J. Agric. Sci. Mansoura Univ., 30 (11): 6565 - 6571, 2005

GENETIC IMPROVEMENT OF MILK PRODUCTION IN EGYPTIAN BUFFALOES THROUGH SELECTION INDEXES

Hammoud, M.H.[1] and O.M. El-Shafie[2]

1- Department of Animal Production, Faculty of Agriculture, University of Alexandria

2- Animal Production Research Institute, Ministry of Agriculture

ABSTRACT

Data relevant to 398 Egyptian buffaloes raised at Mehallet Mousa Experimental Station between 1972-1992 were utilized in this investigation to construct several selection indexes which determine the most suitable combination of age at first calving (AFC), first lactation total milk yield (TMY), first dry period (DP)and first calving interval (CI) in order to realize the most genetic improvement in TMY.

Overall mean of AFC was 1167.12 days, of TMY was 1231.57 kgs, of DP was 315.50 days and of CI was 597.25 days. Heritability estimate of AFC was 0.38, of TMY was 0.43, of DP was 0.32 and of CI was 0.20. Phenotypic correlations were highly significant but mild except those between DP and each of TMY and CI were moderately negative and high positive , respectively. Similarly were the genetic correlations except that between DP and AFC which was moderately positive. The genetic correlation between TMY and each of DP and CI were high negative and very high positive , respectively.

The highest expected genetic improvement (ΔG) for TMY (357.5 kgs) was obtained from the second index (I_2) which incorporated TMY, DP and CI. Also it recorded the highest correlation with the aggregate genotype (r_{IT} = 1.00) and the highest relative efficiency compared with the basic index (RE %= 125). Whereas the lowest correlation with the aggregate genotype (r_{IT} = 0.65) and the lowest relative efficiency (RE%=81) were obtained from I_6 which included TMY and DP.

INTRODUCTION

Genetic improvement in dairy animals may take place either through selection or by adopting particular mating systems. Significant genetic improvement by selection results when the selected animals are superior to the herd average and when the heritabilities of the traits are relatively high. It is important that the traits included in a given breeding programme be of economic importance and are measured objectively. Although selection of dairy animals is based on milk production, their breeding value for others traits such as age at first calving, dry period and calving interval are involved in determining the economics of dairy herds. Therefore, it is necessary for the dairy animal breeder to be concerned with selection for multiple traits simultaneously. Selection index is one of the most effective methods for several traits selection to improve overall economic merit of the animal (Hazel *et al.*, 1994).

In Egypt, the use of selection index for improving milk production in buffaloes has been documented by Ashmawy (1981), Badran and Sharaby

(1989) and El-Arian *et al.* (2001). Also in India, many researchers have constructed several selection indicies by incorporating different economic traits in buffaloes (Johari and Bhat, 1978; Sharma and Basu, 1986; Charkravary and Rathi, 1990; Gupta *et al.*, 1991 and Dutt and Taneja, 1994).

The objective of this investigation is to construct several selection indexes incorporating combinations of some important first lactation economic traits in buffaloes to determine which of them combine best in an index, maximize the relative efficiency and lead to maximum genetic improvement.

MATERIALS AND METHODS

Source of data:

Data used in this investigation were from the records of the buffaloes herd located in Mehallet Mousa Experimental Station, Animal Production Research Institute, Ministry of Agriculture. The records used were relevant to 398 dairy buffaloes which completed at least their first and second normal lactations and were free from diseases and disorders. These records covered the period from 1972-1992.The relevant details of the herd management were described by El-Arian *et al.* (2001) and Aziz *et al.* (2003). Traits under investigation were age at first calving in days (AFC), first lactation total milk yield in kilograms (TMY), first dry period in days (DP) and first calving interval in days (CI).

Relative economic values:

The economic values of the traits were estimated as the change in the difference between cost and income per unit change in the trait (Kolstad, 1975). These values, according to the prices of 1991/1992 ,were L.E.3/day for AFC, L.E. 0.40/Kg for TMY, L.E. 1.85/day for DP and 1.57/day for CI.

The economic value of each trait was divided by that of TMY to get the relative economic value. The relative economic values of AFC, DP and CI were assigned negative in order to have a logic decline in the magnitude of these traits. Therefore, the relative economic values were -7.50, 1.00 , -4.63 and -3.93 for AFC, TMY,DP and CI, respectively.

Statistical analysis:

Mixed Model LSMLMW program (Harvey, 1990) was used to estimate the genetic and phenotypic parameters.

Selection indexes were set up using the general index program SELIND (Cunningham,1970). The weighing factors (b's) of the general index were obtained by solving the following equation given by Cunningham (1969):

$$Pb = Gv \quad \text{to give} \quad b = p^{-1}Gv$$

where:

P : the phenotypic variances and covariances matrix.

G : the Genetic variances and covariances matrix.

v : the economic weights column vector.

b : the weighing factors column vector.

p^{-1} : the original p matrix inverse.

The expected genetic gain (ΔG) for each trait after one round of selection (i = 1) was obtained by solving either of the following two equations (Cunningham, (1969):

$$\Delta G_x = r G_{XI}\ i\ \sigma_{Gx} \quad \text{or} \quad \Delta G_x = b G_{XI}\ i\ \sigma_I$$

where:

ΔG_x : the expected genetic gain.
rG_{XI} : the genetic correlation of the trait with index.
i : the selection differential in standard deviation units.
σ_{Gx} : the standard deviation of genetic variance of the trait.

$$(\sigma_I) = \sqrt{b^{-} Pb}$$

bG_{XI} : the genetic regression of the trait on the index.
σ_I : the standard deviation of the index.

The standard deviation of the index (σ_I) was obtained as:

where:

b : the column vector of weighing factors which is going to be solved.
b` : the transpose of the column vector of weighing factors.
P : the matrix of phenotypic variances and covariance.

The standard deviation of the aggregate genotype (σ_T) was estimated as:

$$\sigma_T = \sqrt{v^{-} GV}$$

where:

V : is the column vector of economic weights.
v^{-} :is the transpose of the column vector of economic weights.
G : is the matrix of genetic variances and covariances.

The correlation between the index and the aggregate genotype (r_{IT}) was obtained as:

$$r_{IT} = \frac{\sigma_I}{\sigma_T} = \sqrt{\frac{b^{-} Pb}{v^{-} GV}}$$

The intensity of selection used in estimation of various parameters was assumed to be 0.35, corresponding to 80 percent selection or 20 percent culling.

RESULTS AND DISCUSSION

The means of the studied traits (Table 1) are in close agreement with those reported by Ashmawy (1981) and El-Arian *et al.* (2001) for AFC, El-Arian *et al.* (2001) and Aziz *et al.*(2003) for TMY, Mahdy *et al.* (1999) for DP and CI.

Table (1): The means ($\overline{X}$), phenotypic standard deviations (σ_p), genetic standard deviations (σ_G) and relative economic values (v) for studied traits

Trait	$\overline{X}$	σ_p	σ_G	V
Age at first calving (days)	1167.12	167.87	103.26	–7.50
Total milk yield (kgs)	1231.57	572.67	374.03	1.00
Dry period (days)	315.50	150.68	84.99	–4.63
Calving interval (days)	597.25	134.15	60.64	-3.93

AFC and TMY had relatively high proportion of genetic variance compared with DP and CI. The latter traits might be subject to man-made decisions regarding estrous detection and/or mating arrangements. Estimates of heritability and correlations among the traits are in Table (2). Their values indicate the possibility of traits improvement through genetics by selection. Heritability estimate for AFC (0.38) is higher than reported in the literature except that depicted by El-Arian *et al.* (2001). For TMY it was quite similar to those documented by Ashmawy (1981) and Badran and Sharaby (1989) and Aziz *et al.* (2003). However, Mahdy *et al.* (1999) and El-Arian *et al.* (2001) reported moderate heritability values for the same trait. Heritability estimate for DP (0.32) and CI (0.20) were higher than those depicted by Mahdy *et al.* (1999).

AFC and DP had highly significant negative genetic and phenotypic correlations with TMY. Whereas, CI had highly significant positive genetic and phenotypic correlations with TMY, but those between CI and TMY were positive (Table 2). Long dry periods are usually associated with low milk production. The strong negative genetic association between the two traits may reflect an evidence for possible genetic influence on such relationship. Meanwhile, the mild association between TMY and AFC indicated independent hereditary mechanisms for the two traits. The mild and strong phenotypic and genotypic correlations between TMY and CI indicated the expected interference of the environmental factors in determining the phenotypic but not the genetic association between the two traits. Generally, the genetic correlations were higher than the phenotypic and had the same sign except that between DP and CI. Estimates of genetic and phenotypic correlations among the traits were in consonance with those reported by Ashmawy (1981), Mahdy *et al.* (1999), and El-Arian *et al.* (2001).

Table(2): Heritabilities (on the diagonal), phenotypic correlations (above the diagonal) and genetic correlations (below the diagonal) for the traits included in the indexes.

Trait	AFC	TMY	DP	CI
AFC	0.38±0.16	–0.13**	0.19**	0.10*
TMY	–0.30**	0.43±0.17	-0.48**	0.19**
DP	0.53**	–0.63**	0.32±0.16	0.67**
CI	0.28**	0.93**	–0.14**	0.20±0.14

* Significant ($P<0.05$); ** Highly significant ($P<0.01$).

Seven selection indexes were constructed and appraised in order to determine the best index which maximizes the relative efficiency and the genetic progress. I_1 incorporated all four available traits AFC, TMY, DP and CI and for comparative purposes it was considered the basic index and was given a relative efficiency of 100%. I_2 to I_4 incorporated three traits, TMY and other two traits, since one of the supporting traits to TMY was omitted alternatively. Similarly I_5 to I_7 included TMY and only one supporting trait while the other two traits were omitted alternatively. For all indexes AFC and DP contributed negative ΔG while TMY and CI contributed positive ones.

The weighing factors (b's), expected genetic gain (ΔG), correlation of index with aggregate genotype (r_{IT}) and the relative efficiency (RE%) of different indexes to the basic index (I_1) are illustrated in Table (3). I_2 which included TMY, DP and CI recorded the highest correlation with the aggregate genotype (r_{IT}=1.00) and had the highest relative efficiency (RE%=125) exceeding that of the basic index which recorded the second position (r_{IT}=0.80). El-Arian *et al.* (2001) depicted that selection index incorporating age at first calving, total milk yield and lactation period of buffaloes was the best (r_{IT}=0.91). I_6 which included TMY and DP was the most inferior (r_{IT}=0.65) and (RE%=81). All other indexes had quite equal r_{IT} and RE%.

Consequently, I_2 was the most efficient and realized the highest expected genetic gain in TMY (ΔG=357.5 kgs), however I_4 which incorporated AFC,TMY and CI was the most inferior and realized the lowest expected genetic gain in TMY(ΔG=167.5 kgs). Ashmawy (1981) found that the index including age at first calving, total milk yield and lactation period was the best criterion for selection for the genetic improvement of total milk yield and age at first calving in buffaloes.

Table (3): Selection indexes (I's), weighing factors (b), expected genetic gain (ΔG), correlations of the index with aggregate genotype (r_{IT}) and the relative efficiency (RE%) of different indexes to the basic index (I_1).

Index	AFC		TMY		DP		CI		r_{IT}	RE%
	b	ΔG	b	ΔG	b	ΔG	b	ΔG		
I_1	–3.2	-59.4	–0.71	284.8	-7.8	–73.2	7.0	12.8	0.80	100
I_2	---	---	–0.57	357.5	-6.0	–78.6	5.7	30.2	1.00	125
I_3	–3.1	–61.8	0.50	183.3	-1.5	–47.5	---	---	0.69	86
I_4	–3.1	–62.1	0.46	167.5	---	---	0.2	7.9	0.66	82
I_5	---	---	0.30	269.0	---	---	0.6	42.0	0.71	89
I_6	---	---	0.46	240.5	-0.6	–43.0	---	---	0.65	81
I_7	–3.0	–60.6	0.58	180.9	---	---	---	---	0.66	82

In conclusion, AFC, DP and CI are influential traits for appraising milk production of Egyptian buffaloes. These traits are highly related to milk production since DP form a considerable value of the lactation behaviour and days in milk form also a considerable part of CI. The adverse effect of late AFC may be neutralized by high degree of evolution of milk secretory system during growth, therefore, AFC did not have crucial effect on the index.

REFERENCES

Ashmawy, A.A. (1981). A Selection index for the improvement of some economic traits in dairy cattle under local conditions. Ph.D. Thesis, Fac. of Agric., Ain-Shams Univ., Cairo.

Aziz, M.M; J.B. Owen; S.A. Azhar; A.E. Mahdy and O.M. El-Shafie (2003). Genetic and phenotypic variation of lactation length and total milk yield of Pakistani and Egyptian buffaloes. Alex. J. Agric. Res. 48(2): 11-22.

Badran, A.E. and M.A. Sharaby (1989). Genetic responses to selection for milk production traits in Egyptian buffalo. The third Egyptian-British Conference, Alexandria Univ., October, 1989, pp. 329-333.

Charkravarty, A.K. and S.S. Rathi (1990). Use of secondary traits in unrestricted index selection of buffaloes. Indian J. Dairy Sci., 43 (1): 28.

Cunningham, E.P. (1969). Animal breeding theory landbruksbokhandlen, Universites Forlaget, Volle-bekk, 0510.

Cunningham, E.P. (1970). SELIND: A fortran computer program for genetic selection indexes. Inst. of Animal Genetic and Breeding. Agric. Univ. of Norway.

Dutt, T. and V.K. Taneja (1994). Index slection in Murrah buffaloes. Indian J. Dairy Sci., 47(10): 825.

El-Arian, M.N.; K.A. Mourad and A.S. Khattab (2001). A comparison of different selection indices for genetic improvement of some milk traits in a herd of Egyptian buffaloes. J. Agric. Sci. Mansoura Univ. 26(5): 2687.

Gupta, B.D.; R.R. Mishra; S.N. Kaushik and G.S. Bhist (1991). Selection index in buffaloes – a modified approach. Indian J. Dairy Sci. 44(6): 363.

Harvey, W.R. (1990). User's Guide for LSMLMW. Mixed model least squares and maximum likelihood computer program. PC Version 2. Ohio State University, Columbus, USA (Mimeograph).

Hazel, L.N.; G.E. Dickerson and A.E. Freeman (1994). The selection index-Then, Now and for the future, J. Dairy Sci. 77(10): 3236.

Johari, D.C. and P.N. Bhat (1978). Selection indexes based on growth, reproduction and production traits for Indian buffaloes. Indian J. Anim. Sci. 48(2): 79.

Kolstad, N. (1975). Selekajonsdekser for verpehons. Inst. of Pult. And Fur Anim. Sci., Agric. of Norway, NLH. Steneiltrylck No. 77.

Mahdy, A.E.; O.M. El-Shafie and M.S. Ayyat (1999). Genetic study and sire values for some economic traits in Egyptian buffaloes. Alex. J. Agric. Res. 44(1): 15.

Sharma, A. and S.B. Basu (1986). Incorporation of profit variables for the maximisation of genetic gain. Indian J. Dairy Sci. 39(1): 35.

J. Agric. Sci. Mansoura Univ., 30 (11), November, 2005

التحسين الوراثي لإنتاج اللبن في الجاموس المصري بواسطة دلائل الانتخاب

محمد حسن حمود[١] – عمر محمد الشافعي[٢]
١- قسم الإنتاج الحيواني – كلية الزراعة – جامعة الإسكندرية
٢- معهد بحوث الإنتاج الحيواني – وزارة الزراعة

أجري هذا البحث على البيانات الخاصة بعدد ٣٩٨ جاموسة تم تربيتها خلال الفترة من عام ١٩٧٢-١٩٩٣ بمحطة بحوث محلة موسى –التابعة لمعهد بحوث الإنتاج الحيواني– وزارة الزراعة. وقد استهدف البحث عمل مجموعة من دلائل الانتخاب متضمنة بعض التوليفات من الصفات الاقتصادية الأربع موضع البحث وهي العمر عند أول ولادة، وإنتاج اللبن الكلي لموسم الحليب الأول، وفترة الجفاف الأولى والفترة بين الولادتين، وذلك لمعرفة أنسب هذه الدلائل للتحسين الوراثي لإنتاج اللبن.

ولقد أوضحت النتائج مايلي :

١- المتوسط العام للصفات: كان بالنسبة للعمر عند أول ولادة ١١٦٧,١٢ يوم ، ولإنتاج اللبن الكلي ١٢٣١,٥٧ كجم، ولفترة الجفاف ٣١٥,٥٠ يوم، وللفترة بين الولادتين ٥٩٧,٢٥ يوم.

٢- المكافئ الوراثي: كان تقديرة بالنسبة للعمر عند أول ولادة ٠,٣٨، ولإنتاج اللبن الكلي ٠,٤٣، ولفترة الجفاف ٠,٣٢ وللفترة بين الولادتين ٠,٢٠.

٣- الارتباط الوراثي والمظهري: كان عالي المعنوية بين كل صفتين من الصفات موضع الدراسة فيما عدا بين صفة العمر عند أول ولادة والفترة بين الولادتين حيث كان معنويا فقط.

٤- معدل التحسين الوراثي : كان أكبر معدل تحسين وراثي متوقع لإنتاج اللبن الكلي (٣٥٧,٥ كجم) عند استخدام الدليل الثاني المتضمن صفات إنتاج اللبن الكلي، وفترة الجفاف والفترة بين الولادتين.

٥- ارتباط الدليل بالقيمة الوراثية الكلية: كان أكبر ارتباط للدليل بالقيمة الوراثية الكلية في حالة الدليل الثاني (١,٠٠) بينما كان أقل ارتباطاً في حالة الدليل السادس (٠,٦٥) المشتمل على إنتاج اللبن وفترة الجفاف.

٦- الكفاءة النسبية لدلائل الانتخاب: أتضح أن الكفاءة النسبية لدلائل الانتخاب مقارنة بالدليل الأول المتضمن كل الصفات تتراوح ما بين ٨١- ١٢٥% من التحسين الوراثي كما لو استخدم الدليل الأول المتضمن الصفات الأربع موضع البحث.

وبصفة عامة أوضحت نتائج هذا البحث أنة في برامج التربية للتحسين الوراثي لإنتاج اللبن في الجاموس المصري يمكن استخدام دلائل الانتخاب التي تتضمن بعض الصفات الاقتصادية الأخرى مثل العمر عند أول ولادة ،وفترة الجفاف والفترة بين الولادتين.