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EFFECTS OF GENOTYPE ENVIRONMENT INTERACTION ON PRODUCTIVE TRAITS OF HOLSTEINS FRIESIAN IN LIBYA

Bozrayda, S. A. M.; Intisar Al-Masli, R.S. Gargoum and A. Abusneina
University of Garyounis, Faculty of Sciences, Zoology Department, 5035, Benghazi, Libya
e-mail: sbozryada@yahoo.com, phone No: +21892842045.

ABSTRACT

Breeding values (BV) for some productive and reproductive traits of Holstein Friesian under Libyan conditions were estimated and compared with those estimated under, European, and North American conditions in an attempt to assess the genotype environment interaction. To investigate the effect of managerial conditions on the same traits, the heritability coefficients were also estimated under Libyan and Dutch managements. The trait's variance and covariance components and the breeding values of sires were computed using the REML method based on mixed model containing the fixed effects of month of calving, year of calving, management and generation and the random effect of sires. The lactation period and age at calving were used as covariates. Genetic correlation values of EBV for the milk yield traits were less than 1. Differences in heritability estimates due to the management system and or to environmental factors reflect Genotype x Environment interaction. Milk yield traits except dry period had a higher EBV during the Libyan than Dutch management. Reproductive traits except Age at first calving also had a higher EBV during Dutch than Libyan management. Correlations between EBV for milk yield ranged between 0.16 and 0.56 during Libyan, European and North American conditions. EBV of both North American and European sires were medium, low and negatively ranked under Libyan environment. EBV of milk yield traits showed higher variability under the Libyan environment. Sires with low EBV (> 500) revealed negative ranking under the Libyan conditions.
Keywords: Genotype x environment interaction, Holstein Friesian, EBV, Correlations

INTRODUCTION

There are four types of interactions as suggested by McBride (1958) and Dunlop (1962). Two of them are expected to be of economic importance in livestock production and can be assessed experimentally. That is, when environmental differences are large and genetic differences are either large or small.

Holsteins Friesian dairy cows imported from Germany to Libya represent a good model for the present study. Semen was also imported to inseminate the first generation of the dairy cows born in Libya. In the later generation, local sires were selected too and used for insemination.

There are significant differences between the imported Holsteins Friesian and the first generation born in Libya as suggested by Ahmed *et al.* (1996). Therefore, it is interesting to estimate the Breeding value among sires imported from Germany under the Libyan environment, and to see if their progeny whose performance was well in Germany still have the same superiority in Libya. It is also interesting to test the effect of inbreeding depression among sires.

MATERIALS AND METHODS

Two approaches were used in this study for testing genotype environment interaction. One approach was through daughters of sires from Libya, Europe and North America. The ratio test was used if r_g between regions was different from one another. The other one was the regression in the milk production of daughters under Libyan conditions of the estimated breeding value that was estimated under Europe and North American conditions. The factors studied included year of calving, month of calving, management and generation as fixed effects and sire as a random effect. Analysis of variance, variance component estimation and covariance was performed using StatSoft (2007) according to the following mixed model:

$$Y_{ijklm} = \mu + S_i + R_j + D_k + O_l + B_m + G_l + G_2 + e_{ijklm}$$

Where:

Y_{ijklm} = the trait studied (milk yield traits or reproductive traits),
μ = the overall mean,
S_i = the effect of the i^{th} month of calving,
R_j = the fixed effect of the j^{th} year of calving,
D_k = the fixed effect of the k^{th} management,
O_l = the fixed effect of the l^{th} generation,
B_m = the random effect of the m^{th} sire,
G_l = the regression coefficients of milk yield on lactation period,
G_2 = the regression coefficients of milk yield on age at calving and the
e_{ijklm} = residual error.

Source of data, management system were fully described by Elmasli (2003).

RESULTS AND DISCUSSION

Heritability Estimates

Table (1) shows a different estimates of heritability for milk yield traits and some reproductive traits during Dutch and Libyan management. It is obvious that, the heritability estimates for milk yield traits were generally high during Dutch management compared with those during Libyan management period.

Table (1): The estimates of heritability with their standard errors of milk yield and reproductive traits for Dutch and Libyan management systems.

Traits	Dutch	Libyan
	h^2 ± SE	h^2 ± SE
Yield 100 day	0.103 ± 0.080	0.056 ± 0.073
Yield 205 day	0.226 ± 0.096	0.023 ± 0.070
Yield 305 day	0.298 ± 0.105	0.001 ± 0.066
Dry Period	0.042 ± 0.071	0.000 ± 0.000
Age at Calving	0.042 ± 0.071	0.002 ± 0.066
Calving Interval	0.068 ± 0.075	0.000 ± 0.000
Days Open	0.068 ± 0.075	0.000 ± 0.000

Correlations:

The correlations between EBV for sires in USA, Canada, Germany and Holland with their EBV under Libyan condition are shown in Table (2). The correlations between EBVs were medium and highly significant ($p < 0.001$) for milk yield traits except for milk yield for 100 day where it was low and not significant. The higher estimate (0.563) between EBV under two environment was found in total milk yield, whereas the lowest (0.165) in 100 day milk yield. Still a negative correlation is observed for dry period, calving interval and days open but not significant. In general, correlations between EBVs for milk yield traits under two environmental conditions are less than unity.

Table (2): The correlation between EBV in Europe and North America and under Libyan environments for milk yield and some reproductive traits

Traits	r ± SE
Yield 100 day	0.1653 ± 0.0273
Yield 205 day	0.4861 ± 0.0123***
Yield 305 day M .E	0.5633 ± 0.1212***
Dry Period	-0.1138 ± 0.0123
Age at Calving	0.0304 ± 0.0122
Calving Interval	-0.4943 ± 0.2443
Days Open	-0.1138 ± 0.0412

Table (3) shows the EBVs under Dutch and Libyan managements. There is a highly significant differences ($p < 0.001$) between the two managements for milk yield and reproductive traits, except for day production and yield 205 day. Under the two management systems milk yield traits generally had higher EBV under Libyan management than Dutch management except for dry period . Age at calving had higher EBV under Libyan management than in Dutch management (-0.42). In contrary, reproductive traits had higher EBV (10.47) than those under Libyan management (- 34.92) .

Table (3): Estimated breeding value for productive and reproductive traits under Dutch and Libyan management systems

Trait	Dutch	Libyan
	Mean ± S.E (n = 45)	**Mean ± S.E (n = 36)**
Yield 100 day	101.76 ± 23.38	179.46 ± 30.13***
Yield 205 day	119.31 ± 48.44	227.50 ± 44.42^{ns}
Yield 305 day	121.19 ± 66.19	259.47 ± 61.91^{ns}
Dry period	10.47 ± 2.54	- 34.92 ± 5.57***
Day open	10.47 ± 2.54	- 34.92 ± 5.57**
Calving interval	10.47 ± 2.54	- 34.92 ± 5.57**
Age at calving	- 0.42 ± 0.018	0.10 ± 0.047***

The means of EBV of sire with different origin for milk yield and reproductive traits are presented in Table (4). It is clearly indicated that the European sires had higher EBV for milk yield and reproductive traits than North American sires. The EBV in North American sires were negative and opposite in the direction as compared to those of Libyan sires. This gives clear evidence for genotype environment interaction for North American sires in milk yield and reproductive traits under Libyan environmental condition.

Table (4): Means, minimum and maximum of estimated breeding value for sires of different origin.

Traits	Total	North American			European			Libyan		
		Mean	Max.	Min.	Mean	Max.	Min.	mean	Max.	Min.
Yield 100 day	122.21	-110.2	0.46	-167	112.2	420.4	-49.7	139.3	420.4	-26.20
Yield 205 day	330.72	-363.6	-736.4	-343.6	308.7	687.5	-584.3	229.2	526.0	-192.9
Yield 305 day	433.01	-769	-939.4	-338.3	425.6	928.9	-907.2	307.4	125.5	-370.00
Dry period	22.884	-51.2	-47.6	-13.8	22.5	99.5	-57.8	9.30	2.00	-21.80
Age at calving	0.083	-0.34	0.01	-0.20	0.07	0.04	-0.26	0.06	0.04	-0.13
Caving interval	22.884	22.50	-47.6	-13.8	9.33	1.60	-57.50	9.33	2.00	-15.20
Days open	22.884	-46.00	-47.50	-13.80	22.50	1.60	-57.5	9.33	2.00	-15.20

The estimated breeding value for sires under Libyan environmental conditions according to level of EBV in Europe and North America at different time of lactation period are presented in Table 5 .

Table (5): Estimated breeding value for sires under Libyan conditions at different time of lactation period.

E B V	100 day	205 day	305 day
Low > 500	20.29	- 157.35 (-137.06)	- 176.49 (-19.14)
Medium < 500 ≥ 1000	122.77	143.23 (20.46)	354.00 (210.77)
High > 1000	91.01	277.45 (186.44)	477.00 (199.55)

( ) differences between period

Sires with low EBV (> 500) shows negative EBV under Libyan environment condition. However, sires with medium or high EBV show a positive EBV under Libyan environmental conditions . It is interesting to note that the differences between lactation period shows a different manner for medium and high EBV, while its inconsistent for medium EBV (20.46 vs 210.77) . It shows steadily increase in case of high EBV (186.44 vs 199.55).

Figure 1 shows the Estimated Breeding Value for sires of different origin under the two environmental conditions. It appeared that the most North American sires ranked negatively under Libyan environment. However, European sires have a lower EBV, but still positive. This indicates the presence of genotype environment interaction for milk yield

Correlation values between EBV under different environmental conditions were between 0.37 and 0.56 for milk yield traits except for milk yield for 100 day where it was 0.17. These estimated values were similar to those obtained by Cienfuegos-Rivas *et al.* (1999) in Mexico, Goddard and Wiggans (1999) in Australia and New Zealand and Costa *et al.* (2000) in Brazil. In all of the countries mentioned, the Holstein-Friesian cows were imported from North America and Europe. Weigel *et al.* (2001) indicated that genetic correlations are high between countries of the same system and low between countries of different systems. Hammami *et al.* (2008) reported very close estimate (0.6) for Holstein Friesian imported from Luxumbourg. Correlations between EBV for milk yield traits less than 1.00, indicate the existence of genotype and environment interaction. Zwald and Weigel (2001) stated that when genetic correlations are less than unity and heritability estimates are different, then each sire receives a productive transmitting ability (PTA) for each unique production system. Goddard and Wiggans (1999) concluded that, different genes are required for a high performance in North America and Europe than those required in Australia and New Zealand. The correlations between EBV of dry period , age at first calving, calving interval and days open were generally low. This might reflect the importance of environmental conditions for these traits. Milk yield traits generally had a higher EBV under Libyan management than the Dutch management, except, for dry period. The EBV value for age at first calving under Libyan management was 10. This value was higher than that during the Dutch management that was -0.42. In contrary, reproductive traits had higher EBV (10.5) than those under Libyan management (- 34.9). Boettcher *et al.* (2001) indicated that, genotype x environment interaction was small between two types of management. Kearney *et al.* (2001) emphasized on the importance of production level and management system. Beerda, *et al.* (2007) found effects of milking frequency and genetic merit were significant only in the groups that were fed rations with high caloric density compared with low caloric density. Fulkerson *et al.* (2008) found in Australia, genetic merit and level of feeding were had significant effect on fat and milk yield.

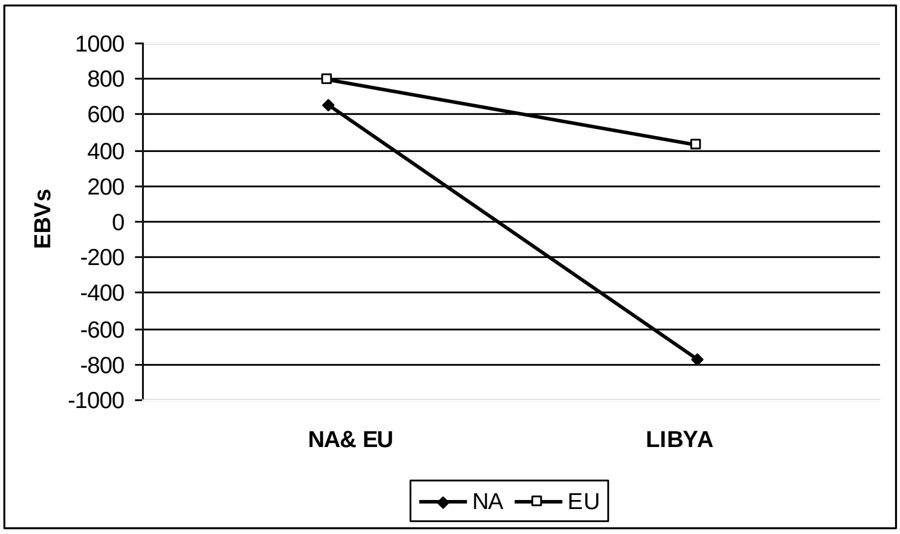

Fig.1: Estimated breeding values of milk yield for North American (NA) and European (EU) sires under two environments

The differences in EBV in addition to different estimates of heritability under two managements clearly indicate that, the existence of genotype and management interaction in milk yield as well as reproductive traits. This is in agreement with the results obtained by Castillo_Juarez *et al*. (1998), who showed that the genetic correlations between mature equivalent yield were lower in high than in low management groups. The results obtained in this study for different estimates of heritability under two management are in agreement with Stanton, *et al.*., (1991), Dimov *et al.* (1995), Valencia *et al.* (1999), Tawfik *et al.* (2000), Fikse *et al.* (2001) and Mulder (2004). Many studies reported smaller sire variance for imported Holstein-Friesian in local environment compared to those in a country of origin Santon *et al.* (1991) Costa *et al.* (1998) Cienfuegos- Rivas *et al*. (1999) costa *et al.* (2000) Tawfik *et al.* (2000) Miglior *et al.* (2001).

It is quite obvious that European sires had a higher estimated breeding value in both milk yield and reproductive traits than North American sires that were negative and in opposite direction Table (4). This gives evidence for genotype environment interaction for North American sires in milk yield and reproductive traits under Libyan environmental condition. Simm and Veerkamp (1996) suggested that, genotype x environment interaction may become important at least in a relatively low input system that tend to be lower than those in a high input system.

In case of European sires, the Estimated Breeding Value under Libyan conditions were lowered nearly to half of that under European conditions for milk yield . The Estimated Breeding Value for Libyan sires was nearly similar to those of European sires. Djemali and Berger (1992), reported that European Friesian yielded more than a cattle developed locally, but still about 6% less yield than North American Holstein. This in agreement with the Results obtained in this study, except, for North American Holsteins that had less EBV than European Holstein-Friesian.

Sires were ranked from lowest to highest EBV for the North American and Europe (un-tabulated data). North American sires ranked negatively under Libyan environmental conditions. Whereas, European sires with low EBV ranked negatively, but as the EBV in Europe increases the EBV in Libya increases too. The Estimated Breeding Value of 305 - day milk yield M. E. shows variability ranged from – 910.6 to 1267.9 which clearly indicate the importance of sire selection under Libyan environmental condition. In some sires, the EBV start with negative value at 100 day milk yield and later turn to positive value. This may reflect the importance of persistency of lactation for cows to show positive EBV . Libyan sires generally show a positive EBV, except, two which had negative values. This indicate the importance of selection even when this selection applied within the herd that is relatively small .

Sire with low EBV (> 500) in North America and Europe shows negative EBV under Libyan environment Table (5). However, sire with medium or high EBV shows positive EBV under Libyan environmental condition. It is interesting, to note that, the differences between the lactation period shows a different manner for medium and high ETA. While they were inconsistent for medium EBV, they showed steady increase in case of high EBV. The latter is in a agreement with the idea that, the high producing cow had a high persistency in lactation curve .

The North American sires ranked negatively under Libyan environment which indicate the presence of genotype environment interaction figure (1). However, European sires had a lower EBV, but still positive under Libyan environment. The European sires had lower EBV, but still positive compared with North American sire that had a negative EBV. This reflects the presence of genotype environment interaction for European and North American sires. Valencia Rosadas *et al.* (1999) indicated that, differences in ranking of sires by different region in Mexico. Powell and Van Raden (2001) reported that there was re-ranking for sires EBV according to management and climate variables. They conclude that, separate regional country or cluster ranking would still be needed to provide selection tools adapted to local conditions.

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تأثيرات التفاعل بين الوراثة والبيئة على الصفات الإنتاجية للهولستين فريزيان في ليبيا

سالم على محمد بوزريدة , انتصار المصلي , رمضان سليمان قرقوم و عبد المحسن بوسنينة .

جامعة قاريونس - كلية العلوم - قسم الحيوان ص ب ٥٠٣٥ بنغازي , ليبيا .

e-mail: sbozryada@yahoo.com, phone No: +21892842045

تم تقدير القيم التربوية لبعض الصفات الإنتاجية والتناسلية للهولستين فريزيان تحت الظروف الليبية ومقارنتها بمثيلاتها المقدرة تحت الظروف الأوروبية وأمريكا الشمالية في محاولة لتقييم التفاعل بين الوراثة والبيئة . ولدراسة تأثير الظروف الإدارية على نفس الصفات , ثم تقدير المكافئ الوراثي تحت الادراة الهولندية والليبية. وقد تم تقدير مكونات التباين والتغاير للصفات باستعمال طريقة REML على أساس نموذج مختلط يتضمن التأثيرات المحددة لكل من شهر الولادة والسنة والإدارة والجيل والتأثيرات العشوائية للآباء. وقد اشتمل النموذج الاحصائى على طول موسم الحليب والعمر عند الوضع ك covariates.

كانت قيم الارتباط الوراثي بين القيم التربوية المقدرة لصفات إنتاج اللبن أقل من واحد وتعكس الاختلافات في تقدير المكافئ الوراثي بسبب الإدارة أو العوامل البيئية التفاعل بين الوراثة والبيئة . كانت تقديرات القيم التربوية أعلى لجميع صفات إنتاج اللبن ما عدا فترة التجفيف خلال الإدارة الليبية مقارنة بالهولندية. في حين أن تقديرات القيم التربوية للصفات التناسلية ما عدا العمر عند أول وضع كانت أعلى خلال الإدارة الهولندية مقارنة بالليبية وكانت الارتباطات بين تقديرات القيم التربوية لإنتاج اللبن ما بين ٠,١٦ و ٠,٥٦ خلال الظروف الليبية والأوروبية وأمريكا الشمالية كانت تقديرات القيم التربوية للآباء الأمريكية والأوروبية متوسطة ومنخفضة وترتبت سلبيا تحت ظروف البيئة الليبية. وأظهرت الآباء المنخفضة في تقديرات القيم التربوية ترتيبا سالبا تحت الظروف الليبية.