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ESTIMATION OF TRANSMITTING ABILITIES FOR LACTATION TRAITS USING THE ANIMAL MODEL FOR HOLSTEIN CATTLE RAISED UNDER COMMERCIAL FARM IN EGYPT

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ABSTRACT

Records of 5662 normal lactations produced by 1029 cows were analyzed by a single-trait Animal Model to estimate transmitting abilities of cows and their dams and sires for some lactation traits of Holstein cattle raised in El-Salhia commercial farm in Egypt. Lactation traits studied were 90-day milk yield (M90), 305-day milk yield (M305), total milk yield (TMY) and length of lactation period (LP). Repeatability estimates were moderate or slightly high (0.388, 0.402 and 0.417) for M90, M305 and TMY, respectively and low (0.146) for LP. Transmitting abilities (TA) were estimated for cows (CTA) using their own records, along with those for their dams (DTA) and sires (STA) without using their own records. Ranges in estimates of CTA for M90, M305, TMY and LP were 321 kg, 1087 kg, 1388 kg and 12.1 days, respectively. The corresponding ranges were 182 kg, 600 kg, 801 kg and 6.7 days for DTA and 208 kg, 702 kg, 851 kg and 8.5 days for STA. The percentages of cows and their dams and sires that had positive transmitting abilities for M90, M305, TMY and LP were 47.9, 47.3, 47.5 and 54.3% for CTA, 46.3, 46.4, 45.7 and 53.3% for DTA and 50.4, 52.5, 50.4 and 51.8% for STA. It could be concluded that selecting cows according to CTA would be more efficient than selecting them according to STA or DTA.

Keywords: Holstein cattle, lactation traits, transmitting ability, Animal Model, commercial farm, Egypt.

INTRODUCTION

At the beginning of the eighties, a common trend has been raised, in Egypt, for establishing large-scale commercial herds of dairy cattle through introducing new standard breeds (Holstein, Brown Swiss, Friesian, Pinzgauer…etc.) in order to increase the national milk production. Since that time and till now, several investigators have screened some of the genetic aspects of productive efficiency of these breeds under the semi-arid conditions in such herds (e.g. Salem, 1991; Gad 1995; others).

Genetic improvement for milk production traits could be achieved through selection and this necessitates identifying the elite cows and superior sires through the evaluation of breeding animals to be selected.

The present study was set up in order: (1) to characterize the lactational performance of Holstein cattle raised in a commercial herd under the Egyptian climatic conditions, and (2) to estimate transmitting abilities of milk production traits for cows with records and their dams and sires without records.

MATERIALS AND METHODS

Animals and breeding plan

Animals used in the present study comprised locally born females and males of Holstein cattle (H) raised in a commercial herd since 1982. Holstein females were imported from USA as pregnant heifers. The herd belongs to the General Cooperative for Developing Animal Wealth and Products, Egypt and was located at El-Salhia, Ismaillia Governorate (East to the south of Nile Delta).

Feeding and management

Cows were kept under similar system of feeding and management. All year round, all cows were fed on good quality concentrates and corn silage. During winter and spring months (from December to May), animals were supplied with Egyptian clover (*Trifolium alexandrinum*) while during summer and autumn months (from June to the end of November) beet, maize and green sorghum (*Sorghum Vulgar Var Saccaratum*) were available. Also, rice straw was available all the year round. Feed was supplied to cows according to their live weight, production and pregnancy status. Clean water and mineral mixture were available all the time. Cows were inseminated artificially using frozen semen imported from USA. Heifers were bred when reached 16-18 months of age (about 350-375 kg) and cow was served during the first heat period following the 45^{th} day post-partum. Pregnancy was detected by rectal palpation 60 days after the last service. Calves were given colostrum for four days after birth and housed in calf-boxes where they were bucket fed on whole milk and/ or milk replacer until weaning at 90 kg weight for male calves and 100 kg weight for females. After weaning and up to six months of age, calves of the same age were housed in-groups in pens provided with yards for exercise. At six-months of age, male calves were separated from females and housed in open sheds up to their sexual maturity. Lactating cows were machine-milked twice daily in a milk parlor. Milk yield was recorded daily to the nearest 0.1 kg at each milking. Cows were dried off two months before the expected date of next calving.

Data

Data used in this study covered nine consecutive years (1983-1991). All abnormal records (aborted cows and records without pedigree and breeding dates) were excluded. A total number of 5662 complete lactations for 1029 cows sired by 139 bulls were used. Lactation records of cows were grouped into age subclasses of 3-months interval, while they were grouped into days-open subclasses of 20-day intervals. Productive traits studied were 90-day milk yield considered as initial milk yield (M90), 305-day milk yield (M305), total milk yield (TMY) and length of lactation period (LP). Numbers of records of the first, second, third and across all lactations were 1029, 1029, 1001 and 5662, respectively.

Estimation of transmitting ability

Transmitting abilities of cows (CTA) and their dams (DTA) and sires (STA) were estimated for milk production traits of all lactations using single-trait Animal Model program written by Misztal (1990). Transmitting abilities for cows (CTA) were predicted using their own records, while dam (DTA) and sire (STA) transmitting abilities were estimated for these animals without their own records. Transmitting abilities were calculated for 1029 cows, fathered by 139 sires and mothered by 1029 dams. The utilized Animal Model (in matrix notation) was:

$$Y=XB + Z_a a + Z_p p + e,$$

where Y= vector of observations for any lactation trait, X = incidence matrix for fixed effects, B= vector of an overall mean and fixed effects (year-season, age of cow and days open), Z_a = incidence matrix for random effects (direct genetic effect), a= vector of direct genetic effects of the cows, Z_p = incidence matrix for permanent environmental effects, P = vector of permanent environmental effects and e= vector of random error.

Since var (a) = $A\sigma^2_{a}$, var (p) = $I_p\sigma^2_{p}$, and var (e) = $I_n\sigma^2_e$. The variance-covariance matrix of the random effects was:

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where A is the numerator relationship matrix, I_p is an identity matrix with order equal to number of animals, and I_n is an identity matrix with order equal to number of records.

RESULTS AND DISCUSSION

Means and variation

Means, their standard deviations (SD) and coefficients of variation (CV%) for lactation traits (M90, M305, TMY and LP) across all lactations of Holstein-Friesian cattle are given in Table 1. Means of lactation traits in this study generally fall within the range of those obtained for Holstein cattle raised in Egypt by Gad (1995). These estimates are higher than those reported by Moharram (1988) and Mokhtar *et al*. (1993). On the other hand, the actual mean of M305 in this study (5275 kg) is lower than that reported on imported Holstein cattle (6506 kg) by Ahmed (1996).

Table 1: Means, their standard deviations (SD) and coefficients of variation (CV%) for lactation traits in Holstein cattle.

Trait+	Mean++	SD	CV%+++
M90 (kg)	1574	310	14.7

M305(kg)	5275	1056	14.8
TMY (kg)	6496	1516	14.7
LP (day)	371.1	54.0	5.0

+ M90= 90-day milk yield; M305= 305-day milk yield; TMY= total milk yield and LP= lactation length.

++ Number of records used was 5662 lactations.

+++ Coefficient of variation computed as the residual deviation divided by the mean of a given trait.

Variance components and repeatabilities

Variance components and repeatabilities for lactation traits are presented in Table 2. Repeatability estimates for lactation traits were moderate or slightly high and ranged from 0.146 to 0.417. These estimates fall mostly within the range (0.22 to 0.55) obtained for Holstein-Friesian and/or Friesian cattle by Abubakar *et al*. (1986a), Boldman and Freeman (1990), Wiggans and VanRaden (1990), Salem (1991), Khalil *et al*. (1994) and Gad (1995). Moderately high estimates of repeatability found in the literature and in this work for milk yield traits indicate that records beyond the first lactation actually add little new information about the producing ability (Soliman and Khalil, 1993). Accordingly, culling policies of cows for milk yield traits based on single record would be efficient from a genetic standpoint and consequently, assessment of several records are not required before selecting cows for these traits.

Table 2: Estimates of cow component of variance (σ^2c) and the remainder variance component (σ^2e), their percentages of variation (V%) and repeatability (t) for lactation traits in Holstein cattle.

Trait[+]	Cow		Remainder[++]		Repeatability
	σ^2c	V%	σ^2e	V%	
M90	34191***	38.8	53875	61.2	0.388+0.015
M305	407020**	40.2	606690	59.8	0.402+0.015
TMY	655339**	41.7	917412	58.3	0.417+0.015
LP	59.36***	14.6	347.18	85.4	0.146+0.013

[+] Traits as defined in Table 1.

[++] Degrees of freedom were 1028 and 4555 for cows and remainder, respectively.

**** = p<0.01, *** = p< 0.001**

Number of iterations and equations for transmitting ability

The number of equations for lactation traits were 7939, while the number of iterations for M90, M305, TMY and LP were 108, 153, 214, and 127, respectively. Ducroco *et al.* (1990) and Wiggans and VanRaden (1990) reported that number of iterations required to reach the adequate convergence criteria might not be met before 100 or more iteration.

Transmitting abilities for cows with records

For cows with records, the minimum and maximum estimates of transmitting ability are presented in Table 3. The difference between the minimum and maximum values of transmitting ability (TA) for M90, M305, TMY and LP were 321 kg, 1087 kg, 1388 kg and 12.1 days, respectively. The range of transmitting ability gives an idea about the genetic variability between cows. Accordingly, the wide range in this respect refers to the presence of wide genetic variability, and this gives the chance for improving milk traits through selection according to the superiority of transmitting ability of the cows. Szkotnicki *et al.* (1978) found that the ranges in estimates of cows transmitting ability (CTA) for M305 were 116 and 173 kg for Brown Swiss and Canadian cattle, respectively. Hintez *et al*. (1978) showed that differences between minimum and maximum values in CTA for M305 were 757, 520, 580, 487 and 907 kg for Ayrshire, Guernsey, Holstein, Jersey and Brown Swiss, respectively. For Holstein cattle raised in Egypt, Ahmed (1996) using Animal Model showed that the rang**e** in CTA for M305 was higher (1631 kg) than that obtained in the present study (1087 kg). Gebriel (1996) reported that the range in buffalo CTA was 642.9 kg for M305 and 85.05 days for LP.

Table 3: Minimum, maximum and ranges of transmitting abilities for cows with records (CTA) predicted by Animal Model for lactation traits in Holstein cattle.

Trait+	Minimum	Maximum	Range
M90	-147	174	321
M305	-485	602	1087
TMY	-582	806	1388
LP	-6.5	5.6	12.1

+ Traits as defined in Table 1.

Transmitting abilities for animals without records

The ranges of DTA for M90, M305, TMY and LP were 182 kg, 600 kg, 801 kg, and 6.7 days, while those of STA were 208 kg, 702 kg, 851 kg and 8.5 days, respectively (Table 4). These values indicate that the ranges recorded for STA were larger than those estimated for DTA. Hintez *et al* (1978) showed that ranges of STA for M305 were 383, 199, 266 and 226 kg in Ayrshire, Guernsey, Holstein and Jersey cattle, respectively. Aboubakar *et al.* (1986b) found that the range in STA for M305 was 504 kg for Holstein cattle in Colombia. Also, Aboubakar *et al.* (1987) reported that the ranges in transmitting abilities for M305 for sires from USA, Mexico and Colombia were 792, 733 and 542 kg, respectively. These ranges are higher than those obtained in the present study (702kg). Rozzi *et al.* (1990) found that ranges in STA for milk yield were 156, 544 and 151 kg for Holstien cattle raised in Canada, USA and Italy, respectively. Results of Adbel-Glil (1991) with Friesian cattle raised in Egypt, showed that the ranges in STA for M305 in the first, second, and third lactation were 552.9, 435.0, 491.3 kg for M305 and 704.5, 736.3 and 587.5 kg for TMY, respectively. With Friesian cattle raised in Egypt, Sadek *et al*. (1993) indicated that the range in STA was 340 kg, while Abdel-Gill (1991) found that the ranges in STA for LP were 46.1, 49.3 and 56.3 days in the first, second and the third lactation, respectively. Gebriel (1996) found that the ranges in transmitting ability for dams of buffalo cows (animals without records) were 361.3 kg for M305 and 43.52 days for LP. The same author added that the range recorded for buffalo cows CTA was higher than that obtained for dams of buffalo cows.

Table 4: Minimum, maximum and ranges of transmitting abilities for dams (DTA) and sires (STA) without records predicted by Animal Model for lactation traits in Holstein cattle.

Trait+	DTA for dams without records			STA for sires without records		
	Minimum	Maximum	Range	Minimum	Maximum	Range
M90	-85	97	182	-96	112	208
M305	-277	323	600	-328	374	702
TMY	-364	437	801	-390	461	851
LP	-3.6	3.1	6.7	-4.7	3.8	8.5

+ Traits as defined in Table 1.

Animals with positive transmitting ability

The percentages of cows and their dams and sires that have positive estimates of transmitting ability for M90, M305, TMY and LP, respectively were 47.9, 47.3, 47.5 and 54.3% for CTA, 46.3, 46.4, 45.7 and 53.3% for DTA and 50.4, 52.5, 50.4 and 51.8% for STA (Table 5). The percentages for milk yield traits were mostly less than 50% for CTA and DTA, but they were higher than 50% for STA, *i.e*. positive estimates of transmitting ability obtained for cows are nearly similar to those obtained for their dams, but they are slightly smaller than those estimated for their sires. Ahmed (1996) found that the percentage of the positive CTA was 53.0% for M305 of Holstein cattle raised in Egypt. Gebriel (1996) with the Egyptian buffaloes found that the percentages of positive estimates of buffalo CTA (animals without records) for M305 and LP were equal. The same author added that positive estimates for buffalo CTA (44%) were lower than those for buffalo DTA (51%). El-Chafie (1981) found that the percentage of sires with positive BLUP estimates were 22% for Friesian sires raised in Egypt. In north and south America, Abubakar *et al.* (1987) noted that 47% of the Holstein sires had positive predicted sire values (PSV) for M305 in both Mexico and Colombia, while 94% of the sires had positive PSV in USA. Abdel-Glil (1991) with Friesian cattle in Egypt, found that the positive percentages of STA for M305 in the first, second and the third lactation constituted 50.0, 45.6 and 51.0%, respectively, while they were 43.4, 43.2 and 51.0 for TMY and 49.1, 47.3 and 46.9% for LP.

Table 5: Numbers and percentages of Holstein animals with and without records with positive estimates of predicted transmitting abilities recorded by the Animal Model.

Trait+	Cows with records	Dams without records	Sires without records

	No. of cows	% of cows	No. of dams	% of dams	No. of sires	% of sires
M90	469	47.9	476	46.3	70	50.4
M305	487	47.3	477	46.4	73	52.5
TMY	489	47.5	470	45.7	70	50.4
LP	559	54.3	548	53.3	72	51.8

+ Traits as defined in Table 1.

CONCLUSION

In spite of the importance of sire transmitting ability in the herd, the present ranges in estimates of transmitting abilities indicate that Holstein cows (animals with records) had the highest ranges of transmitting ability for all milk traits, followed by their sires and dams (animals without records) in descending order. So, selecting cows from the herd of the study (which belongs to the General Cooperative for Developing Animal Wealth and Products, Egypt, EL-Salhia) for milk traits according to the cow transmitting ability would be more reasonable than selecting them according to either their sire transmitting ability or their dam transmitting ability.

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تقدير المقدره التمريريه لصفات إدرار اللبن باستخدام نموذج الحيوان لماشية الهولشتين المرباه فى مزرعه تجاريه فى مصر

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تم تحليل ٥٦٦٢ سجل لبن طبيعي أعطتها ١٠٢٩ بقره باستخدام نموذج الحيوان Animal model لتقدير المقدره التمريريه للأبقار ولأمهاتها ولآبائها لبعض صفات إدرار اللبن لماشية الهولشتين المرباه في مزرعة الصالحيه التجاريه فى مصر٠ كانت الصفات المدروسه هي محصول اللبن لأول ٩٠ يوم، محصول اللبن في ٣٠٥ يوم، المحصول الكلى من اللبن في موسم الإدرار، بالإضافه إلى طول فترة الإدرار٠

كانت قيم المعامل التكراري لهذه الصفات متوسطه أو مرتفعه قليلا (٠,٣٨٨، ٠,٤٠٢، ٠,٤١٧)وذلك لصفات محصول اللبن لأول ٩٠ يوم، محصول اللبن فى ٣٠٥ يوم، المحصول الكلى من اللبن على التوالى- ومنخفضه (٠.١٤٦) لفترة الإدرار٠ تم تقدير المقدره التمريريه للأبقار باستخدام سجلاتها بالإضافه إلى تقدير هذه القيم لأمهاتها وآبائها بدون استخدم سجلاتها٠ وكانت الفروق بين أعلى القيم التمريريه وأدناها لمحصول اللبن لأول ٩٠ يوم، محصول اللبن في ٣٠٥ يوم، المحصول الكلى من اللبن، طول فترة الإدرار على التوالي ٣٢١ كجم، ١٠٨٧ كجم، ١٣٨٨ كجم، ١٢,١ يوماً٠ وكانت الفروق المناظره ١٨٢كجم، ٦٠٠كجم، ٨٠١كجم ، ٦,٧ يوماً للأمهات ، ٢٠٨ كجم ، ٧٠٢ كجم ، ٨٥١ كجم ، ٨,٥ يوماً للآباء٠ كانت نسب القيم التمريريه الموجبه لصفات محصول أول ٩٠ يوم، محصول ٣٠٥ يوم، المحصول الكلى، طول فترة الإدرار على التوالي ٤٧,٩، ٤٧,٣ ، ٤٧,٥ ، ٥٤,٣ % للأبقار ، ٤٦,٣ ، ٤٦,٤ ، ٤٥,٧ ، ٥٣,٣% للأمهات، ٥٠,٤ ، ٥٢,٥ ، ٥٠,٤، ٥١,٨% للآباء ٠