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Original Article

Genetic and phenotypic trends of milk production traits in an Egyptian Friesian herd

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ABSTRACT

The main objective of this study was to estimate the genetic and phenotypic trends for Total milk yield (TMY), adjusted 305-days milk yield (adj305-MY), daily milk yield (DMY), lactation period (LP), peak yield (PY) and lactation persistency (PER) in Frisian herd. The final data set included 2,852 records obtained from 741 cows and 76 sires,. Estimated breeding values (EBVs) of for all traits were obtained by the best linear unbiased prediction (BLUP). Means for (TMY), (adj305-MY), (DMY), (LP), (PY) and (PER) were 4581 kg, 4646 kg, 14.68 kg, 314.27 d, 22.78 kg and 64.5 % respectively. Estimates of phenotypic trends for these traits were, respectively, +72.65, + 65.71, +0.196, + 0.630, + 0.307 and + 0.002. The annual genetic changes in the estimated breeding values (EBVs) were positive for all above mentioned traits 11.473 kg/yr, 4.15 kg/yr, 0.0026 kg/yr, 0.58 d/yr, 0.002 kg/yr and 0.0002 %/yr. The estimates of annual genetic changes for (adj 305 -MY), (DMY), (PY) and (PER) were not significant ($p>0.05$), the TMY and LP were significant ($p < 0.05$). It could be concluded that using top ranking bulls on the basis of their EBVs for TMY in breeding programs will lead to noticeable genetic improvement in productivity of an Egyptian Friesian cows, however, the positive genetic trends for all studied traits which may allow the possibility of improving the current herd. The fluctuated rhythm in the curves maybe due to environmental conditions or use sires with low breeding value.

Keywords: Friesian, genetic trends, phenotypic trends, milk yield, BLUP.

Introduction

Friesian cows are among the important dairy cows in most countries of the world, and most of the milk produced comes from Friesian cows. This breed is able to maintain high levels of performance in different management systems and hot environments due to their adaptability to the local conditions (Amr, 2013). Milk production in general is the most economically important trait in dairy cattle breeding programs. Genetic improvement concepts and theories are widely used in the dairy industry for production, vitality and conformation traits of dairy cattle. Profitability in dairy industry is based on milk price and longevity of the animals. Thus, genetic evaluation is a key to produce high performing

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animals and to increase profitability in the future (Canadian Dairy Network 2002). In any genetic improvement program, there is a need to track and evaluate the progress and aim at optimizing genetic gain and to increasing farm profitability (Canaza-Cayo *et al.*; 2016). Genetic trend is the best parameter to assess the efficiency of selection, (Falconer and Mackay, 1996). The breeding value for an animal is defined as its total genetic ability for a given trait. Therefore, the breeding value refers to the value of an animal in a breeding program for a particular trait (Salem and Hammoud, 2016). It is important to evaluate the changes in breeding values of dairy cattle bulls and their genetic merit over time. To understand how to achieve future goals, genetic information from the past should be examined to determine the trends and improvement that have been gained. A genetic trend is defined as a change in performance per unit of time due to changes in mean breeding values. It is derived by comparing the average levels in the cow populations for each year (Herbart and Bhatnagar, 1988). The understanding of trends in genetic progress will help future genetic direction to be established by defining specific goals for breeding a profitable and sustainable dairy herd (Missanjo *et al.*, 2012). Therefore, the aim of this study was to estimate the necessary genetic and phenotypic change of productive traits in the Friesian cows to calculate the phenotypic and genetic trends for TMY, 305-MY, DMY, LL , PY and PER to achieve the genetic improvement.

Materials and Methods

Data included 2852 lactation records from 741 cows sired with 76 bulls during the period from 1979 to 2014. Pedigree information and data were obtained from Abees farm, Alexandria University, Egypt. Prior to analyses, quality control for the data was applied so that lactations shorter than 90 days and longer than 500 days were excluded. The cows were milked twice daily and. twice a week test day milk records were used to calculate the traits of interest. Animals were fed ad–libitum on clover and rice straw from November to May and on Sorghum and berseem hay from June till October. Cows were artificially inseminated. Pregnancy was detected by rectal palpation 60 days after insemination. Original data file for milk production consisted of insemination records that were matched to pedigree.

Data analysis:

Milk production traits selected for this study were total milk yield (TMY), adjusted 305-days milk yield (adj. 305-MY), daily milk yield (DMY), lactation period (LP), peak yield (PY) and persistency (PER).

The annual phenotypic change for different traits was calculated as a regression of the trait value on the year of calving after adjusting the records for the non-genetic factors (month of calving and parity) as mentioned above, using the PROC REG using the SAS/STAT package (SAS, 2003). Based on the following model:

$$R_{ijk} = \mu + M_i + P_j + b_y + e_{ijk}$$

Where:

R_{ijk} = the individual observation of the trait;

μ = the overall means;

M_i = the fixed effect of the month of calving (i= 1-12);

P_j = the fixed effect of parity (k=1-8);

b_y = the linear regression of the trait on year of calving;

y = year of calving and

e_{ijk} = the residual effect with $e_{ijk} \sim N(0, \sigma_e^2)$

The genetic trend was obtained by calculating the regression of the breeding value of animal on the year of birth (1979 – 2013). (El–Awady, *et al.,* 2017) estimated breeding values (EBV) of animals were obtained by the best linear unbiased prediction (BLUP) method using the WOMBAT software (Meyer, 2017) fitting repeatability animal models.

P= μ+ fixed + animal + Pe + e

where P is the EBV of the trait; fixed effect is the effect of parity, year of calving and month of calving; animal is the random genetic effect; pe is the random permanent environment effect and e is the random residual effect. In matrix notation, the mixed model was y=Xb+Zu+Wp+e, where: ***y*** = vector of observations, ***b*** = vector of fixed effects, ***u*** = vector of animal genetic effects, ***p***= vector of permanent environment effect and ***e*** = vector of residual effects, ***X, Z, W*** are incidence matrices.

Results and discussion

Descriptive statistics of phenotypic values (Table 1), and genetic values (Table 2) for animals were considered in this study for milk production traits. The tables show number of records, animals, phenotypic means, EBVs means, standard deviation, minimal , maximal values and phenotypic and genetic trend values. In general, there was an increase in phenotypic and genetic trends for all traits over the years, the genetic improvement was in progress significantly in TMY and LL but not significant in adj. 305 - MY, DMY, PY and PER. The distributions of the EBVs and phenotypic values of all traits are presented in Figures (1) and (2), the genetic trend analysis of the herd recorded during the period of 1979-2014 was based on the available phenotypic traits in the farm. Figures (1) and (2) illustrate the similarity between phenotypic and genetic trend of the herd for TMY and adj. 305 - MY. The yearly mean of phenotypic and breeding value for total milk yield and adj. 305 - MY increased after 2000.

Falconer and Mackay (1996) reported that any population undergone selection program will improve its EBV with the slope of the estimated breeding value on year of birth bigger than zero. The pattern of relationship between EBV mean and the year of birth was weak to medium degree of linear regression. The results revealed that there is no quadratic regression between EBV mean of the traits and their birth year.

The fluctuated rhythm in the curves maybe due to environmental conditions such as sudden changes in climatic condition, nutrition, management changes and hygienic levels, interaction between genetic and environment or use sires with low breeding value (Yaeghoobi, *et al.*, 2011).

Table 1. Descriptive statistics of phenotypic values for An Egyptian Friesian cows of the studied traits.

Trait	No. of records	Mean	SD	Min	Max	phenotypic trend
TMY	2586	4581.88	1664.53	474	12461	+ 72.65 **
adj 305-MY	2595	4646.46	1310.12	915	13845.6	+ 65.71 **
DMY	2588	14.68	4.11	3.00	46.45	+ 0.196 **
LP	2586	314.27	80.98	100	500	+ 0.630 **
PY	2850	22.78	6.18	5.0	59	+ 0.307 **
PER	2852	64.5	10.83	22.00	100	+ 0.002 ns

ns ($p > 0.05$) * ($p < 0.05$) ** ($p < 0.01$)

Table 2. Descriptive statistics of genetic values for An Egyptian Friesian cows of the studied traits.

Trait	No. of animals	Mean EBV	SD	Min	Max	genetic trend
TMY	733	-49.68	608.84	-1804.93	2218.99	+11.473**
Adj-305MY	724	-15.08	497.96	-1755.22	1746.94	+4.15 ns
DMY	723	-0.01	0.97	-3.07	3.02	+0.0026 ns
LP	733	-2.77	13.13	-33.08	35.41	+0.58 *
PY	741	-0.013	1.217	-4.79	3.5	+0.002 ns
PER	741	0.010	0.0687	-0.235	0.243	+0.0002 ns

ns ($p > 0.05$) * ($p < 0.05$) ** ($p < 0.01$)

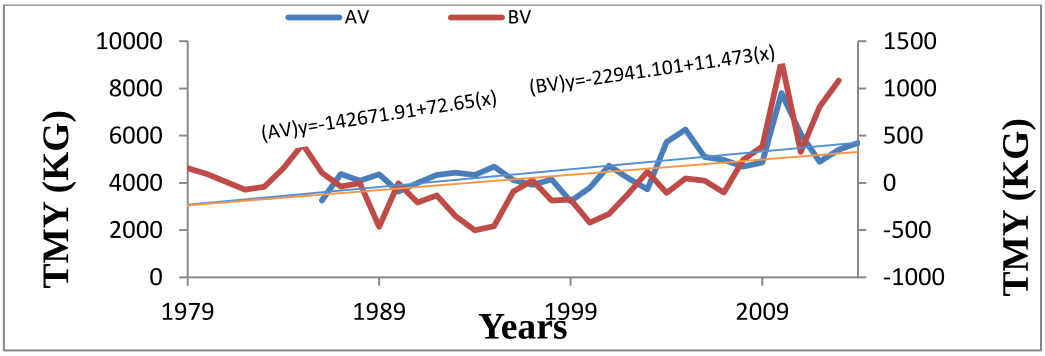

Figure 1. Mean breeding values and Annual values for TMY through the years in Frisian cows.

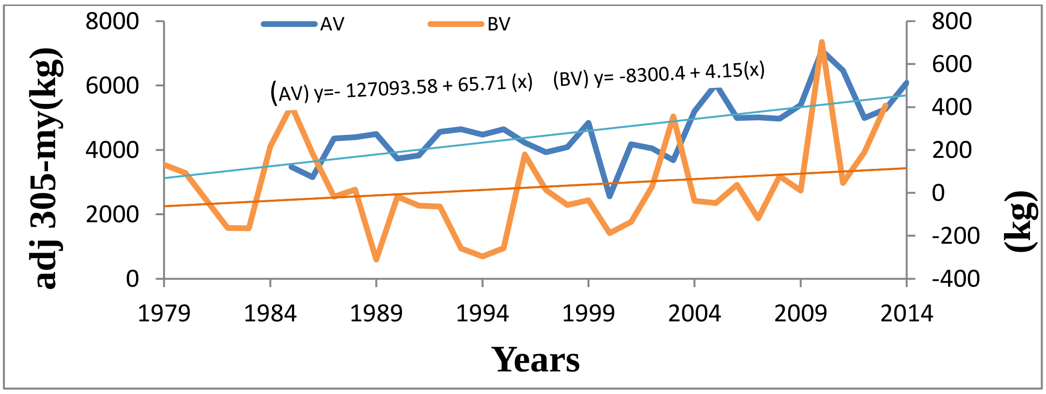

Figure 2. Mean breeding values and Annual values for adj. 305-MY through the years in Frisian cows.

The average annual phenotypic changes and genetic changes for TMY presented in Figure (1) and Table (1) and (2), showed a slightly upward increasing tendency, the estimated values of this trait were significant at ($p < 0.0001$) and were estimated +72.65 and +11.473 respectively for Frisian cows and are reasonably similar to (Yaeghoobi, *et al.,* 2011) for Frisian cow which +71.99 and +19.61 respectively, It was noticeable that phenotypic values for TMY ranged from 747 to 12461 kg. $year^{-1}$, and genetic values ranged from -1804.93 to 2218.99 kg. Year-1. Salem and Hammoud (2016) reported that the breeding values of the Frisian cows for TMY ranged from -2736.6 to 3284.5 kg/year. Despite the annual fluctuations, the results in Figure (1) showed that positive genetic trend in TMY trait overall improvement in the environmental components of the breeding program. These trends demonstrate the effectiveness of selection for the improvement of milk. None of the estimates of annual genetic trend for adj. 305 - MY in the Herd differed significantly from zero ($p>0.05$). In contrast, the estimates for PV were larger and statistically significant ($p<0.0001$), estimates of the phenotypic and genetic trend were + 65.71 and +4.15 kg. $year^{-1}$ respectively. The phenotypic values ranged from 915 to 13845.6 kg/year , and genetic values ranged from -1755.22 to 1746.94 kg/ year. (Salem and Hammoud, 2016) reported that the breeding values of the Frisian cows for 305 - MY ranged from -1698.0 to 1337.8 kg/year. Generally negative genetic trends in milk production traits were reported under tropical condition in Ethiopia (Effa, *et al.*, 2011). The reason of this variation was due to environmental conditions such as feeding, stress and management as mentioned by (Rahbar *et al.,* 2016). These results were not in agreement with those by authors who obtained a genetic trend to the increment of 305-MY, such as Peixoto *et al.*, (2006) who found that annual genetic trend in EBV of cows for 305-MY was about 7.09±0.71 kg/year between 1987 and 2004. Changes in the average EBVs for daily milk yield DMY of Egyptian Frisian against birth year from 1979 to 2014, are presented in Figure (3), the corresponding linear regression coefficient was not different from zero ($P > 0.05$). In the trend curve for DMY (Figure 3), a positive trend line was for the phenotypic value, but for the genetic value it was around zero, which were estimated +0.196 and +0.0026 and kg. $year^{-1}$ respectively.

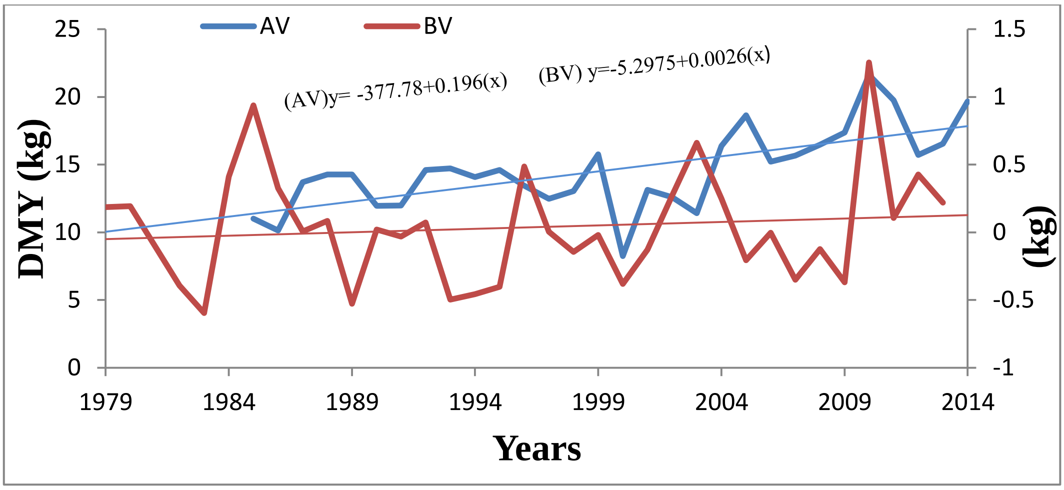

Figure 3. Mean breeding values and Annual values for DMY through the years in Frisian cows.

In contrast, linear regression of breeding value means for lactation period on year of birth had significant ($P<0.05$) slight slope, the phenotypic values for LP ranged from 300 to 500 day. $year^{-1}$, and genetic values ranged from -33.08 to 35.41 days. $year^{-1}$ respectively, while the phenotypic and genetic change were +0.63 and +0.58 days respectively (Figure 4). Salem and Hammoud (2016) reported that the breeding values of the Frisian cows for LP ranged from -45.0 to 71.1 days/year. Radwan *et al.,* (2015) reported breeding values of all animals for LP ranged between -76.5 and 75.6 days/year.

None of the estimates of annual genetic trend for PY trait in the Herd differed significantly from zero ($p>0.05$), In contrast, the estimates for PV were larger and statistically significant ($p<0.0001$) as shown in figure (5). Salem and Hammoud (2016) reported that the breeding values of the Holstein cows for ranged from -6.7 to5.6 kg/year in Egypt. Radwan *et al.,* (2015) reported breeding values of Holstein Friesian cows for PY ranged between -8.3 and 11.7 kg/year.

Both Genetic and phenotypic trends were close to zero for persistency trait (figure 6), while environmental and phenotypic trends fluctuated over the years, the phenotypic values ranged from 22 to 100% , the genetic trend ranged from -0.235 to 0.243 % . the phenotypic and genetic changes were similar +0.0002 % , the linear regression analyses of the PER trait did not find any positive slope (the linear regression coefficient for both genetic and phenotypic trends was not different from zero ($P>0.05$).

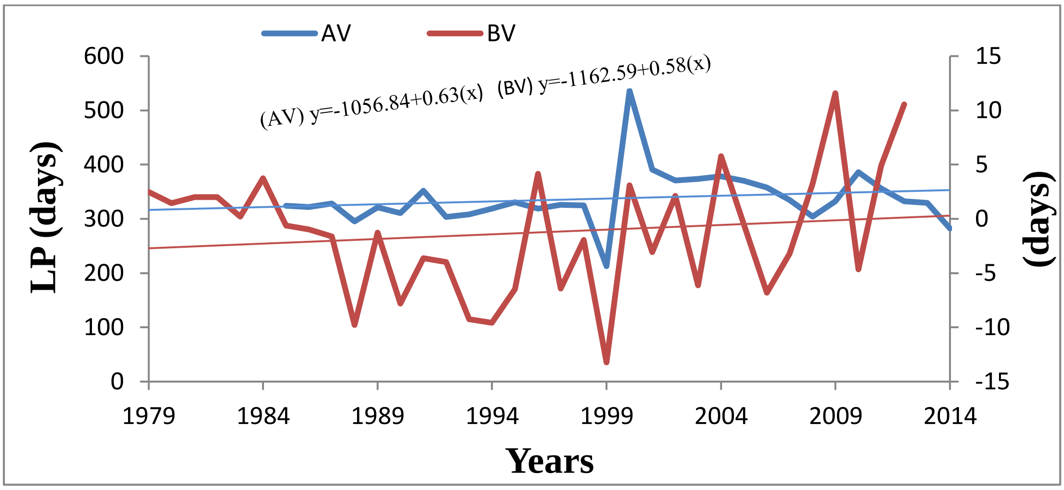

Figure 4. Mean breeding values and Annual values for LP during the execution period in Frisian cows.

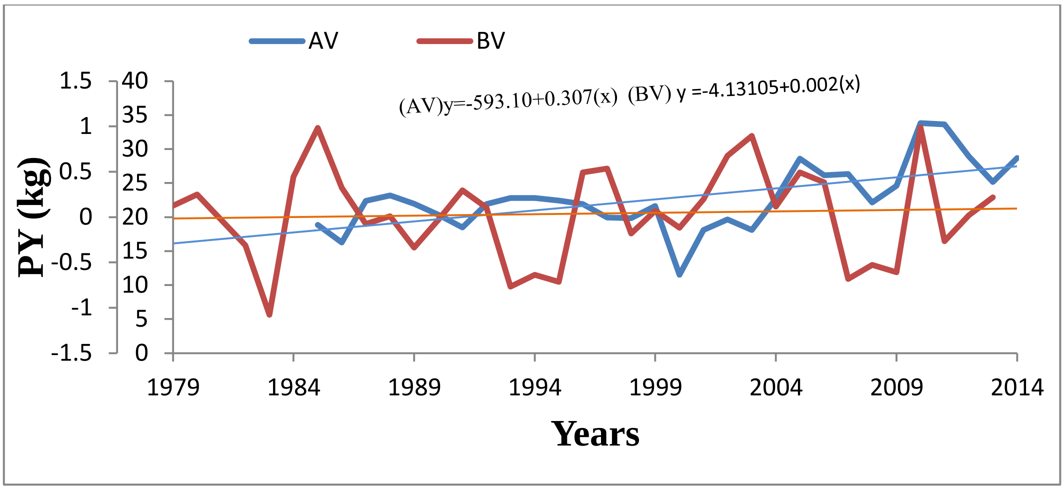

Figure 5. Mean breeding values and Annual values for PY during the execution period in Frisian cows.

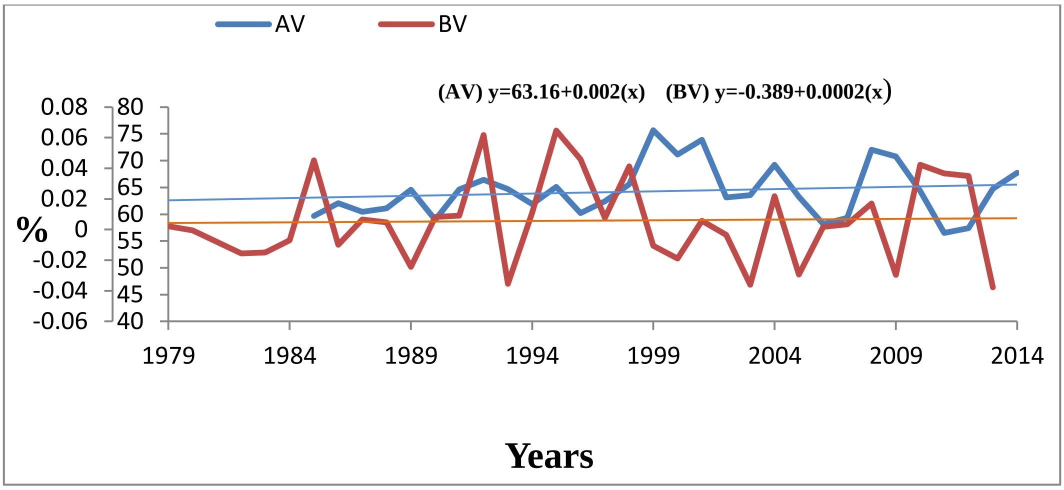

Figure 6. Mean breeding values and Annual values for persistency during the years in Frisian cows.

The Libyan Journal of AGRICULTURE. Volume (26), No. (1) 2021: 76 - 87

Conclusions

Overall, the results of this study show that the designed genetic program focuses only on total milk yield; the use of top ranking bulls on the basis of their EBV for total milk yield in breeding program will lead to noticeable genetic improvement in this trait; However the positive genetic trends for all studied traits were an indication of the possibility of improving the current herd genetically. The fluctuation through the years for the studied traits maybe due to environmental changes or use sires with low breeding value

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المجلة الليبية للعلوم الزراعية
المجلد (26): العدد (1) 2021: 66 - 75
ورقة أصيلة

الإتجاه الوراثي والمظهري لصفات إنتاج الحليب في قطيع أبقار فريزيان المصرية

فتحي مصطفى أبوساق و خالد محمد بن نصر

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المستخلص

تهدف هذه الدراسة لتقدير القيمة التربوية والمتوسط السنوي لتقدير الإتجاه الوراثي والاتجاه المظهري لصفات إنتاج الحليب الكلي و 305يوم المعدل وإنتاج الحليب اليومي وفترة الإدرار و قمة إنتاج الحليب والمثابرة في قطيع من ابقار الفريزيان. تضمنت مجموعة البيانات المستخدمة عدد 2852 سجل لعدد 741 بقرة و76 طلوقة. وتم حساب القيمة التربوية المقدرة للحيوانات باستخدام أفضل تنبؤ خطي غير متحيز BLUP. وكان متوسط قيم الصفات المذكورة أنفا 4581 كجم و4646 كجم و 14.68 كجم و 314.27 يوم و 22.78 كجم و64.5% على التوالي. وكانت قيم الاتجاه المظهري للصفات المذكورة موجبة 72.65 و 65.71 و 0.196 و 0.630 و 0.307 و 0.002 على التوالي. أما مقدار التغير الوراثي السنوي باستخدام القيم التربوية فكان موجبا لكل الصفات 11.473 كجم\السنة و 4.15 كجم\السنة و 0.0026 كجم\السنة 0.58 يوم\السنة و 0.002 كجم\السنة و 0.0002 %\السنة وكان مقدار التغير الوراثي معنويا (P<0.05) لصفتي إنتاج الحليب الكلي وفترة الإدرار. من خلال النتائج خلصت الدراسة إلى أن النظام المتبع يهتم بصفة إنتاج الحليب الكلي، حيث استخدم طلائق ذات القيمة التربوية العالية لصفة إنتاج الحليب الكلي مما أدى التحسن الملحوظ في هذه الصفة ، ومع ذلك فإن القيمة التربوية الموجبة لجميع الصفات مؤشرا لإمكانية تحسينها الوراثي في القطيع . التذبذب الحاصل خلال سنوات الدراسة قد يكون سببه التغيرات البيئية أو استخدام بعض الطلائق ذات القيمة التربوية المنخفضة.

الكلمات الدالة: الإتجاه الوراثي والمظهري. إنتاج الحليب – أبقار الفريزيان – القيمة التربوية

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