Egyptian J. Anim. Prod. (2003)40(2):89-98.

A STUDY ON APPLYING TEST DAY MODEL FOR GENETIC EVALUATION OF MILK YIELD OF HOLSTEIN CATTLE IN EGYPT

A.A. Nigm, S.A. Attallah , S. Abou-Bakr and R.R. Sadek

Department of Animal Production, Faculty of Agriculture, Cairo University. Giza, Egypt

SUMMARY

This study was conducted to investigate feasibility of applying test day model (TDM) to estimate heritability and breeding values of milk yield of Holstein cattle maintained in Egypt. A total number of 10945 test day (TD) records of 1163 first lactation cows , daughters of 59 bulls, were used . Models tested were: (1) traditional 305-day (305-Y) ; (2) all TD records (the 1st 10 records), fitting year-season as fixed effect, (10 t-YS) ; (3) all TD records (the 1st 10 records), fitting test date as fixed effect , (10t-TD) ; (4) the first 4 test day records, fitting YS as fixed effect , (4t-YS) or (5) the first 4 test day records, fitting TD as fixed effect, (4t-TD). Statistical analyses were performed using SAS (1996) . DFREML (Meyer, 1998) was used for estimating h^2 and breeding values.

Test day models showed higher estimates of additive genetic variance as compared to traditional 305-Y . Heritability estimates obtained were 0.06 , 0.10, 0.15, 0.10 and 0.13 for 305-Y , 10t-YS , 10t-D , 4t-YS and 4t-TD , respectively . High product moment and rank correlation coefficients were obtained between breeding values estimated from traditional 305-Y and those obtained from the four test day models.

Results obtained indicated the advantages of applying test day model in genetic evaluation of Holstein cattle in Egypt . Also , first four test day records would be used in early genetic evaluation with reasonable accuracy. Test date was recommended to replace year season as a fixed effect in the statistical model.

***Keywords**: Test-day model, heritability, breeding value, year-season, test-date effect*

INTRODUCTION

Traditional 305-day milk yield has been used in genetic evaluation of dairy cattle since 1935. Test day model (TDM) was developed in Canada in 1992 . The main objective was to cut recording cost and increase accuracy of genetic evaluation. (Schaeffer , 2002)

Vargas *et al.* (1998) indicated the importance of implementing TDM in developing countries because of lack of sufficient authenticated records and high cost of recording. However, no study was reported to deal with TDM in Egypt . The main objective of the present study was to investigate the feasibility of applying TDM to estimate heritability and breeding values of Holstein cattle maintained in Egypt. Also, the study aimed at comparing significance of both test date and year-season as fixed effect in analyzing lactation records.

MATERIAL AND METHODS

Herd management

Animals were maintained at El-Tobgy Farm, Fayoum, about one hundred kilometers to the south of Cairo . Animals were housed in open sheds . Total mixed ration was introduced according to milk production level and pregnancy status. Cows were machine milked three times per day . Frozen semen was used in A.I.

Data

The Holstein herd is enrolled in the milk recording program operated by Cattle Information System/Egypt (CISE) of Cairo University. CISE is a member in the International Committee for Animal Recording (ICAR) and follows its recording guidelines .

The data provided by CISE included 10945 test - day records of 1163 first lactation Holstein cows , daughters of 59 A.I. bulls .

Traits

The 305-day milk yield was calculated according to the ICAR formula (ICAR, 2000):

305-Y = (TMY * 405) / (LP + 100)

where TMY = Total milk yield and LP = Lactation period .

The test-day yields were calculated by applying Mao formula (Mao,1995) as follows: TDY1, $(TDY_1 + TDY_2)/2$,$(TDY_2 + TDY_3)/2$,.., $(TDY_{n-1} + TDY_n)/2$ and TDYn. The first ten or less (10 t) and the first four or less (4t) test - day milk records were used in the study.

Statistical analysis

Significance of fixed effects was tested by applying the General Linear Model (GLM) procedure (SAS, 1996) . The following statistical models were assumed :

Model 1 for analysing 305-day MY (305-Y)

$Yij= u + S_i + b_1x+ b_2z+ e_{ij}$ where ,

Yij = 305-Y record ; u = the overall mean ;

S_i = the fixed effect of year-season; I = 22 class : 11 year (1992-2002) and 2 season of calving (cool= Sept-Feb.and hot = March-August) ; b_1 = regression of 305-Y on age at calving ; b_2 = regression of 305-Y on days in milk (DIM) at 1^{st} test date, and x, z are least squares deviations of independent variables from their corresponding means , and e_{ij} = residual variance assumed to be IRND $(0,\sigma^2)$.

Model 2 for analysing 10 t and 4 t day records:

$Yij = u + S_i + b_1 x + b_2z + b_3v + eij$

where b_3 = regression of test day record on (DIM/C) (linear , duadratic and cubic) ; c= 305, v is least squares deviation of the independent variable (DIM/C) from its mean , and all other items are defined as in model 1.

Model 3 : For analysis of all (10t) and the 1^{st} four (4t) test-day records (dependent variables) :

Test date replaced year season as the single fixed effect :

$Yij = u+ T_i + b_1x + b_2z + b_3v + {}^{e}ij$.

Separate analysis was performed to compare between Year-season and test date fixed effects (Model 4 and 5) .

Model 4 : Year-Season was the single effect in the model

$Yij = u + S_i + {}^{e}ij$.

Model 5 : Test date was the single effect in the model :

$Yij = u + T_i + eij$.

The Derivative-Free Restricted Maximum Likelihood (DFREML) procedure (Meyer, 1998) was used for estimating variance components, heritability (h^2), and breeding values .

The correlation analyses (Pearson and Spearman) were applied to determine the relationship between breeding values estimated from traditional 305-Y and those from test-day models , and between ranking of breeding values estimated by the two types of models .

RESULTS AND DISCUSSION

Simple statistics of data are shown in table 1. All means , standard errors and CV's are within the ranges reported for Holstein cattle maintained in commercial herds in Egypt . Average yield of the 1st 4t is slightly higher than that of the 1st 10-t . The latter included more tests performed in descending phase of lactation .

Table 1. Simple statistics of total milk yield (TMY, kg), 305-day milk yield (305-Y,kg), lactation period (LP,d), first ten test day (10t-Y, kg), and first four test day milk yield (4t-Y,kg)

Traits	No.	Mean	SD	CV%
TMY (Kg)	1163	8472	2538.2	30
305-Y (Kg)	1163	7184	1581.0	22
LP (day)	1163	377	97.6	26
10t-Y (Kg)	10945	24	6.4	24
4t-Y (Kg)	4583	25	6.6	24

Analyses of the variance of the 305-Y and test-day records are shown in table 2. Year-season (YS) and Test Date (TD) showed significant effect on all and the 1st four test-day records (P<. 001). Also, days in milk (DIM) had a significant effect on all- and the 1st 4 records under both statistical models (YS and TD). However, their inverses showed nonsignificant effect, except for the 1st four test-day records on quadratic $(C/DIM)^2$ and cubic $(C/DIM)^3$ terms. These results are in agreement with those of El-Saied (1995) who showed that DIM reflects accurately the effect of lactation stage. The author indicated that DIM either linear, quadratic or cubic and their inverses had a significant effect on test day yields of Churra sheep .

The separate analysis performed to compare between YS and TD as fixed effect showed that TD had higher accuracy (R^2) than YS (Table 3).

Model 4 : Year-Season was the single effect in the model

$Yij = u + S_i + {}^{e}ij$.

Model 5 : Test date was the single effect in the model :

$Yij = u + T_i + eij$.

The Derivative-Free Restricted Maximum Likelihood (DFREML) procedure (Meyer, 1998) was used for estimating variance components, heritability (h^2), and breeding values .

The correlation analyses (Pearson and Spearman) were applied to determine the relationship between breeding values estimated from traditional 305-Y and those from test-day models , and between ranking of breeding values estimated by the two types of models .

RESULTS AND DISCUSSION

Simple statistics of data are shown in table 1. All means , standard errors and CV's are within the ranges reported for Holstein cattle maintained in commercial herds in Egypt . Average yield of the 1^{st} 4t is slightly higher than that of the 1^{st} 10-t . The latter included more tests performed in descending phase of lactation .

Table 1. Simple statistics of total milk yield (TMY, kg), 305-day milk yield (305-Y,kg), lactation period (LP,d), first ten test day (10t-Y, kg), and first four test day milk yield (4t-Y,kg)

Traits	No.	Mean	SD	CV%
TMY (Kg)	1163	8472	2538.2	30
305-Y (Kg)	1163	7184	1581.0	22
LP (day)	1163	377	97.6	26
10t-Y (Kg)	10945	24	6.4	24
4t-Y (Kg)	4583	25	6.6	24

Analyses of the variance of the 305-Y and test-day records are shown in table 2. Year-season (YS) and Test Date (TD) showed significant effect on all and the 1^{st} four test-day records ($P<.001$). Also, days in milk (DIM) had a significant effect on all-and the 1^{st} 4 records under both statistical models (YS and TD). However, their inverses showed nonsignificant effect, except for the 1^{st} four test-day records on quadratic $(C/DIM)^2$ and cubic $(C/DIM)^3$ terms. These results are in agreement with those of El-Saied (1995) who showed that DIM reflects accurately the effect of lactation stage. The author indicated that DIM either linear, quadratic or cubic and their inverses had a significant effect on test day yields of Churra sheep .

The separate analysis performed to compare between YS and TD as fixed effect showed that TD had higher accuracy (R^2) than YS (Table 3).

Table 2. Analysis of variance of 305 d MY and test day records

Source of	d.f.	Significance
305-Y:		
YS	21	***
Regression on :		
Age at calving	1	NS
D_1	1	*
10t-YS :		
YS	21	***
Age at calving	1	NS
DIM/C	1	***
$(DIM/C)^2$	1	***
$(DIM/C)^3$	1	***
(C/DIM)	1	NS
$(C/DIM)^2$	1	NS
$(C/DIM)^3$	1	NS
10t-TD:		
TD	126	***
Regression on		
Age at calving	1	NS
DIM/C	1	***
$(DIM/C)^2$	1	***
$(DIM/C)^3$	1	***
C/DIM	1	NS
$(C/DIM)^2$	1	NS
$(C/DIM)^3$	1	NS
The 1st four t-day MY (YS):		
YS	21	***
Regression on:		
Age at calving	1	NS
DIM/C	1	***
$(DIM/C)^2$	1	***
$(DIM/C)^3$	1	**
(C/DIM)	1	NS
$(C/DIM)^2$	1	**
$(C/DIM)^3$	1	**
The 1st four t-day MY (TD):		
TD	121	***
Regression on:		
Age at calving	1	NS
DIM/C	1	**
$(DIM/C)^2$	1	**
$(DIM/C)^3$	1	*
(C/DIM)	1	NS
$(C/DIM)^2$	1	*
$(C/DIM)^3$	1	*

D_1 = days in milk at 1st test date ; C = 305 days ; D = days in milk at test date ; TD = Test date ; and YS = Year -Season of calving .
*Significant (P<0.05) ; **P< 0.01) ; ***P< 0.001; NS = Nonsignificant.

These results are in agreement with those of Meyer *et al* . (1989) and Ptak and Schaeffer (1993) . The advantage of TD over YS was due to its higher accountability to environmenttal variance which would magnify additive genetic variance. This conclusion is explained by the results shown in table 4.

Table 3. Percentage of variance explained by YS or TD

Trait	R^2	
	YS	TD
10t MY record	0.16	0.23
4 t MY record	0.14	0.20

Table 4. Percentages of phenotypic (PCV), genetic (GCV) and residual coefficient of variability (RCV)

Model	PCV %	GCV %	RCV %	R^2
305-Y	19.17	4.88	18.54	0.26
10t-YS	23.75	7.43	16.65	0.24
10t-TD	23.33	8.88	15.24	0.30
4t-YS	23.79	7.44	15.26	0.21
4t-TD	23.48	8.43	14.81	0.25

Several reports showed that accounting for short term environmental variation at test day level was more accurate than adjusting for long term environmental variation at 305-d model (Ptak and Schaeffer , 1993 ; Schaeffer *et al.*, 2000; Jensen , 2001; and Murray, 2003).

Heritability and Repeatability:

Additive, permanent environmental and residual components of variation, heritability (h^2) and repeatability (t) are shown in table 5. Test Date Model (TDM) had higher estimate of additive genetic variance thanYSM . This difference was clear in all 10 records as well as the first four test day records .

Table 5. Estimates of variance components , heritabilty (h^2) and repeatability (t) for all models

Model	Additive genetic variance	Permanent Environmental variance	Residual variance	h^2 ±SE	t
305 - Y	123110	--	1775345	0.06 ± 0.06	--
10t -YS	3.1	13.2	15.9	0.10 ± 0.05	0.51
10t-TD	4.5	13.3	13.3	0.15 ±0.05	0.57
4t-YS	3.4	17.5	14.5	0.10 ±0.06	0.59
4t-TD	4.4	16.4	13.7	0.13 ±0.07	0.60

Heritability estimated using all test day records was higher than that of the 1st four records . Also , h^2 tended to increase as TDM was applied instead of YSM (Figure 1). Swalve (1995) indicated that h^2 varied with number of test day records included for each cow. The relative higher estimate of h^2 under TDM over YSM is due to lower residual coefficient of variability (Falconer and Mackay, 1997) .

Repeatability of all test day records were lower than that of the first four records (Table 5). Applying TDM showed higher estimate of repeatability than that estimated by YSM only in the case of all records .

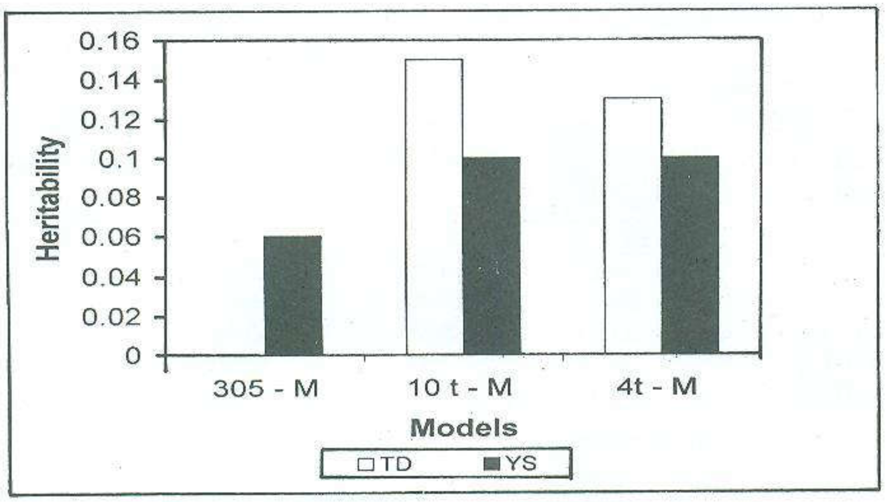

Figure 1 : Estimates of heritability using different models

Breeding Values

Simple statistics of breeding values estimated for animals, sires and cows are shown in table 6. Higher SD and wider range of BV's were observed for 305-Y. Breeding values of all test day records showed markedly higher estimates with relatively higher SD's than those of 4t-TD records .

Ptak and Schaeffer (1993) indicated that breeding values estimated from test day model differed from those estimated from 305-Y. The differences were attributed to herd test date effect which accounted more precisely for effects peculiar to each test day .

Table 6. Simple statistics of breeding values estimated for animals, sires and cows by different models

Model	Mean (Kg)	SD (Kg)	Minimum	Maximum
Animals :				
305-Y	2.17	106.4	-539.7	492.5
10t-TD	-0.09	0.8	-4.3	5.9
4t-TD	-0.05	0.9	-3.2	11.5
Sires :				
305-Y	15.46	127.3	-444.3	305.6
10t-TD	-0.08	1.2	-3.9	3.1
4t-TD	-0.04	0.9	-2.7	1.9
Cows:				
305-Y	1.63	105.5	-539.7	492.5
10t-TD	-0.09	1.1	-4.3	5.9
4t-TD	-0.05	0.9	-3.2	11.5

Correlation analysis

Pearson and Spearman correlations are presented in table 7 . The estimates obtained were all highly significant . The ranking correlation estimates in the presant study are comparable with those obtained by Reents *et al* . (1997) .The authors reported 0.83 to 0.85 for young cows and 0.87 to 0.92 for older cows as the ranking correlations between BV's estimated from test day model and 305 M.

Table 7. Pearson correlation (rp) and Spearman correlation (r_s) among breeding values estimated by 305-d model (305-Y) and test day model (TDM)

Model	10t TD		4t TD	
	r_p	r_s	r_p	r_s
305 - Y :				
Animals	0.84	0.84	0.75	0.76
Sires	0.82	0.82	0.82	0.85
Cows	0.84	0.84	0.75	0.75
10t TD :				
Animals			0.85	0.84
Sires			0.85	0.82
Cows			0.85	0.84

Correlations between BV's estimated from 305 M and all records were relatively higher than those between 305-Y and 4t-TD records. In general , as most r_p estimates are high and significant, test day models could be applied for genetic evaluation of Holstein cattle maintained in commercial herds in Egypt .

CONCLUSIONS

The high estimates of heritability, R^2 , and correlations indicated that test day model would be used satisfactorily to replace standardized 305-Y records in genetic evaluation of Holstein cattle maintained in commercial herds in Egypt .

The first four test day records could be used for early and preliminary genetic evaluation of young dairy animals. Also , the results confirmed the significance of fitting test date instead of year-season as a fixed effect in test day model for genetic evaluation of dairy cattle.

REFERENCES

El-Saied U.M, 1995. Estimation of heritability and breeding values assuming a repeatability animal model. A Comparative study using test-day and standardized lactation records of Churra dairy sheep . M.Sc. Thesis, Mediterranean Agronomic Institute . Saragossa , Spain .

Falconer D.S. and T.F.C. Mackay, 1997. Introduction to quantitative genetics. Longman Group , Edinburgh Gate , Harlow , England .

ICAR, 2000. Yearly enquiry on the situation and results of cow milk recording in member countries . International Committee for Animal Recording .

Jensen J., 2001. Genetic evaluation of dairy cattle using test-day models.J. Dairy. Sci.84:2803.

Mao I.L., 1995. Comparison of methods for calculating lactation total yield from test-day records . Report to Lactation Working Group of ICAR. http : www. Icar.org.

Meyer K., 1998. DF-REML (Derivative-Free Restricted Maximum Likelihood) Package. Version 3.1.6th world cong. Genetic . Appl. Livest . Prod. Armidal, Newsouthwales , Australia .

Meyer K, H.U. Fraser and K. Hammond, 1989. Estimates of genetic parameters for first lactation test day production of Australin Black and White cows . Livest . Prod.Sci.21:177.

Murray B., 2003.Test day model for genetic evaluations for dairy production traits . http // www. Gov.on.ca/OMAFRA / English / livestock/dairy/facts/info-cdn.htm.

Ptak E. and L.R.Schaeffer, 1993 . Use of test day yields for genetic evaluation of dairy sires and cows. Livest. Prod. Sci. 34 : 23.

Reents R, J.C.M. Dekkers and L.R. Schaeffer, 1995.Genetic evaluation for somatic cell score with a test day model for multiple lactations.J.Dairy.Sci.78:2858.

SAS, 1996. Procedures Guide, Version 6.12, SAS Inst., nc., Cary,NC.

Schaeffer L.R., 2002. Dairy cattle test day models: A case study. http://www.aps.uoguelph.ca/-Irs/Papers/patent2.

Swalve H.H., 1995 . The effect of test day models on the estimation of genetic parameters and breeding values for dairy yield traits . J. Dairy Sci. 78 : 929 .

Vargas B., E. Perez and J.A.M. Van Arendonk, 1998. Analysis of test day yield data of Costa Rican dairy cattle. J. Dairy . Sci. 81:255.

إســتخدام نمــوذج يــوم الإختبار فى تقدير معالم موسم الحليب الأول لقطيع تجارى من أبقار الهولستين في مصر

على عطيه نجم ، شريف عبدالغنى عطاالله ، سامى أبوبكر محمود ، ربيع رجب صادق

قسم الإنتاج الحيوانى- كلية الزراعة- جامعة القاهرة

إستهدفت الدراسة تحديد إمكانية استخدام نموذج يوم الاختبار لتقدير المعالم الوراثية والقيم التربوية لأبقار الهولســتين المرباة فى المزارع التجارية فى مصر . وكذا استخدام يوم الأختبار كمؤثر ثابت بدلاً من تأثير سنة وموسم الولادة على إنتاج اللبن . أيضاً تم إجراء التقييم الوراثى باستخدام سجلات يوم الإختبار الأربعة الأولى وقورنت النتائج مع استخدام كل سجلات أيام الإختبار (١٠ سجلات) .

أســتخدم فى الدراسة ١٠٩٤٥ سجلاً من السجلات الشهرية لعدد ١١٦٣ بقرة فى الموسم الأول وكانت هــذه الأبقــار بنات لــ٥٩ طلوقة من الطلائق المستخدمة فى التلقيح الأصطناعى بأمريكا وكندا . تم تجميع البيانات فى الفترة من ١٩٩٢ إلى ٢٠٠٢ من مزرعة الطوبجى بالفيوم والمشتركة فى نظام التسجيل بمركز نظم معلومات الماشية – كلية الزراعة – جامعة القاهرة .

تــم التحليل الإحصائى باستخدام برنامج SAS (1996) لاختبار معنوية العوامل الثابتة وتقدير معامل التحديد فى خمسة نماذج إحصائية : –

١- نموذج ٣٠٥ يوم (القياسى) .

٢- نموذج موسم وسنة الولادة(YS) باستخدام ١٠ سجلات شهرية لكل بقرة على الأكثر .

٣- نموذج يوم الاختبار (TD) باستخدام ١٠ سجلات شهرية لكل بقرة على الأكثر .

٤- نموذج موسم وسنة الولادة (YS) باستخدام السجلات الأربعة الأولى لكل بقرة على الأكثر .

٥- نموذج يوم الاختبار (TD) باستخدام السجلات الأربعة الأولى لكل بقرة على الأكثر .

اســتخدم برنامج DF-REML (MEYER,1998) لتقدير مكونات التباين والمعالم الوراثية والقيم التربوية بأستخدام النماذج الإحصائية المختلفة .

ويمكن تلخيص أهم النتائج التى تم الحصول عليها فيما يلى :

١- متوســطات محصــول اللبــن فى ٣٠٥ يوم ، محصول اللبن الكلى ، فترة الحليب ، إنتاج اللبن للعشر ســجلات الأولى ، إنتاج اللبن للأربعة سجلات الأولى هى ٧١٨٤ كيلو جراماً ، ٨٤٧٢ كيلو جراماً ، ٣٧٧ يوماً ، ٢٤ كيلو جراماً ، ٢٥ كيلو جراماً .

٢- كان نموذج يوم الاختبار أكثر قدرة على تعديل العوامل البيئية بالمقارنة بنموذج ٣٠٥ يوم .

٣- إرتفــاع التباين الوراثى والعمق الوراثى عند تطبيق نموذج يوم الإختبار مقارنة بنظيريهما عند استخدام نموذج ٣٠٥ يوم .

٤- حقــق معــامل الارتــباط البسيط ومعامل ارتباط الرتب بين القيم التربوية المقدرة من نموذج ٣٠٥ يوم ونماذج يوم الأختبار قيما عالية .

والنــتائج المتحصــل عليها تشير إلى جدوى استخدام نموذج يوم الأختبار ، وإمكانية استخدام السجلات الأربعــة الأولى لكل بقرة فى التقييم الوراثى المبكر ، كما أشارت النتائج إلى أهمية استخدام تاريخ الاختبار (كمؤثر ثابت) بدلاً من أستخدام تأثير سنة وموسم الوضع فى النموذج الإحصائى .