reach the 8.6-10.3 kg/cow/day range, and a differential increase was achieved in relation to the basic scenario (506 ± 32.5 kg/ha) annually, with a profitability of 22.6-25.3% in terms of operational capital, corroborated in validation case studies (Guevara *et al*., 2013).

On Ciego de Avila farms, a marked seasonal effect was observed on productive yields, when births occurred in the April-August period (76-86%) (Curbelo *et al*., 2014). Soto, Uña, and Machado (2018) noted the existence of seasonality of births in the period between mid-July and early September, but with sufficient pasture and forage availability in relation to the animal stocking rate. It determined negative forage balances, which, together with reproduction management, limited the efficiency of bioproductive and financial indicators, among other factors.

In Ciego de Avila cooperatives, the effect of moment of calving was studied at the beginning of the maximum grassland growth, on various efficiency indicators of Siboney heifers (including estrus). Significant differences were observed in the main indicators of milk production, and the supply for the two-week periods of May, with 170-180 grazing days compared to June, when the production costs of a kg of milk were CUP $0.27, 0.34, and 0.38, vs 0.46 in the four two-week periods of May-June, respectively (Guevara *et al*., 2005a).

In the 2008-2012 period, ten commercial cattle farms from Ruta Invasora Livestock Company, in Ciego de Avila, were studied to evaluate the effect of calving concentration patterns in April-August, on the bio-economic efficiency of insufficient forage availability conditions. Year/hectare production improved 21.2% with 76-86 % calving patterns. Improvements were also observed in mean daily/cow production (24.7%), and feed conversion to milk (17.4%). The average calving interval was reduced 10 days, in comparison to the 51-53 % pattern of calving concentrated in the same period (Soto *et al.,* 2014).

Likewise, a case study was done on a farm from the same company, under heavy forage restrictions, and low feedstuff consumption, with few births in the April-July period (80-86%), the highest percent in May, which determined a higher performance, particularly, in its best year, in reproductive efficiency indicators (78% natality), and productive (1 393 kg/ha), compared to the other farms. These results confirm the possibility of higher milk production efficiency when the birth peaks coincide in the rainy months (Uña *et al*., 2015).

Overall, it must be considered that all these results were achieved in low supply conditions, indicating that concentrating milk production in this particular season can be done in order to achieve better use of bulky feedstuffs, a modality that can be easily adapted to different system input levels.

In Ecuador, Armas *et al.* (2015) reported that the occurrence of calving in almost half the herd (39.1-48.2%) at the beginning of the maximum growth period, determined that the animals in these groups increased milk production in 518 kg during lactation (272 days average), compared to the group of animals that calved in more unfavorable periods. It was achieved with 22-26 New Zealand-descendant cows with low live weights.

The inclusion of forest grazing may bring considerable contributions to the volume and quantity in the diet of dairy cows, which can lead to higher results in relation to productivity and efficiency of production, generally. It has been confirmed in studies (Guevara *et al.*, 2013), where productive responses of 8 kg/cow/day were achieved when forest grazing technologies based on *Leucaena leucocephala* associated to the grassland were used. Even with the introduction of the Protein Bank technology to 30% of the area, 9 kg/cow/day were achieved. Though this is a less costly and faster alternative to recover an investment, in relation to enhanced pasture or rehabilitation work in the entire the area, which additionally permits better grassland management (Soto, 2010).

Likewise, concentrating milk production in a particular season, with ensuing supply improvements, may constitute a different and enhanced vision, in terms of productivity and efficiency of the system, even when the resources to produce it are short. Hence, it can be inferred that the best bio-economic response of dairy systems is linked to higher concentration of calvings in the April-August period, coinciding with the period of highest grass productivity.

Perspective of milk production concentration in a particular season

Precipitation prospects in Cuba are looking at wider distribution throughout the year, with a decline in the region (15%) until 2040, including a probable rise of the mean annual temperature (1.8-2.1 ºC, unpublished data), but the aridity index indicates a continuation of sub-humid climate conditions until 2100, at least (Soto, 2010).

According to the agro-climatic conditions of Cuba, and its effects on dairy and double purpose cattle production in a particular territory, Mendoza *et al.* (2019) reported that the results achieved determine birth seasonality, which confirms the trend that the biological behavior of dairy cows in Camagüey coincide with the season of high pasture availability, and, in that sense, the feasibility to strategically handle dairy herds, regardless of organizational changes taking place in Cuban agriculture.

Implementing a seasonal model for dairy production is worth analyzing, considering the calving time of dairy cows, just when the grass begins to grow, and the effect that this fact may have on animal lactation, maintenance economy, production, and grass and the utilization of its nutrients (Guevara *et al*., 2004). It produces a reduction in the consumption of supplementary feeds, and consequently, in operational costs (Guevara *et al*., 2013; Soto *et al*., 2017).

In the production conditions of Cuba, where the diet is almost exclusively pasture dependent, it is important to concentrate calvings in the season with the highest food availability. It allows for a more efficient use of the stocking rate, and therefore, focusing more on efficient production by hectare, rather than production by animal (Del Risco *et al*., 2009).

In that sense, an increase in the number of calvings throughout the rainy season, and in the late dry season, contributes to a greater influence production during the rainy season (Guevara *et al*., 2017).

A very important element is that calving intensification should be planned depending on the particular characteristics of the place. A study comprising herds from three forms of dairy production in the municipalities of Florida and Jimaguayu, Camagüey, done by De Loyola *et al.* (2015) found that the behavior of total milk production, and the average litter per cow underwent seasonal increases coinciding with the period with the highest grass availability, but the birth peaks were not supported by the milking cows or by dairy production indicators evaluated, which was attributed to feeding restrictions during the dry season, which did not allow the cows to reach the maximum productive level, and on many occasions, they were not ready for milking.

In Siboney de Cuba and Mambi de Cuba females, García-Díaz *et al.* (2019) observed a better reproductive performance in the cows that calved in the July-August-September quarter, attributed to the fact that the last third of gestation takes place in the period with the highest pasture availability, thus ensuring a better nutritional scenario, and improved body condition.

According to Guevara *et al.* (2017), the main shortcoming to the development and time projection of this type of production system is the high level of reproductive efficiency of herds. The utilization of such reserves is fundamental as a source of energy for a period with high demands, whereas voluntary consumption is heavily reduced. The results show the convenience of achieving calvings in advance, during the late dry period.

On dairy farms in neighboring provinces Camagüey and Ciego de Avila, the implementation of seasonality in dairy production is expected to improve very important aspects substantially. In that sense, four aspects on which seasonal milk production models have a positive influence (human resource productivity, labor organization, time distribution, and resource use) have been presented (Soto *et al*., 2017).

A reproductive strategy that determines calving concentration allows for proper arrangement of the zootechnical flow on the farm, improvements of the growth rate of replacement, and concentration of every effort and resource in a more favorable period of the year. It will enable higher efficiency in the primary production-industry-sales-consumer chain (Guevara *et al.*, 2017).

The consequence of a seasonal mating pattern is that it requires a significant amount of semen from the best studs throughout the intensive mating period to meet the demands (Roche *et al.*, 2017). These authors note that the resulting concentration in parturitions can surpass the limited resources of labor, feed, apart from other inconveniences, such as transportation and milk processing.

Considering that the success of seasonal grazing systems depends on the recovery of females that favors a calving interval of 365 days, the gestation period is shorter, requiring reproduction technology use. Recently, Horrach Junco *et al.* (2020), suggested seasonality associated to time fixed artificial insemination (TAI), and control of reproduction through the overall biorreproductive efficiency index methodology (OBREI), as zootechnical alternatives to increase the reproductive efficiency of cattle systems under artificial insemination.

CONCLUSIONS

In Cuban cattle systems, especially in the mid-eastern regions, proper management of forage resources is a particularly important criterion to implement rational approaches on business management, especially if the lactation peaks are to coincide with the highest pasture yield period.

Considering the real possibilities of cattle systems in mid-eastern Cuba, the implementation of a seasonal strategy might increase the bio-economic efficiency of dairy production, with limited dependency on external supplies.

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AUTHOR CONTRIBUTION

Conception and design of research: SASS, RVGV, and GEGV; data analysis and interpretation: SASS, RVGV, and GEGV; redaction of the manuscript: SASS, RVGV, and GEGV.

CONFLICTS OF INTERESTS

The authors declare no conflict of interests.