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Milk Production and Persistency of Lactation in Cuban Siboney Cows

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ABSTRACT

Background: Milk production and lactation persistency are two relevant economic features of dairy cows, defined as the ability to maintain relatively constant dairy yields throughout lactation. **Aim.** To determine the non-genetic factors that affect the persistency of lactation, milk production at 100, 244, and 305 days, and its correlations. **Method:** 151 259 milk records from 57 744 Cuban Siboney Cows distributed in 15 genetic projects in the country, whose calving took place between 1980 and 2020, were evaluated. The fix effects were company, dairy facilities, calving year, lactating cows. Besides, the duration of lactation as a linear co-variable was determined using a linear model. The SAS CORR procedure was performed to estimate the Pearson correlations. Persistency (P) was determined as the production decline rate between 100 and 244 days. **Results:** The general means and standard deviation of milk production were 779.62 and 261.01; 1 741,47 and 518.74; and 1 906,02 and 574.43 for L100, L244, and L305, respectively, and persistency (P) was 52.30 and 13.79 %, respectively. All the variables were significant (P <0.001). The correlations were all significant and positive, except between L100 and P. **Conclusions:** The variation sources in milk production and persistency differed significantly at 100, 244, and 305 days. Positive phenotypical correlations were found between milk production and persistency.

Keywords: non-genetic factors, lactation persistency, milk production, Cuban Siboney cows (*Source*: *BVS*).

INTRODUCTION

In the 1960s, Cuba initiated crossings between Holstein and Zebu to obtain a genotype ready to produce milk under the tropical conditions of adverse environments. Two main breeds came out of these experiments: Siboney (5/8 Holstein and 3/8 Zebu) and Mambí (3/4 Holstein and 1/4

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Zebu) (López and Ribas 1993). Siboney emerged as part of the National Genetic Breeding Project to obtain genotypes that were less susceptible than Holstein. They achieved an adequate productive potential under grazing conditions in the tropics. (Ribas *et al*., 2004).

Milk production and persistency are two relevant economic features of dairy cows. They have particular features, as they are manifested repeatedly throughout a female's life. therefore, the total production in every lactation is high variable, which is associated with numberless genetic and non-genetic factors, as stated by Fernández Tronco (2011).

Persistency can be defined as the cow's ability to continue to produce high levels of milk upon reaching the lactation peak, or the cow's capacity to maintain a relatively constant dairy yield during lactation (Elahi and Hosseinpour, 2018). That way, persistent animals are capable of showing the most stable lactation curves (Togashi and Lin, 2004). Improvements in persistency during lactation are associated with a lower milk production after reaching the lactation peak.

Physiologically, knowing the existing differences between first-calving and multiparous cows is fundamental, as they may have a heterogeneous performance (Kadzere *et al*., 2002). The lactation curve shows milk production along the production cycle (from day 0 to the last one), which is supposed to last 305 days, the ideal time. A lactation curve has critical dots, such as the maximum production time (Tmax), the production of maximum yields (P max), and the level of maximum production, known as persistency (P) (Lemus-Ramírez, Guevara-Escobar and García-Muñiz, 2008). In addition to the genetic factor, the variations in the total milk volume along the lactation (LT) may be linked to factors such as infrastructure (technological development), herd management, feeding, reproduction, health, climate, and the number of parturitions per cow. The last two in the list are usually the most critical ones in the evolution of lactation (Renaudeau *et al*., 2012).

The improvement of persistency during lactation may contribute to cutting down the costs of production systems. This feature is related to a decline in the costs associated with higher nutritional efficiency, fewer health and reproductive problems, and greater resistance to diseases (Dekkers, Tem Hag, and Weersink, 1998).

Accordingly, this paper aims to determine the non-genetic factors that affect the persistency of lactation, milk production at 100, 244, and 305 days, and its correlations.

MATERIALS AND METHODS

The data used was collected from 57 744 Siboney cows belonging to 15 genetic projects, based on 151 259 milk production records. The databases were edited and selected to a final number of 146 613 lactation records (from the first lactation to the eight one), and included higher numbers, with calving that took place in the 1980-2020 period.

Persistency (P) was estimated, according to Johansson and Hansson (1940), adjusting the formula as follows:

$$P21=((PL244-PL100)/PL244)*100$$

P21 is persistency expressed as the milk decline rate at 244 days compared to the first 100 days.

PL244 is milk production at 244, and PL100 is the production at 100 days.

PROC-GLM (overall linear model) was based on the SAS-9.4 (SAS-2013) program, which included the following variation sources: company (E), dairy farm (V), calving year (AP), lactation number (NL), four-month calving period as the criterion for season (C), and lactation duration (DL) as linear co-variables. Duncan's multiple comparison of means was performed.

The model used was,

$$Yijklmno = \mu + Ei + Vj + APk + NLl + Cm + \beta n\,(Xn - X) + eijklmno$$

Where:

Yijklmno is persistency or milk production at 100, 244, and 305 days.

μ was the common general mean in all the observations

Ei represents the company effect (i = 1,…..15)

Vj is the dairy farm (j=1,2….240)

APk is the calving year between 1980 and 2020 (l= 1, 2, …,41)

NL1 is the lactation number (l=1,2….8)

Cm is the four-month calving period (m=1,2…3)

βn (Xn – X) is the linear regression of persistency lactation duration.

eijklmno is the residual or random error ~ N (o, δ^2_e).

RESULTS AND DISCUSSION

Table 1 shows the general statistics of the features analyzed, with the high variation coefficients (VC), demonstrating a high data variability, which encompassed 15 companies and 41 years of calving.

Table 1. General means (Mean), standard deviation (SD), and variation coefficient (VC) of the milk persistency and production means (n=146 613)

Variable	Mean	SD	VC (%)
L100 (kg)	779.62	261.01	33.48
L244 (kg)	1 741.47	518.74	29.79
L305 (kg)	1 906.02	574.43	30.14
P (%)	52.30	13.79	26.37

Note: L100, L244, and L305 represent the milk production at 100, 244, and 305 days. P- persistency

The characterization analysis results evidenced a lower performance when compared with the initial objectives of the Cuban Siboney project, with expected yields of 4 000 kg of milk. López and Ribas (1993), regardless of the management conditions and nutrition of the period. Under similar conditions, other authors have reported adjusted mean yields of 2 582 kg at 305 days, approximately 270 days of LD, on average. Their levels were between 2 183,04 and 2 583,12 kg as a mean, at 244 and 305 days of LD, respectively (Ribas *et al*., 2004, Suárez and Pérez, 2005).

Hernández *et al*. (2021) on Cuban Siboney and similar conditions, but with a smaller sample, reported yields of 1 957 305 days in the first lactation. Meanwhile, Hernández and Ponce de León (2016) reported 1 545.55 ± 805.62 kg in 272 days of lactation. The results of this paper are set within the above intervals, though they have lower variation coefficients (30.14% vs. 52.12%), so the population in this study was more homogeneous.

Likewise, Castillo *et al*. (2019) reported yields of 5 360 kg at 305 days, in Holstein cows at first-calving, whereas Huamán, Almeyda and Isique (2018), stated that in first-calving crossbred F-1 (Gir x Holstein) cows, it was 4 031 kg. Vásquez *et al.* (2021) reported higher results.

Table 2 shows that every correlation was significant and positive, except between L100 and P, which was the lowest, meaning that the greater the milk production in the first 100 days (the highest peak), the shorter the persistency. The correlations were greater in the nearest stages (100-244 was greater than 100-305, and 244-305 greater than 100-305). Being the correlations positive between persistency and yields at 244 and 305, which tells us that a high persistency leads to high milk production. The correlations found by González *et al.* (2011) between persistency and PL305 varied between –0.06 and 0.11.

Table 2. Linear correlation coefficients of the features included in the study (n= 146 613)

	L100	L244	L305	P21
L100	-	0.71***	0.69***	-0.25***
L244		-	0.99***	0.42***
L305			-	0.43***

***** P< (0.001)**

A similar result between persistency and milk yields at 305 days (0.45) was reported by Elahi and Hosseinpour (2018). According to the definition of persistency, some researchers estimated a positive phenotypical correlation between persistency and milk yields at 305 days, but others found that persistency had a negative correlation with total milk yields. Farhangfar and Rowlinson, (2007) achieved an estimate of 0.23 in Iranian Holstein heifers, whereas Boujenane and Hilal (2012) found that the phenotypical correlation between persistency and milk production at 305 in Moroccan dairy cows was -0.25.

Table 3 shows the significance levels of the variation sources for the milk productions and persistency, where all the variation sources were highly significant, evidencing their influence of this indicator.

Table 3. Significance levels of variation sources according to persistency

Variation sources	L100	L244	L305	Persistency
Company	***	***	***	***
Dairy farm	***	***	***	***
Calving year	***	***	***	***

Four-month period	***	***	***	***
Lactation No.	***	***	***	***
Lactation duration	***	***	***	***
R^2 (%)	36.44	55.27	56.56	23.06

Note: * (P<0.001); R^2 determination coefficient**

The variation sources included in the statistical models corroborate the importance of non-genetic factors in milk production, being highly significant (P< 0.001) for all the production traits of Holstein (De los Reyes, 1985). This author found effects that coincided with Siboney and its crossbreds (Suárez, Zubizarreta and Pérez, 2009). Likewise, the duration of lactation, considered as a linear co-variable, was highly significant, demonstrating its influence on milk production, thus coinciding with Fernandez and Tronco (2011).

Figure 1 shows the variation of persistency means, depending on the company. The highest values are from the companies with the highest milk yields, except companies 3507 and 3652, which may be associated with the existing conditions.

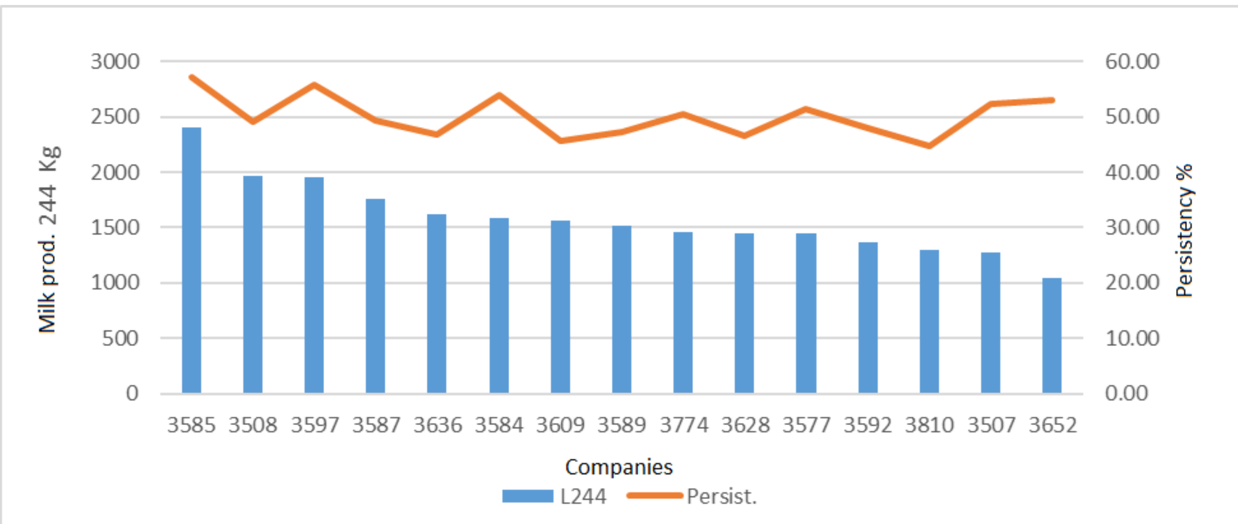

Figure 1. Variation of the arithmetic means of persistency, depending on the company

Figure 2 shows the variation of persistency means, depending on the calving year, with unstable values, and the existence of a slight decline in the last 15 years. These results might be caused by non-controlled management variations and poor grass availability.

The changes may vary depending on the decade. Between 1980 and 1990, this trend remained stable or slightly positive, whereas it rose in the 1991-2000 period (possibly due to the low production levels). Then, in 2001-2010, it dropped again, with a rising trend at the end of the period, but with low persistency values, which may be a breed's feature.

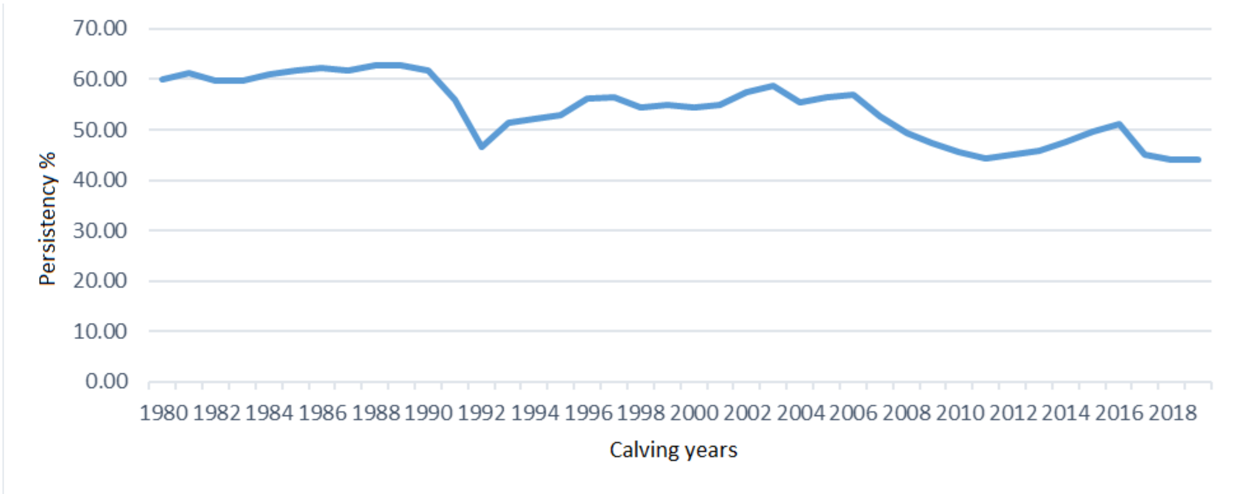

Figure 2. Variation of the minimum quadratic persistency means, depending on the calving year

Higher values were reported by Madrid Gallego, Calvo Cardona, and Arismendy Morales (2020) in Holstein and Jersey. However, Huamán *et al* (2018) found differing values in Gyr and Gyr x Holstein (F-1)

Figure 3 shows the variation of persistency according to the lactation number at 244 days, demonstrating that the animal goes through three marked phases in terms of persistency during their production cycle. From the initial lactation, an increase was observed, until a peak was reached during the second lactation, followed by a plateau or stability, preceding a gradual decline as the lactation number increased. It can be explained by the fact that as cows grow older their ability to produce milk decrease.

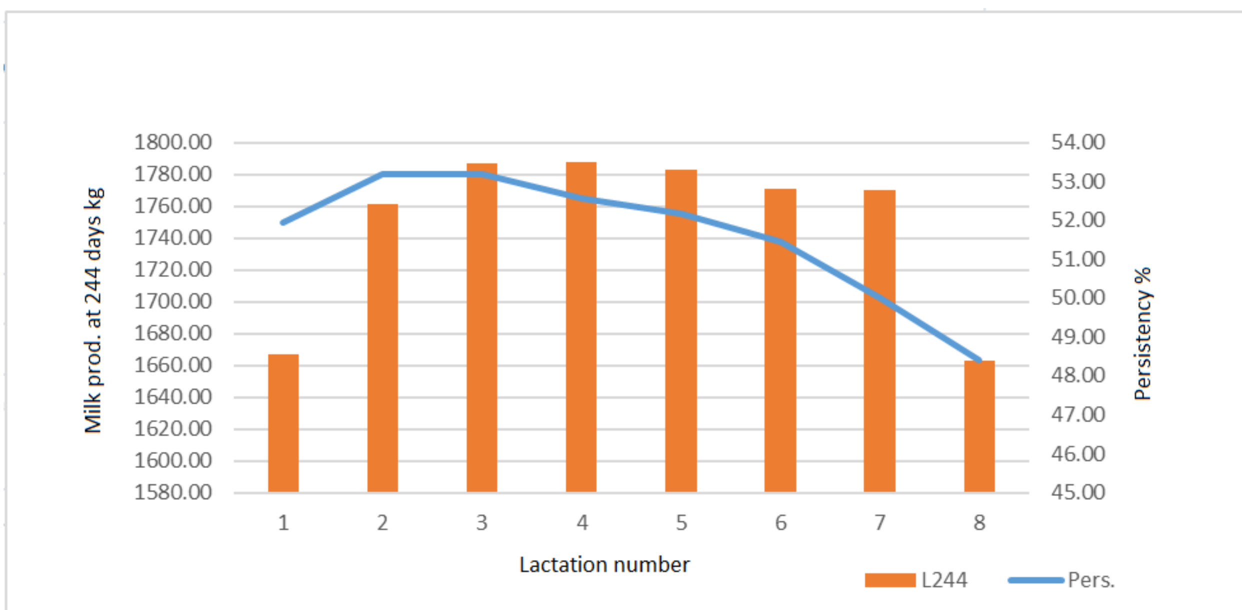

Figure 3. Variation of the arithmetic persistency means and L244 days, depending on the lactation number

The performance of persistency associated with the lactation number indicates that the cows improve their persistency quickly as they age (to the third lactation), then they start to show lower values. It is similar to the lactation curve, which justifies or supports the fact that older cows in the herds may reduce their production of milk because the animals are less persistent. The effect of the calving number on production start and peak may be attributed to the fact that the first-calving cows are still growing, so they must first meet their maintenance and growth requirements, and those of production, thus explaining why their yields are lower.

Figure 4 shows the milk production performance in 244 days, according to the four-month calving period, and the behavior of persistency. It clearly shows that the period with the highest yields corresponded to the greatest persistency.

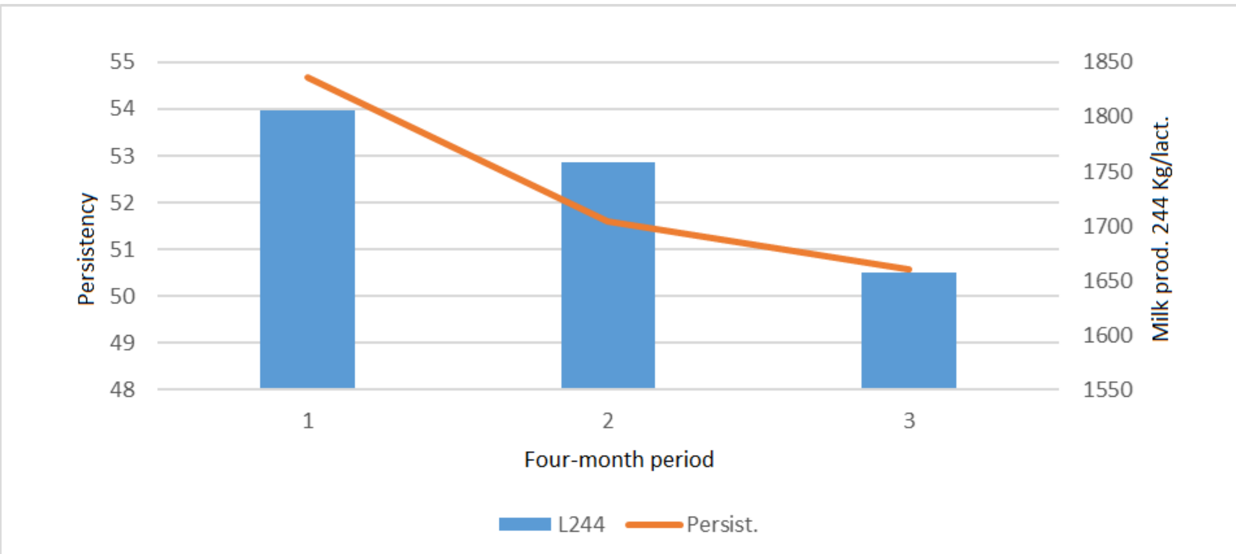

Figure 4. Milk production performance (244) and persistency according to the four-month period

The effect of the calving season influences this breed’s milk production, coinciding with Segura and Osorio (2005), in two-purpose Bos taurus cows x Bos indicus cows. There was a clear difference in all the four-month periods where the production was measured. Comparing the mean of the best four-month period (January-April) with the worst four months, the difference was remarkable (147.72 kg/lact), which translated into unproduced milk, accounting for 1 107 900 kg less a year. Similar results were achieved by Fernández and Tronco (2011) in this genotype between 1979 and 1999.

CONCLUSIONS

The non-genetic variation sources had a significant influence on milk production and persistency at 100, 244, and 305 days.

Positive phenotypical correlations were found between milk production and persistency.

The Cuban Siboney showed a low and variable persistency.

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AUTHOR CONTRIBUTION STATEMENT

Research conception and design: MCGR, MAST, analysis and interpretation of data: MCGR, MAST, YCD, AGP; redaction of the manuscript: MCGR, MAST.

CONFLICT OF INTEREST STATEMENT

The authors declare the are no conflicts of interest.