MULTI-SOURCE MULTI-TRAIT SELECTION INDICES FOR IMPROVING SOME BEEF CHARACTERISTICS IN FRIESIAN CATTLE IN EGYPT.

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ABSTRACT

Carcass data are nowadays easy collected in routinely regime from Dutch slaughter houses. The aim of this study was to develop a selection index for beef production traits in a dairy cattle population based upon such data. Records during 10 years (1995-2004) for body weights at 12 (w12), 18 (w18) months of age and four years (2001-2004) for hot carcass weight (HCW) and lean weight (LW) at the experimental farm of Faculty of Agriculture, Minufiya University were utilized to construct different selection indices (general index, reduced indices, and sub-indices) by using multi-source of information (W12 and W18 as an Own-performance traits ; LW and HCW as a Paternal half-sibs traits) to improve some beef characteristics in Frisian bull calves. The secondary objective is to evaluate and predict genetic parameter estimates of body weights at 12, 18 months of age, HCW and LW.

Overall means for the previous body weights were 291.97, 358.73, 283.54 and 215.09 kg respectively. Heritability estimates for the previous traits were 0.59, 0.71, 0.67 and 0.29, respectively. All estimates of genetic (r_G) and phenotypic (r_P) correlations among different body weights were positive. Fifteen selection indices were constructed using four traits and two sources of information in different combinations, own-performance for ($w12$), (w18) and Paternal half-sibs for (HCW) and (LW). Indices (I_2), (I_3), (I_5), (I_6), (I_9), (I_{10}) and (I_{13}) gave high (RIH) and (RE) values compare with general index (I_1). Therefore, it could be suggested that to use (I_3) and (I_1) to improve beef traits in Friesian bull calves under the large scale because the highest values of excepted genetic change for lean weight as an economic target.

Key Words: *Body weight, Genetic parameters, Multi-Source, Selection indices*

INTRODUCTION

The selection index summarizes the breeding value of a given individual in one score. According to these scores, the breeders can rank candidates for selection. An individual's phenotypic values (own-performance) are not only the source of information for predicting its breeding value but also reflects the performance of its relatives such as full- and half - sibs. **Osborne (1957)** described the procedures of ranking the individuals as per the information available on the individual itself and its full- and half -sibs with respect to one trait. Multiple trait selection indexes with Multiple source of information is expected to have the advantages of both methods described above and using traits like carcass traits in seleetion index for live animals. **Liljedahl et al., (1979)** documented that similar procedures could be used for selection of more than one trait with more than one source of information.

The use of information from relatives is very important in the application of selection index because the seleeted traits usually have low heritabilities and the mean value of relatives usually provides a more reliable guide to breeding value than the individual's own phenotypic value **(Falconer and Mackay, 1996)**.

Henningsson et al. (1986) reported that live weight was the most important explanatory factor for weight of carcass and muscle for beef bull. Beef production traits used in genetic evaluation in dairy sires varies widely between countries. Lately some European countries have started to use the routinely collected data from slaughter houses on progeny carcass in the genetic evaluation of dairy bulls **(Liinamo and Van Arendonk, 1999)**. Growth in dairy cattle has not been studied extensively, particularly the genetic component of growth **(Coffey et al., 2006)**.

In Egypt beef production from dairy cattle is obtained mainly from bull calves that passed the veal stage in addition to young and old cows or bulls culled from the breeding stocks of dairy cattle herds after being fattened **(Farrag et al., 2001)**. Friesian cattle are the most reputed dairy cattle in Egypt and they are potential dual-purpose animals **(Abdel-Glil and Elbanna, 2001)**.

In this study, we have not considered correlations between dairy and beef-production traits. Van **Veldhuizen et al., (1991)** found for Dutch Red and White cattle correlations of milk production traits with beef production to be slightly positive but not significantly different from zero. The latter had also been found for Dutch Friesians **(Van der Werf et al., 1987)**. Therefore, we do not expect large changes in our results if these correlations would be taken into account.

Selection for many traits simultaneously saves time and effort. Selection index was developed by **Hazel and Lush (1942) and Hazel (1943)** as a method of selection for more than one trait at the same time. This method helps breeders to rank and evaluate the individuals on their total breeding values by condensing and summarizing the breeding values of the different economic traits in one total score for each one.

Multiple trait selection requires the definition of a breeding goal including individual traits weighted according to their relative contribution to efficiency of production as expressed by economic values **(Hazel, 1943)**. The number of traits used to construct a selection index depends mainly on the ultimate breeder's goal.

The main objective of this study is to improve beef characteristics by using different selection indices contains multi-source of information.

MATERIALS AND METHODS

Data used for this study obtained through the period of 1995 to 2004 for body weights at 12, 18 months of age and for four years (2001-2004) for hot carcass weight (HCW) and lean weight (LW) around 24 months of age in Friesian bull calves. Data collected from Experimental and Researches Unit of Animal Production in Tokh Tanbisha, in the middle Nile Delta, Egypt, which belong to Faculty of Agriculture, Minufiya University. Calves were produced mainly by artificial insemination (imported frozen semen of Friesian sires) rather than by natural service mating. Data consisted of 1342,1066, 357 and 515 records of body weights at 12, 18 months of age, HCW and LW respectively of Friesian bull calves. The management and rearing of these calves were described by **Ghoneim et al., (2006)**.

The genetic parameters were estimated by derivative free REML with a simplex algorithm using the Multiple Trait Derivative Free Restricted Maximum Likelihood (MTDFREML) programs of **Boldman et al. (1995)**.

The animal model in matrix notation was:

$$Y = Xb + Za + e$$

Where: Y= the vector of observations (body weights at 12, 18, HCW, LW);

b= the vector of fixed effect (Year);

a= the vector of random additive genetic direct effects;

X and Z=Known incidence matrices relating observations to the respective;

e= fixed and random effects with Z augmented with columns of zeros for animals without records; and the vector of residual effects.

Selection Index Program **(Wagenaar, et al., 1995)** and Matlab program **(Matlab, 2002)** were used to set up and construct the selection indices. The four traits studied were used in different combinations of relative sources of information (W12 and W18 as an Own-performance traits; LW and HCW as a Paternal half-sib traits) to construct fifteen selection indices.

$$I = b_1P_1 + b_2P_2 + \dots b_n P_n = \Sigma \quad bi\,Pi$$

Where: I = selection index, bi = index weights for each trait in the index

Pi= phenotypic measurement for each trait in the index.

The general index (I_g) was obtained in terms of heritability, phenotypic and genetic correlations among the studied traits by solving the following equations given in matrix expression according to Cunningham (1969):

$$Pb = GV \quad \text{to give} \quad b = P^{-1}\,GV$$

Where: P = Phenotypic variances and covariances matrix.

G = Genetic variances and covariances matrix.

V = Economic weights column vector.

b = Weighting factors column vector, which is going to be solved.

Furthermore, according to **Cunningham (1969)** the other different properties of the selection index were calculated as following:

The standard deviation of the index = σI = b'Pb

The standard deviation of aggregate genotype = σT = 'GV

The correlation between the index and the aggregate genotype = $R_{IH} = \sigma I/\sigma T$

The expected genetic change (ΔG) for each trait, after one generation of selection on the index (i = 1) was obtained by solving either of the following equations (Van der Werf, 2003):

$$\Delta Gi = (i\, b' G_i)/\sigma I.$$

Where: i = Selection differential in standard deviation units.

σI = Standard deviation of the index.

G_i = the i^{th} column of the G matrix.

The reduce selection index can be developed by omitting one or more traits from the original index. In relation to the original index the efficiency of the new index, the reduced index, is expected to decrease depending on the value of the omitted trait in the original index. The breeder can decide whether such traits can be included or not in selection index to save time, cost and effort depending on the relative importance of the omitted trait in the original index and the value of including such that trait in the index.

The relative efficiency or enhancing of each trait in the general index can be calculated by dropping this trait from the general index. The efficiency of the new reduced index can be compared with that of the general index by using the following formula:

$$_{T1}/\ _{T} = (B'SB/\ b'Pb)$$

Where: B'SB is the reduced index variance after dropping some sources of information with new weighting factors (B) produced from reduced matrix of phenotypic covariances (S). Omitting one variant means that the reduced index has no phenotypic information about this trait and the variance of the aggregate genotype is the same as for the general index (v'Gv) before omitting due to including of all variants in the aggregate genotype.

The relative economic values (V) of the traits under study were calculated by estimating the expected change in the lean weight (LW= 1.00) per kg as a marketing weight that determine the profit depends on the change one unit per kg in the trait (w12= 0.098, w18=0.216 and HCW= 0.856) by using the regression method.

RESULTS AND DISCUSSIONS

Table (1) shows the overall means and standard deviation of W12, W18, HCW and LW. The yearling body weight obtained for Friesian bull calves in the present study was 292 kg. However, yearling body weight in this study is much lower than the estimates reported by **Nigm et al. (1984)** for Friesian (315 kg) and much lower than the mean (376 kg) reported by **Nigm et al. (1995)** for Charolais X Friesian in Egypt. The same trend can be seen when body weight at 18 month of age were examined. The differences getting larger between the present estimates and corresponding estimates reviewed for the same breed or for Holstein X Friesian in temperate areas. These differences could be due to the straight dairy breeding of Holstein and the feeding practices followed for fattening bulls in those commercial dairy farms. The overall means of carcass and lean weights of were 283.54 and 215.09 kg, respectively which seem to be equaled value with **Apple et al.**

(1991) who reported that average of hot carcass weight was 289.5 ± 8.75 kg at 485.7 kg slaughter weight for Holstein steers but lower value than 343 ± 28.33 kg at 600 day of age at slaughter of Friesian beef bulls **(Van der Werf, et al., 1987)**.

Estimates of heritability (h^2) as well as genetic (r_G) and phenotypic (r_P) correlations among different body weight traits are presented in table (2). Heritability estimates for body weights at 12 and 18 months of age were 0.59 , respectively. The heritability estimates, which reported in literature for both traits were similar to those obtained in the present study when compared with that reported by **Al-Amin (1979)** 0.72; Meanwhile. **Abdel-Moez (1996)** reported 0.30 in Holstein for heritability estimates of body weight at 12 month of age.

In the present study, an estimate of heritability for body weight at 18 months is 0.71. **Preston and Willis (1974)** cited estimates of heritability ranged from 0.12 to 1.00 for body weight at 18 months for various breeds, while the value of heritability was 0.70 for body weight at 18 months as shown by **Abdel-Moez, (1996)**.

In the present study, an estimate of heritability for HCW and LW were 0.67 and 0.29. This is in agreement with that reported by **Coffey et al. (2006)** (0.75 ± 0.11), from Friesian bull calves for HCW and reported by **Crews and Franke (1998)** from Brahman (0.28 - 0.57) for LW. These moderate to high heritability estimates in this study indicate the possibility of improving growth performanee of Friesian calves through effective selection program.

Table (2) also presents phenotypic (above diagonal) and genetic (below diagonal) correlation coefficients among different weights of body and carcass traits under study. Phenotypic and genetic correlations among traits were positive and significant (Table 2). These results are of practical significance in managing beef production projects.

General (I_g) and Reduced (RD) selection indices are shown in table (3). The general index (I_g) is considered as the main index due to its properties, whereas this index is assumed to contain all traits under selection program without any reducing or restrictions. Furthermore, the general index is used as a standard efficient index to determine the relative efficieneies of the other types of selection indices.

Fifteen selection indiees were constructed (Table 3). The original selection index (I_1) which included the four traits (body weights at 12, 18 month of age, HCW and LW) was suggested to be used for improving the aggregate genotype of four traits, while the reduced indices (I_2 to I_5) included three traits, (I_6 to I_9) included two traits, while the sub-indices (I_{12} to I_{15}) included only one traits. The expected genetic change per generation (EG) in each trait (body weights at 12, 18 month of age, HCW and LW) assuming the selection intensity of 1.00 is given in Table 3. The expected genetic ehange per generation (EG) ranged between 25.13 to 26.59 kg for w_{12}, 42.73 to 43.04 kg for w_{18}, 14.45 to 35.65 kg for HCW and 4.84 to 14.51 kg for LW. The maximum genetic improvements in traits under study were achieved by using the selection indices (I_1, I_2, I_3, I_5, I_6, I_9 and I_{13}).

The least accuracy (R_{IH} =0.28 (I_{15}) and 0.39 (I_{14}) would result from any index ignoring W_{12}, W_{18} or both of them as an own-performance. On the other hand, including w_{12} and w_{18} from (I_2) to (I_{10}) increased the accuracy (RIH) to value 0.92 at least, and came to the efficiency of 93.88 at least, relatively from the original index (I_1). **Shemeis et al. (2006)** working on Holstein cattle concluded that the selection indices which incorporated yearling body weight were high in RIH (0.53 to 0.54).

Furthermore, the selection indices (I_2, I_3, I_5, I_6, I_9 and I_{13}) gave high (RIH) and (RE) values compared with general index (I_1). Therefore, it could be suggested that to use them to improve beef traits in Friesian bull calves under the large scale.

The expected genetic gain after one generation through the general index (I_1) will be (1) increase in W_{12} by 25.07 kg, (2) increase in W_{18} by 42.73 kg, (3) increase in HCW by 35.52 kg (4) increase in LW by 14.51kg. This index is very simple and easy to construct, therefore, its use is recommended for selection of beef characteristics in Friesian bull calves

CONCLUSION

Results show that we can use multi-source of information to construct selection indices especially to improve carcass traits in alive animals of Friesian cattle by using paternal half-sibs values as another source of information in Egypt. The traits under study are high heritable and the genetic correlations of weights at 12, 18, HCW and LW are also generally favorable. Fifteen selection indices were constructed, the selection indices (I2, I3, I5, I6, I9 and I13) gave high (RIH) and (RE) values compared with general index (I1). Therefore, it could be suggested that to use them to improve beef traits in Friesian bull calves under the large scale.

Table 1: The overall means, standard deviations for body weights at 12, 18 month of age, HCW and LW for Friesian bull calves.

Trait	*№ of animal*	*Mean (kg)*	±	*S.D (kg)*
W12	1342	291.96	±	34.78
W18	1291	358.73	±	43.11
HCW	357	283.54	±	44.00
LW	515	215.09	±	33.79

Table 2: Heritabilities, genetic and phenotypic correlations for body weights at 12, 18 month of age, HCW and LW for Friesian bull calves.

Trait	*w12*	W18	HCW	LW
W12	***0.59***	0.83**	0.28*	0.15*
W18	0.97*	***0.71***	0.62**	0.55**
HCW	0.95*	0.99*	***0.67***	0.98**
LW	0.67**	0.76*	0.77*	***0.29***

Heritabilities are on the diagonal, Genetic Correlations (r_g) below; Phenotypic Correlations (r_p) are above the diagonal.

Table (3) Selection indices for W12, W18, HCW and LW for Friesian bull calves.

Selection Index	Trait								R_{HI}	RE
	Own-performance				Paternal half-sibs					
	W12		W18		HCW		LW			
	b1	EG	b2	EG	b3	EG	b4	EG		
I_1	-0.783	25.07	1.795	42.73	-0.304	35.52	0.554	14.51	0.98	100.00
I_2	-0.871	25.13	1.827	42.82	0.014	35.62			0.97	98.98
I_3	-0.842	25.11	1.799	42.79			0.158	14.33	0.97	98.98
I_4	2.003	26.54			-0.329	34.12	0.769	12.65	0.92	93.88
I_5			1.327	42.90	-0.363	35.52	0.664	14.17	0.97	98.98
I_6	-0.872	25.13	1.83	42.82					0.97	98.98
I_7	1.946	26.68			0.127	34.24			0.92	93.88
I_8	1.946	26.59					0.361	12.44	0.92	93.88
I_9			1.301	43.04	0.019	35.65			0.97	98.98
I_{10}			1.289	42.99			0.194	13.93	0.97	98.98
I_{11}					1.521	15.89	-0.934	4.64	0.40	40.82
I_{12}	1.987	26.71							0.92	93.88
I_{13}			1.305	43.04					0.97	98.98
I_{14}					1.011	14.45			0.39	39.80
I_{15}							1.152	5.84	0.28	28.57
V	0.098		0.216		0.856		1.00			

Index weights for each trait in the index (bi), Expected genetic change per generation in each trait (EG), correlation of index with aggregate genotype (R_{HI}) and the efficiency (RE) of different indices relative to original index (I_1). Economic weights column vector (V).

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الملخص العربى

إشتقاق أدلة إنتخابية لتحسين بعض صفات إنتاج اللحم فى ماشية الفريزيان فى مصر باستخدام مصادر متعددة للمعلومات لعدة صفات

إلهام محمد غنيم

قسم الإنتاج الحيوانى - كلية الزراعة - جامعة المنوفية

جمعت البيانات من وحدة بحوث وتجارب الإنتاج الحيوان بطوخ طنبشا التابعة لكلية الزراعة - جامعة المنوفية وشملت البيانات وزن الجسم عند ١٢ و ١٨ شهر من العمر على الحيوان نفسه خلال عشر سنوات (١٩٩٥ - ٢٠٠٤) وبيانات وزن الذبيحة الساخن ووزن اللحم الأحمر للأخوة أنصاف الأشقة من الأب خلال أربع سنوات (٢٠٠١ - ٢٠٠٤) بهدف اشتقاق أدلة إنتخابية لصفات إنتاج اللحم باستخدام مصادر متعددة للمعلومات وذلة لتحسين بعض صفات إنتاج اللحم فى عجول الفريزيان بمزارع ماشية اللبن.

قدر المتوسط العام لصفات وزن الجسم عند ١٢ و ١٨ شهر ووزن الذبيحة الساخن ووزن اللحم الأحمر بـ ٩٧ر٢٩١، ٧٣ر٣٥٨، ٥٤ر٢٨٣ و ٩٠ر٢١٥كجم على التوالي، كما تم تقدير المعايير الوراثية للصفات المدروسة حيث كانت قيم المكافىء الوراثى للصفات المدروسة ٥٩ر٠، ٧١ر٠، ٦٧ر٠ و ٢٩ر٠ على التوالى.

قدرت الارتباطات المظهرية والوراثية بين الصفات المدروسة واشتق ١٥ دليل إنتخابى باستخدام الأربعة صفات المدروسة بتوليفات مختلفة، أعطى الدليل الثانى، الثالث، الخامس، السادس، التاسع والعاشر أعلى دقة وكفاءة مقارنة بالدليل العام وعليه فقد اقترح إستخدام الدليل الثالث والأول لتحسين صفات إنتاج اللحم فى عجول الفريزيان على نطاق واسع بناء على أعلى قيمة للعائد الوراثى لصفة وزن اللحم الأحمر والمستهدفة إقتصادياً.