Egyptian Journal of Agricultural Research

Animal Production

ORIGINAL ARTICLE

Egypt. J. Agric. Res., (2020), 98 (3), 397-409

Estimation of the genetic and environmental trends for milk traits of Holstein herd.

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(Manuscript received 27 Jul 2020)

Abstract

The study is to evaluate the performance of the herd and assess the different effects (genetic and non-genetic) on the production of this herd. Also, to improve the accuracy of genetic prediction of the traits affecting milk production as well as to determine the effect of different non-genetic factors (environmental trend). The total number of records used in this study was 2651 productive records in Holstein Friesian (HF) over 10 years in a commercial farm located in the northern part of Nile Delta, Egypt. Milk production for 305 days (305d-MY, kg), Peak yield (PY), and Persistency (PER). Records were analyzed Animal Models using WOMBAT software to estimate heritability (additive h^2_a and maternal h^2_m), breeding values of sires, dams and cows (SBV, DBV and CBV), and Environmental trend (EVT) and Epigenetic trend (EPT) for all studies traits of (HF) cattle. Average for (305d-MY, kg), (PY) and (PER).were 4227kg, 22.8kg and 64.5%, respectively, additive (h^2_a) estimates for (305d-MY, kg), (PY) and (PER) were: 0.43±0.05, 0.28±0.05 and 0.08±0.03, respectively, while low (h^2_m) were estimated as 0.057±0.033, 0.017±0.028 and 0.024±0.023, respectively. Permanent environmental impact (P_e), where 0.044±0.031, 0.0 and 0.0 respectively. The average (SBV) were 1687, 10.3 kg and 14.3% for 305d-MY, kg, PY and PER; while the average (DBV) for the same traits were 1514.3, 9.3 kg and 15.9%.Whereas, the average (CBV) were 1747.4, 9.4 kg and 18.8%, respectively. The estimates of the (h^2_a) in this study indicated that the genetic and environmental variability of PER is low, while the moderate value of h^2_a for 305d-MY and PY indicates the possibility of selection for these traits as this leads to the possibility of improving productivity in future generations for cows under Egyptian conditions. These results suggest that selection based on the selection of higher cows in (CBV). Also, genetic trends indicate that herd's productive performance is influenced by environmental changes; Epigenetic trend was generally positive in the cold climate seasons (winter and spring), while it was negative in the hot climate (summer and autumn) for both (305d-MY, kg) and (PY). Therefore, adequate care and nutrition are necessary as it helps in the emergence of full genetic potential by improving environmental conditions.

Keywords: *Holstein Friesian; Milk traits; environmental and genetic parameters; Epigenetics trend.*

INTRODUCTION

In Egypt, the total cattle are estimated to be about 5.4 million. As a result of the increasing demand for milk and meat the needs of the population increase in Egypt, where per capita consumption of milk in the developed countries is about one 180 kg or more in the year, while the average per capita consumption of milk in developing countries is 40 kg **Ranawana, 2008**. Productive traits are determining the profitability of dairy production **Lobago *et al.*, 2007.** The production of cows is affected by many genetic and non-genetic factors. Where environmental factors are an important factor to show the true genetic ability on the basis of which the selection of the cows **Lateef *et al*, 2008**. Good management is important to determine the most important environmental factors affecting the productive performance of the herd, as a regular and continuous evaluation of environmental factors affecting animal productivity is very important when planning the establishment of dairy farms, Therefore, the aim of this study to evaluate the productive of Holstein cows (HF), in the Nile Delta , Egypt and identify the most important Environmental trend (EVT) and Epigenetic trend (EPT) affecting the productivity of the study herd.

MATERIALS AND METHODS

Farm location: Data was collected from a commercial farm located in the northern part of the Nile Delta, Structure of the data analyzed for Holstein Friesian (HF).This data was used for the assessment of genetic parameters that affect milk traits of HF cattle in dairy herds.

Structure of data: The total number of records used is 2651 normal lactation records from 439 dams and 80 sires within 10 years, 6 parities of calving and 4 seasons of calving.

Management and feeding: The sire and dam number for each animal was determined in addition to recording the date of birth and the date of pollination for each cow in the herd. The productive traits recorded were *(*305d-MY, kg*), (PY) and (PER).*

Cow's milk is twice daily, taking into account the drying process of cows two months before birth, pregnancy diagnosis by rectal palpation was performed on 60 day after the last service. Heifers served when reaching 350 kg and age 18 months; cows inseminated artificially with medical supervision to prevent diseases and necessary treatment if necessary, for disease management control and vaccination.

Statistical analysis: Data were analyzed using WOMBAT software **Meyer, 2017**. The model:

$$\mathbf{Y = X_b + Z_a + Z_m + Z_{pe} + e, \; cov\ am}$$

Where;

y= a vector of observations, b= a vector of fixed effect, a= a vector of additive effects, m= a vector of maternal effects, p_e= a random permanent environmental effect and e= a vector of residual effect. Cov (a,m) = σ_{am} , where σ_{am} is the covariance between direct and maternal genetic effects, σ^2_a the direct additive genetic variance, σ^2_m the maternal genetic variance. Environmental Trend (EVT) and Epigenetic Trend (EPT) were estimated using the method found by **Legates and Myer 1988.**

The studied traits were Milk production for 305 days (305d-MY, kg), Peak yield (PY) and Persistence (PER).

RESULTS AND DISCUSSION

Table1. Represented the overall means (Mean), standard deviation (SD) in addition to coefficients of variation (CV%) for some production traits of (HF) cows. (305d-MY, kg), (PY) and (PER) as 4227kg, 22.8kg and 64.5%, respectively. Mean of 305d-MY, kg was higher

than those reported by **Safaa and Gharib, 2017** as 2935 kg. The present estimate of 305d-MY, kg was nearest to estimates reported by **Abosaq *et al*, 2017**.

The overall unadjusted mean of peak yield was 22.8 kg, this value was similar to estimates observed by **Abosaq, *et al* 2017** but it was higher than that estimated **by El-Awady, 2013** as (15 kg) in using Friesian cows and **Ahmed *et al.*, 2004** 6 kg in Friesian crosses. Also, the mean (PY) was more than in accordance with 12.3±0.1kg and 12.5±0.8 kg in HF as shown by **Kumar *et al.*, 2014.**

Table1. Means, (SD) and (CV%) for some productive traits of HF.

Traits	(N)	(Mean)	(SD)	(CV%)
305d-MY (kg)	2651	4227	1454	34.4
Peak (Kg)	2651	22.8	6.2	27.2
Persis (%)	2651	64.5	10.1	15.7

Genetic parameters

Heritability estimate (h^2_a) for 305d-MY, PY and PER were 0.43±0.04, 0.28±0.04 and 0.08±0.03 respectively (Table 2). **Guler et al., 2010** and **Yilmaz et al. 2011** found that heritability estimates were 0.25 and 0.36 for 305-dMY, respectively. Metetnal heritability estimates (h^2_m) were low 0.057±0.033, 0.017±0.028 and 0.024±0.023, respectively. These estimates indicate similarity to that showed by **Safaa and Gharib 2017** respectively.

The permanent environment (P^2_e) was 0.044±0.031 for 305d-MY. It was higher than those reported by **Safaa and Hassanane, 2017** they obtained that P^2_e estimates was 0.00012.

Table 2. Heritability estimates (additive $h^2_a$and maternal h^2_m) for some productive traits of HF cows.

	305d-MY±S.D	Peak(PY) ±S.D	Persis(PER) ±S.D
h^2_a	0.43±0.04	0.28±0.04	0.08±0.03
h^2_m	0.057±0.03	0.02±0.03	0.03±0.02
Cove $_{a,m}$	-0.942±0.19	-0.86±0.59	-.99±0.24
P^2_e	0.044±0.031	0.0	0.0
e^2	0.62±0.039	0.77±0.04	0.94±0.039
V_a	78.64	7.45	8.52
V_m	10.53	0.47	2.57
V_{am}	-27.12	-1.61	-4.68
$V_{Pe}{}^2$	8.04	0.0	0.0
V_e	114.15	20.69	99.07

Cove $_{a,m}$ = covariance between h^2_a and h^2_m, P^2_e = Direct permanent environmental variance effect and e^2=direct environmental effect.

In this study, the (h^2_a) estimates persis (PER) estimates indicate a decrease compared to other traits under study, while the moderate value of heritability estimates for 305-dMY and PY traits would indicate moderate contribution of additive.

Guler *et al.*, 2010, and **Yilmaz *et al.* 2011** found that heritability estimates were 0.23 and 0.22 of peak yield respectively.

Estimates of (PBV) for sire breeding value (SBV), dam breeding value (DBV) and cow breeding value (CBV) 305d-MY, kg, peak yield (PY) and persistency (PER) are presented in Table 3.The average of (SBV) were 1687 kg, 10.3 kg and 14.3% for 305d-MY, kg, PY and PER; respectively. The average of predicted breeding values of dam (DBV) were 1514.3 kg, 9.3 kg and 15.9%, respectively. Whereas, the range of (CBV) were 1747.4 kg, 9.5 kg and 18.8% respectively. These results indicate that selection for 305d-MYand PER for the highest of cows, will increase milk traits in the next generations. The accuracy of (SBV) ranged from 77 to 81% It was higher than the accuracy of both DBV (64%) and CBV (51 to 66%) for 305d-MY. The same trends were obtained by **Safaa and Hassanane 2017**, while was lower that reported by **Safaa and Gharib 2017** for CBV.

Table 3.Prdected breeding values (PBV) for some productive traits in HF cows.

PBV	Traits	Minimum	SE.	Accuracy%	Maximum	SE.	Accuracy%	Range
Sires (SBV)	305d-MY(kg)	-766.6	360.3	77	920.4	299.2	81	1687
	Peak (kg)	-5.4	1.6	74	4.7	1.8	77	10.3
	Persis (%)	-7.02	3.6	81	7.3	2.3	84	14.3
Dams (DBV)	305d-MY(kg)	-721.1	391.8	64	793.2	393.5	64	1514.3
	Peak (kg)	-3.52	1.9	62	5.8	1.6	75	9.3
	Persis (%)	-6.92	3.1	75	9.0	3.3	70	15.9
Cows (CBV)	305d-MY(kg)	-794.6	437.7	51	952.8	383	66	1747.4
	Peak(kg)	-4.95	1.9	60	4.5	1.8	69	9.5
	Persis (%)	-11.58	3.3	71	7.2	3.4	68	18.8

Range (BW Max- BW Min)

It is clear from table 3. That a wider range of PBV, this provides an opportunity for the genetic improvement of the traits through selection on the basis of the higher animals in the BV. Estimates of the considered traits for this study are higher than those estimated by **Sanad 2016,** where the results of the study show that there is a large range of BV for SBV, DBV and CBV for studied traits.

Environmental trend (EVT):

It is noted from figures (1-6) that there is an effect of the environmental factors represented by the influence of the non-genetic effects (parity, season, and year) on the studied traits represented in (305d-MY, kg), peak yield (PY) and persistency (PER).

From figures (1&2) it is clear that year of birth had a high effect on the status of 305d-MY, kg of milk production as well as the status of the peak yield (PY), where the value of the status of the increase in age and then decreased while the impact of the year on the period of persistency there is no clear direction.). **Safaa and Gharib,2017.**

We conclude from figures (1-6) that winter and autumn had a higher impact compared to spring and summer. It is also clear that the peak production was reached in the 8 year, then the rate of milk production for cows decreased at the end of the lactation period.

Figures (3&4) showed that the effect of birth season was higher during the autumn and summer for 305 days of milk yield, while it was higher for peak production during the spring and winter, while the effect was significant for persistency during the summer and autumn season. Figures (5&6) showed that the effect of parity for the height of 305d-MY and the peak of production increased with age and then decreased while there was no clear trend of the effect of the parity to persistency. The results of the present study are also in agreement with the findings of **Abosaq *et al*; 2017.**

kg

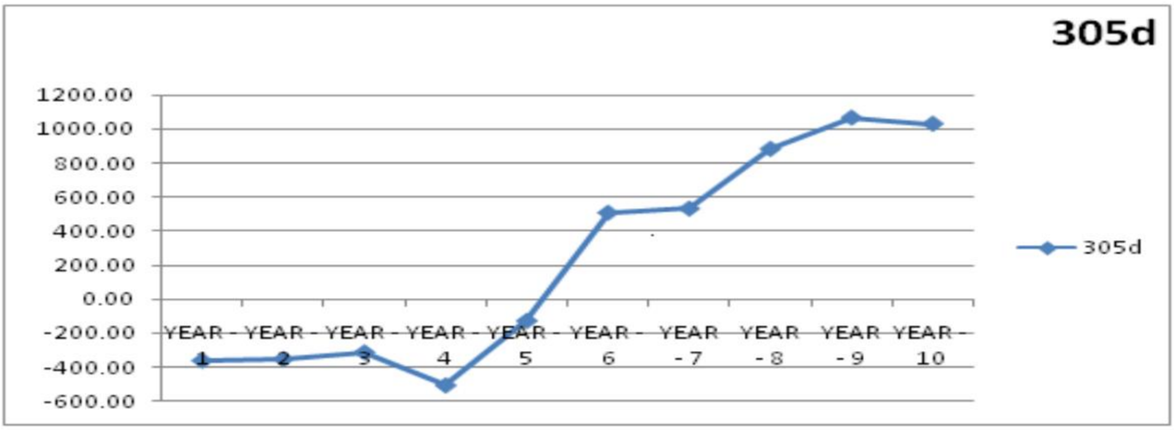

Fig 1. EVT of 305d-kg, MY as regressed against year

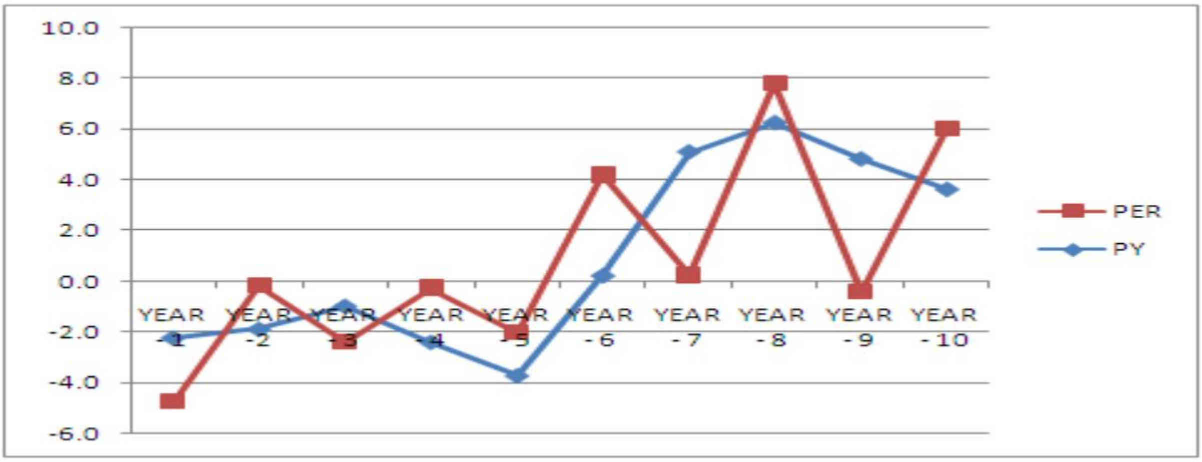

Fig 2. EVT of peak yield (PY) and persistency (PER) as regressed against year

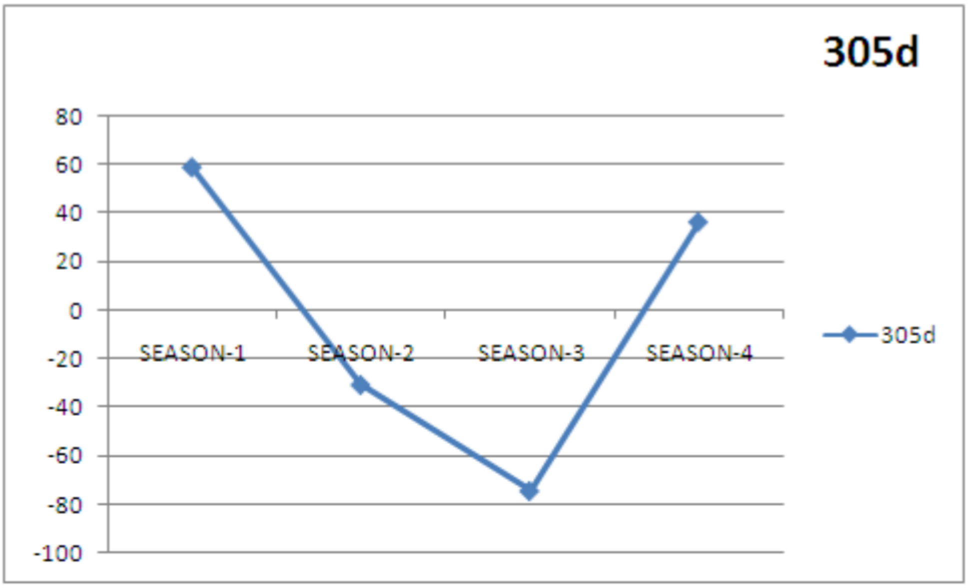

Fig 3. EVT of 305d-kg ,MY as regressed against season

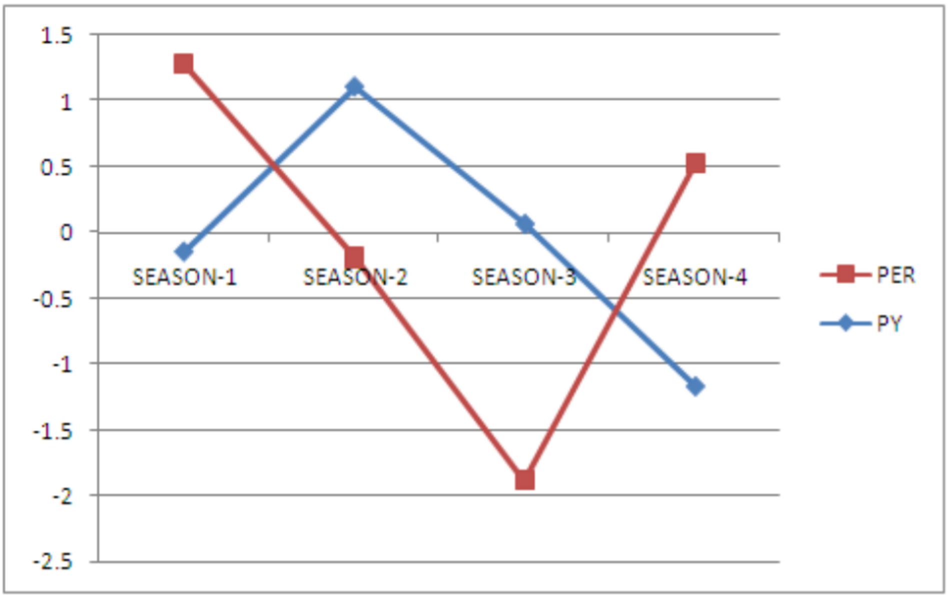

Fig 4. EVT of peak yield (PY) and persistency (PER) as regressed against season

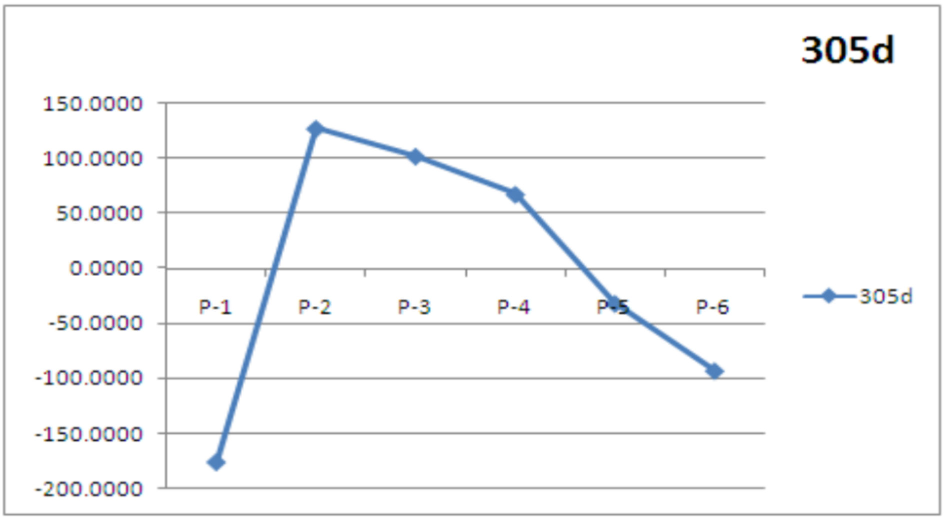

Fig 5. EVT of 305d-kg MY as regressed against parity

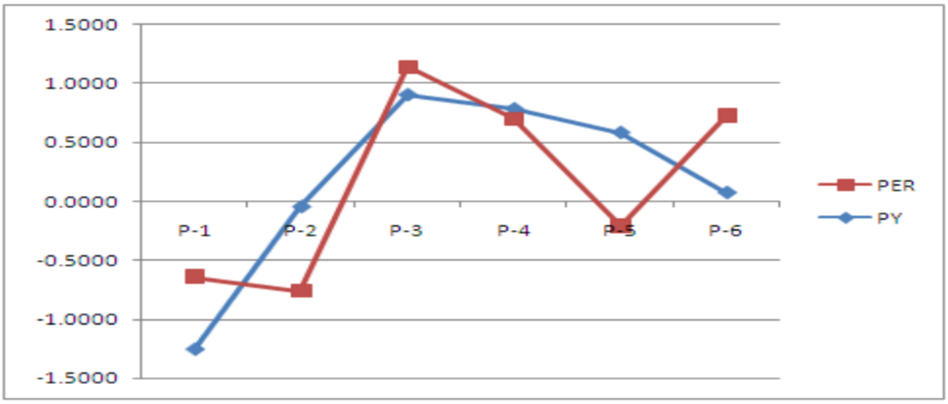

Fig 6. EVT of peak yield (PY) and persistency (PER) as regressed against parity

Epigenetic trend (EPT):

Figures (7-12) should that genetic effect of HF cows under study herd, where the effect of the year, season and parity appears on the traits of the study effect of year in figures (7 and 8) showed that the general effect on 305d-MY, kg is not clear. There was a clear trend in the 3^{rd} and 10, while 305d-MY, kg was lower in the rest of the years, while the overall effect on the top of production and persistency was better for the years 4, 5, 6 and 7. Effect of season, in Figs. 9 and 10 in year, the effect of season on the studied traits was evident. The effect of spring and winter was higher than summer and autumn for 305d-MY, kg and top production, while the autumn and summer were better for persistency. The general trend of parity effect was negative and increased with age **Canaza-Cayo *et al.*, 2016** found that the genetic program has a positive on 305 days of milk yield. This is due to the different genotypes that are affected by different environmental factors and accordingly, we need good management in addition to providing appropriate environmental conditions. **Nilforooshan and Edriss, 2007.** The present results are in close agreement with the findings of **Safaa and Gharib, 2017**.

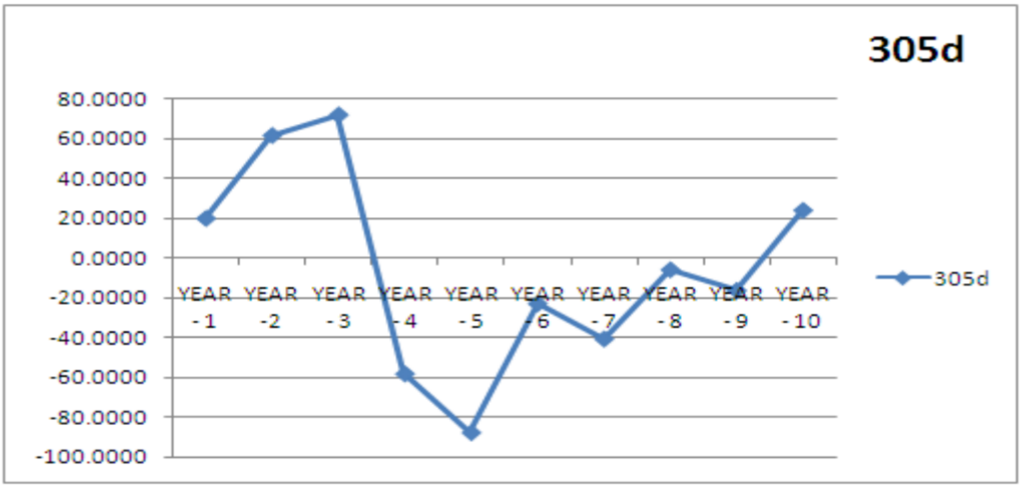

Fig 7. Epigenetic trend of 305d-MY, kg as regressed against year

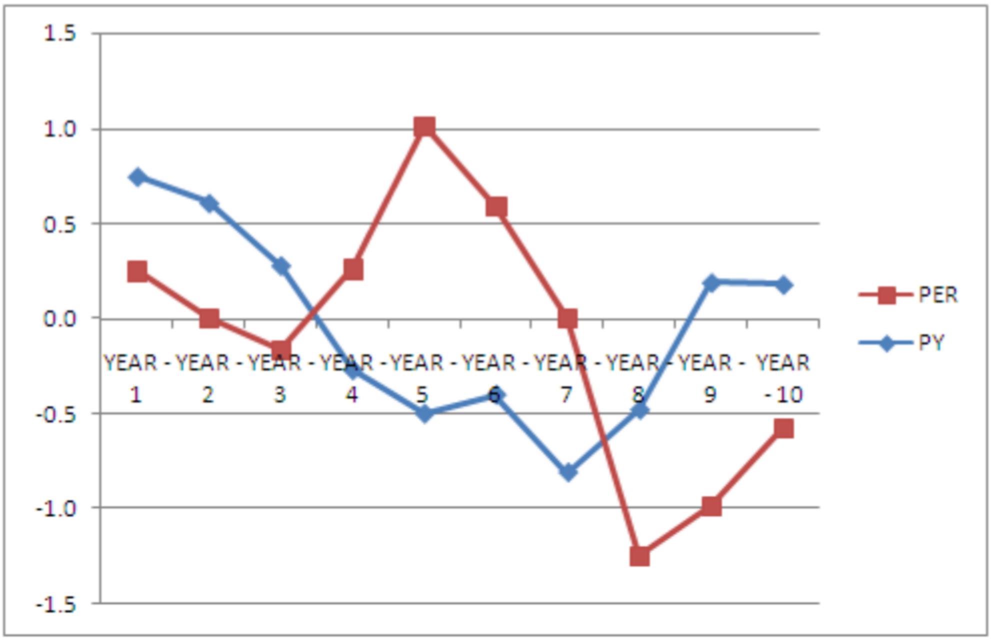

Fig 8. Epigenetic trend of peak yield (PY) and persistency (PER) as regressed against year

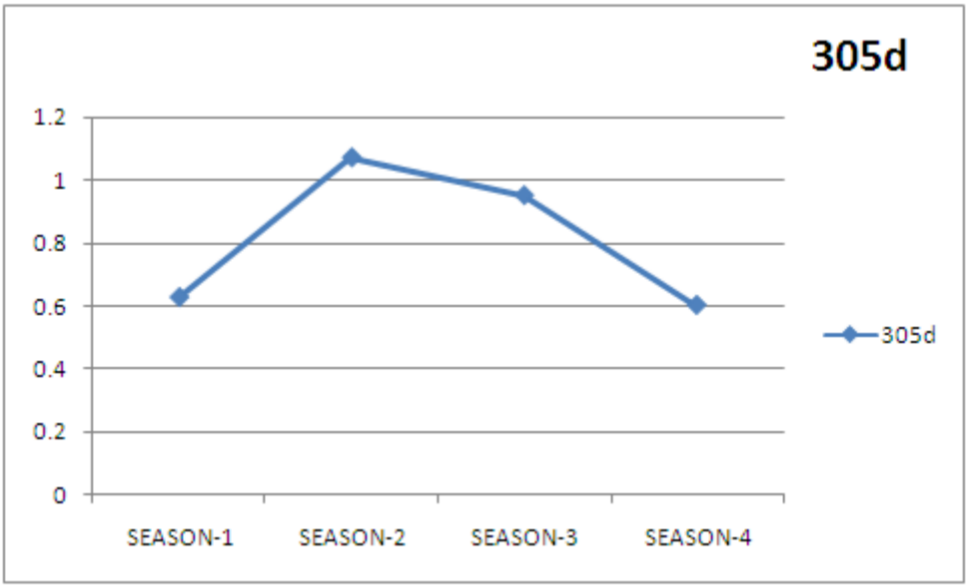

Fig 9. Epigenetic trend of 305d-MY, kg as regressed against season

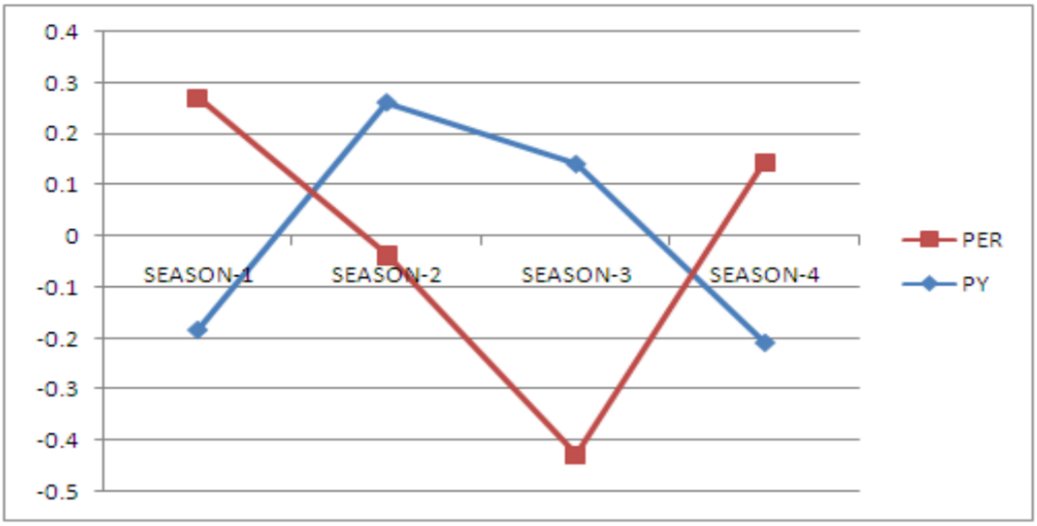

Fig 10. Epigenetic trend of peak yield (PY) and persistency (PER) as regressed against season.

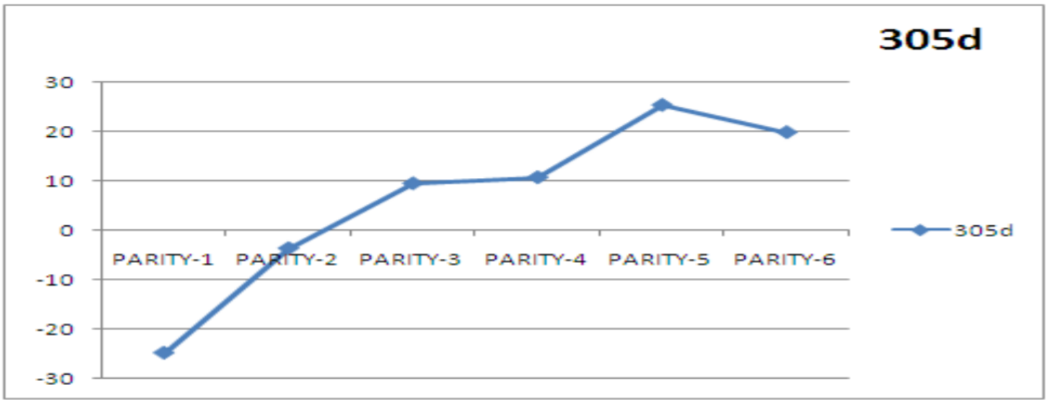

Fig 11. Epigenetic trend of 305d-MY, kg as regressed against parity

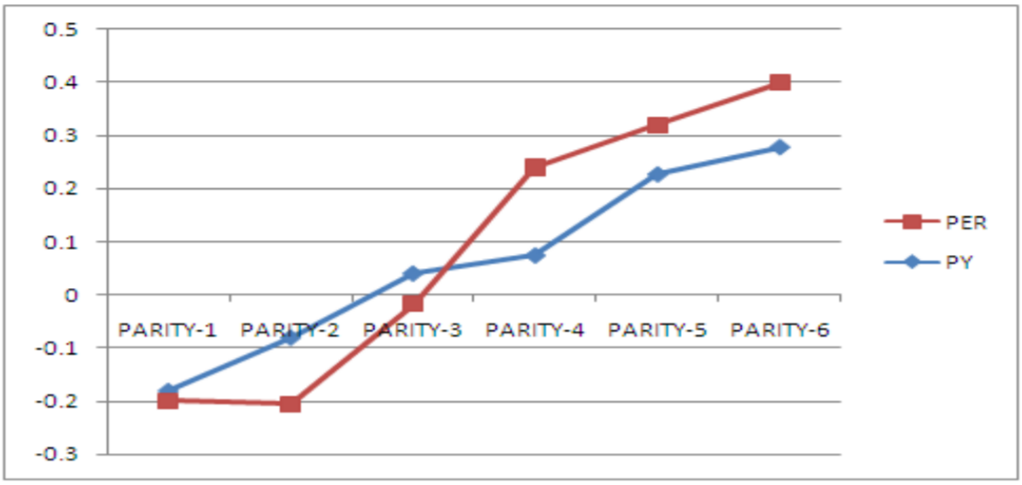

Fig 12.Epigenetic trend of peak yield (PY) and persistency (PER) as regressed against parity.

Cilek and Tekin 2005 found that milk production gradually increases with increasing age of the cow and then decreases again. **M'hamdi *et al.*, 2012** that this effect may be due to the presence of physiological factors specific to the cow or environmental conditions.

CONCLUSION

The most important result of this study that increase milk production is subject to many genetic and environmental factors. The h^2_a is a low value for PER, while the moderate value of heritability estimate for 305d-MY, and PY would indicate the moderate contribution of additive. To achieve a better production level, a breeding plan should first be devised to raise the high genetic capacity for the production of these animals by choosing the best animals that carry high BV, in addition to the importance of good care by improving the environmental conditions surrounding the animals. Where figures of additive variance components revealed the strong and the importance of the environmental component linked with the genetic differences effecting on productive traits.

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الملخـــــــص العربــــي

تقدير االتجاه الوراثي والبيئي لصفات أنتاج اللبن في قطيع هولشتاين

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تهدف الدراسة إلى تقييم أداء لقطيع الهولشتاين وتقييم التأثيرات المختلفة)الوراثية وغير الوراثية(على إنتاج هذا القطيع. بهدف لتحسين دقة التنبؤ الجيني للسمات التي تؤثر على إنتاج الحليب وكذلك لتحديد تأثير العوامل غير الوراثية المختلفة)االتجاه البيئي(. بلغ العدد اإلجمالي للسجالت المستخدمة في هذه الدراسة 2651 سجل إنتاجي البقار هولشتاين فريزيان)HF(على مدى 10 سنوات في مزرعة تجارية تقع في الجزء الشمالي من دلتا النيل ، مصر. وكانت الصفات المدروسة 305 يوم إنتاج اللبن ، وقمة االنتاج خالل موسم الحليب)PY(، وفترة المثابرة)PER(.تم تحليل البيانات باستخدام برنامج WOMBAT لتقدير المكافئ الوراثي)المضيف h^2_a واألمي $h^2{}_m$ (، باإلضافة لتقدير القيمة التربوية)BV(لإلبقار وابائها وامهاتها) SBV، DBV و CBV(، واالتجاه البيئي)EVT(واالتجاه الوراثي المقدر)EPT(لصفات الحليب)MT(من الماشية الهولشتاين فريزيان.

كان متوسط قيم الصفات لـ)305 يوم إنتاج لبن ،كجم(،قمة االنتاج (PY) و فترة المثابرة) PER) 4227 كجم، 22.8 كجم و 64.5 ٪ على التوالي . كانت تقديرات المكافئ الوراثي المضيف)h^2_a(لـ)305-يوم انتاج لبن، كجم(،(PY) و) PER) كانت 0.43± 0.04 و ±0.04 0.28 و 0.08 ± 0.03 على التوالي بينما كان المكافئ الوراثي األمي h^2_m منخفض حيث كان 0.57±0.03 و 0.02.±0.03 و 0.02 ±0.03 على التوالي. وكانت تقديرات البيئة الدائمة P^2 لصفات الدراسة 0.44±0.031 و 0.0 و 0.0 على التوالي .

كان مدي القيم التربوية ل BV بالنسبة لل SBV 1687 كجم و10.3 كجم و 14.3 ٪ لـ 305 يوم أنتاج لبن كجم ،PY و PER على التوالي. وكان مدي القيم التربوية لل)DBV(لنفس الصفات 1514.3 ، 9.3 كجم و 15.9 ٪ على التوالي. بينما كانت القيم التربوية لألبقار) 1747.4 CBV(كجم و 9.5 كجم و 18.8 ٪ على التوالي.

المكافئ الوراثي)h^2_a(في هذه الدراسة يشير إلى انخفاض نسبة التباين الوراثي والبيئي لصفة المثابرة ، بينما تشير القيمة المعتدلة لتقدير)h^2_a(لـصفة 305 يوم أنتاج لبن وقمة االنتاج إلى امكانية االنتخاب لهذه الصفات حيث يؤدي ذلك الى إمكانية تحسين االنتاجية في االجيال القادمة لألبقار تحت الظروف المصرية. كما تظهر النتائج أن االختيار يعتمد على اختيار األبقار األعلى في)CBV(. كما تشير االتجاهات الجينية إلى أن األداء اإلنتاجي للقطيع يتأثر بالتغيرات البيئية. حيث كان االتجاه الجيني إيجابيًا بشكل عام في مواسم المناخ المعتدل)الشتاء والربيع(بينما كان سلبيًا في المناخ الحار)الصيف والخريف(لكل من)305MY-d(و)PY(لذا فإن الرعاية والتغذية الكافية ضرورية حيث تساعد على ظهور االمكانيات الوراثية الكاملة عن طريق تحسين الظروف البيئية.