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GENETIC AND PHENOTYPIC TRENDS OF 305-DAY MILK YIELD OF HOLSTEIN COWS RAISED AT COMMERCIAL FARM IN EGYPT

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SUMMARY

The purpose of this study was to estimate the genetic and phenotypic trends of 305- day milk yield of Holstein cows in a commercial farm. Data consisted of 2654 lactation records for 850 Holstein cows sired by 316 sires, collected from 1991 to 2007. The data were analyzed using Least Squares technique to examine the effect of year, season of calving, parity and interaction between season of calving and parity factors on 305- day milk yield. Heritability of 305 day milk yield trait and breeding values were estimated using VCE 6.0.2 software.

Highly significant effects for year of calving, parity and the interaction between season of calving and parity on the 305- day milk yield were observed. However, season of calving had a non significant effect on the 305- day milk yield. The average of 305- day milk yield was 7042 kg. The heritability estimate of 305- day milk yield was 0.06. The regression of 305-day milk yield on year of calving showed a significant negative phenotypic trend being -91.6 kg per year. However, the genetic trend depicted a significant positive trend (+ 2.19 kg per year). In conclusion, although the trend in the estimated breeding values found for cows was positive, it still did not lead to change in the average milk production due to the probable reduction in the nutritional and /or management conditions of the herd.

Keywords: Heritability, genetic and phenotypic trends, 305- day milk yield, Holstein cows

INTRODUCTION

The increase of production efficiency could be achieved either by improving the environmental conditions of the population, by improving the mean breeding values of members of the population, or by a combination of both (Katkasame *et al*., 1996). Fundamental aims of animal breeding schemes are to increase profits of keeping producing animals. Partitioning the phenotypic value of the most important economic important into genetic and environmental component plays an important role in determining and estimating the real progress that can be achieved. Genetic trend is defined as a change in performance per unit of time due to change in the mean breeding value while phenotypic trend is a change in production per unit of time (Herbert and Bhatnagar, 1988).

The estimates of trends in the performance traits of dairy cattle seem to vary from breed to breed and from herd to herd due to differences in locality, management and selection objectives (Amimo *et al*., 2007).The trends are indicative of the progress or decline that has been attained using the breeding strategy in place (Rege and Mosi, 1989; Njubi *et al*., 1992 and Ojango and Pollot, 2001).

The measurement of genetic capacity of the dairy cows is of economic importance and improvement in genetic capacity is measured by the genetic trend (Kunaka and Makuza, 2005). Due to economic value of milk, milk yield has traditionally been the single most important trait of dairy cattle selection programs in most countries (Campos *et el*., 1994). Therefore, milk yield is expected to show positive (favorable) genetic trend (Rege, 1991). In general, favorable phenotypic and genetic trends can be achieved if the environment and breeding management are improved. There is, therefore, a need to continuously evaluate the genetic and phenotypic parameters and trends in dairy cattle, to monitor whether the parameters and trends are desirable for each trait (Amimo *et al*., 2007).

The purpose of this study was to estimate the genetic and phenotypic trends of 305- day milk yield of Holstein cows reared in a commercial farm.

MATERIALS AND METHODS

A total of 2654 lactation records for 850 Holstein cows sired by 316 sires were used in the present study. Data were collected from a commercial farm (International Company for Animal Wealth), located at Giza Governorate in Egypt. The data were obtained during the period from 1991 to 2007. The original herd was imported from the USA as 425 pregnant heifers in 1991. Cows are artificially inseminated at the third observed estrus after parturition using frozen semen imported from USA and Canada. All cows were machine milked.

The 305- day milk yield is calculated according to the following equation: 305- day milk yield = (total milk yield / (lactation period+100))*405 (ICAR, 2000). Lactations longer than 130 days were included in the analysis.

Statistical analysis:

The data were analyzed using Least Squares technique (XLSTAT, 2009) to examine the effect of year, season of calving, parity and interaction between season of calving and parity factors, as fixed effects, on 305- day milk yield. Preliminary analysis of data indicated that the interactions between each of years and season of calving and between year of calving and parity could not be calculated due to missed cells of data. The following statistical model was used:

$$Y_{ijkl} = \mu + YC_i + SC_j + IP_k + (SC*IP)_{jk} + e_{ijkl}, \qquad (A)$$

Where,

Y_{ijkl} = 305- day milk yield,

μ = the overall mean,

YC_i = the fixed effect of the i^{th} year of calving (i=1991,1992,…,2007),

SC_j = the fixed effect of the j^{th} season of calving (j=1, 2, 3, 4), where 1= winter (December, January, February), 2= spring (March, April, May), 3= summer (June, July, August) and 4= autumn (September, October, November).

IP_k = the fixed effect of the k^{th} parity (k=1, 2,…, 7),

$(SC*IP)_{jk}$ = the interaction between season of calving and parity, and

e_{ijkl} = random error assumed NID $(0,\sigma^2 e)$.

The heritability and breeding values were estimated by using VCE 6.0.2 software (Groeneveld *et al*., 2008) according to the following statistical model:

$Y_{ijklmn} = \mu + A_i + Per_j + YC_k + SC_l + IP_m + (SC*IP)_{lm} + e_{ijk}i_{lmn}$, (B)

Where,

A_i= the random effect of animal additive genetic effect, $A_i \sim NID(0,\sigma^2_A)$.,

Per_j= the random permanent environment effect on the animal, $Per_j \sim NID(0,\sigma^2_{per})$, and the other components of the model was defined in the model (A).

Phenotypic trend was estimated by regression of the 305- day milk yield on the year of calving. The genetic trend was obtained by regression of the breeding value for animal on the year of calving.

RESULTS AND DISCUSSION

Preliminary least-squares analysis showed highly significant effects for year of calving and parity and the interaction between season of calving and parity on the 305 day milk yield as presented in Table 1. However, season of calving had a non-significant effect on the 305- day milk yield. Abdelharith, (2008) reported non-significant effect of season of calving on 305- day milk yield. Year of calving had a significant effect (P<0.0001) on the 305-day milk yield, this was consistent with reports in the literature (Rege and Mosi, 1989; Olukoye and Mosi, 2002 and Amimo *et al*., 2007). Parity significantly (P<0.0001) influenced 305- day milk yield, this result is similar to findings in other studies (Rege, 1991; Njubi *et al*., 1992; Olukoye and Mosi, 2002 and Abdelharith, 2008).

Table 1. Mean-Squares of 305-day milk yield of Holstein cows

Source of variation	df	Mean Square
Year of calving	16	39056056**
Season of calving	3	2311538^{NS}
Parity	6	13557716**
Season * Parity	18	4809074**
Error	2610	2367728

** P<0.0001 NS= Not Significant (P>0.05)

The average of 305 day- milk yield was 7042 kg. This estimate was higher than that found by Bakir and Kaygisiz, 2004; Atil and Khattab, 2005; Amimo *et al*., 2007 and Abdelharith, 2008.

Phenotypic fluctuations in the 305- day milk yield were noticed (Fig. 1) in the present study. There was a significant (P< 0.02) negative phenotypic trend in milk yield with an overall rate of -91.6 ± 35.16 kg per year. The decline in this trait may largely be attributed to environmental factors. The variation in milk yield from one year to another could be attributed to changes in age of the animals, attacks of different diseases and management practices level followed from year to another, e.g. fluctuations in feed availability, and quality and prices. Rege (1991); Atil *et al*., (2001); Kunaka and Makuza (2005) and Amimo *et al*. (2007) also came to the same conclusion.

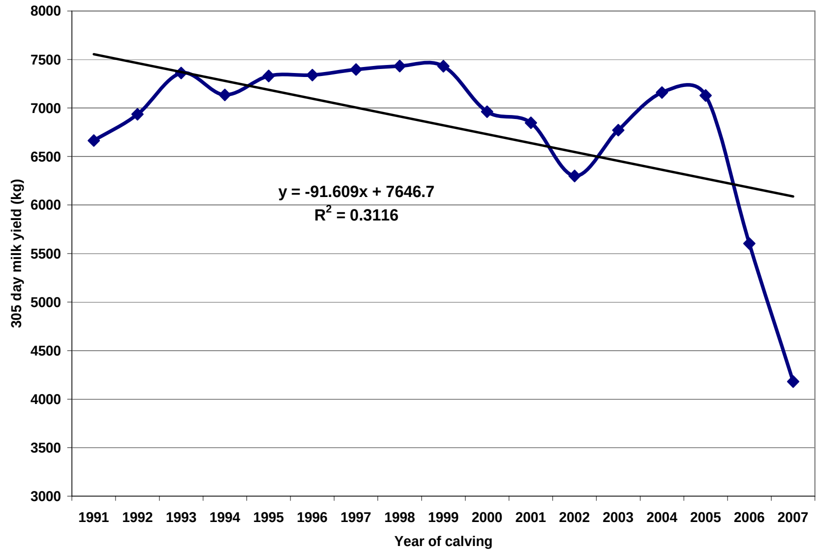

Figure 1. Phenotypic trend for the 305- day milk yield

The heritability estimate of 305- day milk yield and its standard error was 0.06 ± 0.04. This estimate was less than estimates found in the literature (Jamrozik and Schaeffer (1997; 0.32); Dematawewa and Berger (1998; 0.20); Abou-Bakr *et al*. (2000; 0.09); Ojango and Pollott (2001; 0.29); Abou-bakr (2003; 0.08); Kaya *et al*. (2003; 0.25); Atil and Khattab (2005; 0.26) and Abdelharith (2008; 0.19)). The low heritability estimate for 305- day milk yield revealed in this study could be attributed to the use of genetically similar sires from the same source over a long period. Differences in heritability estimates among various studies for the same trait of the same breed may be due to differences in the record number used, the correction for different non-genetic factors, the model used and the methodology for estimating heritability of the trait.

The estimated breeding values of Holstein cows for 305-day milk yield ranged from – 32.780 kg to + 47.994 kg (Table 2). The genetic trend for 305- day milk yield depicted a significant positive (+ 2.196 ± 0.93 Kg, P=0.033) value (Figure 2). These results indicate a slight genetic improvement in the present herd overtime. It might be due to the use of imported semen from sires having some better higher breeding values for milk yield.

The positive genetic trend obtained in the present study was also found by Ojango and Pollott (2001; +12.9 kg); Atil and Khattab (2005; +44.85 kg); Kunaka and Makuza (2005; +14.4 kg); Peixoto *et al*.,(2006; +7.09 kg) and Abdelharith (2008; +0.27 kg). Amimo *et al*. (2007) reported that genetic trend for 305-day milk yield was negative (-2.1 kg/year).

Table 2. Estimates of breeding values

Year of calving	Breeding value(kg)
1991	+ 1.008
1992	- 8.593
1993	- 6.711
1994	+ 2.317
1995	+21.829
1996	+20.044
1997	+17.167
1998	+ 5.566
1999	-25.304
2000	-32.780
2001	+20.251
2002	- 2.106
2003	+24.924
2004	+13.522
2005	+35.619
2006	+33.748
2007	+47.994

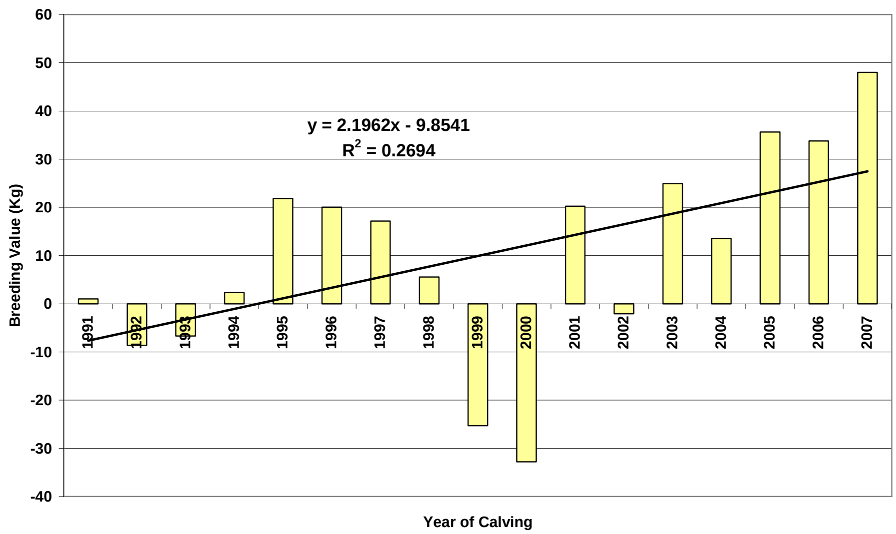

Figure 2. Genetic trend for the 305- day milk yield

CONCLUSION

Although the trend in the estimated breeding values found for cows of the present study was positive, it still did not lead to a positive change the average milk production. This result could be explained by the probable reduction in the nutritional and / or management conditions of the herd.

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الإتجاهات الوراثية و المظهرية لصفة انتاج اللبن فى 305 يوم فى قطيع هولشتين بمزرعة تجارية فى مصر.

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الهدف من الدراسة هو تقدير الإتجاهات الوراثية و المظهرية لصفة انتاج اللبن فى 305 يوم لأبقار الهولسشتين بمزرعة تجارية. و شملت الدراسة 2654 سجل لــ 850 بقرة هولسشتين لـ316 طلوقة، خلال الفترة من 1991 الى 2007 . و تم تحليل البيانات باستخدام طريقة المربعات الصغرى لدراسة تأثير موسم و سنة الولادة و ترتيب الوضع و التداخل بين موسم الولادة و ترتيب الوضع على انتاج اللبن فى 305 يوم. و قدرت قيمة العمق الوراثى و القيم التربوية باستخدام برنامج VCE 6.0.2 .

وكانت أهم النتائج ما يلى:

1. كان التأثير معنويا لكل من سنة الولادة و ترتيب الوضع و كذلك التداخل بين موسم الولادة وترتيب الوضع على صفة إنتاج اللبن فى 305 يوم.
2. بينما تأثير موسم الولادة لم يكن له تأثير معنوى على الصفة المدروسة.
3. متوسط انتاج اللبن فى 305 يوم هو 7042 كجم لبن.
4. قيمة العمق الوراثى لصفة انتاج اللبن فى 305 يوم هو 0.06 .
5. كان الإتجاه المظهرى لصفة انتاج اللبن فى 305 يوم سالباً معنوياً وهو -91 كجم / سنة. بينما أظهر الإتجاه الوراثى للصفة إتجاهاً موجباً معنوياً و قدره +2.19 كجم/سنة.
6. نستنتج من الدراسة، بالرغم من أن الإتجاه الوراثى للصفة موجب إلاً أنه لم يؤدى إلى تغيير موجب فى متوسط إنتاج اللبن بسبب تدهور التغذية و/أو ظروف الرعاية والإدارة للقطيع خلال سنوات الدراسة.