Egypt. J. Anim. Prod. **19**, No. 2, pp. 233-239 (1979)

The Relative Efficiencies of Selection Indexes Computed from on-the Farm Records of Sheep

A.S. Abdel-Aziz, S.A. Imam, M. T. Ragab and M.A. Sharafeldin

College of Agriculture, University of Cairo, Giza, Egypt.

ESTIMATES of heritability, genetic and phenotypic correlations were calculated for birth weight (BW), four-month weight (WW), yearling weight (YW) and first greasy fleece weight (FL) of 3855 Fleisch Merino lambs after removing the effects of farm, sex, type, season and year of birth using the least squares method of analysis of variance (Harvey, 1960). The estimates were used to construct 11 selection indexes involving all combinations of 2 or more traits. The reduced indexes were compared to the basic one by means of their correlations with defined aggregate genotype (T) to measure their relative effciency (EF). The results shew the advantage of including all traits in the index (index 1), and suggest that in situations where information and all traits is not recorded, selection on basis of an index including WW, YW and FL would ensure a considerably high rate of progress in T. If lambs are marketed before shearing, the index involving the 3 body weight traits would be recommended followed by the index containing only WW and YW. Values of EF for the 3 proposed indexes are 98.5%, 95.6% and 93.2%, respectively. An extremely low value of EF of 58.6% was obtained when both WW and YW were ignored. The probable effect of the estimates of genetic and economic parameters on the numerical values of the weigting factors of the indexes and their correlations with the aggregate genotype was discussed.

Early selection would allow for rapid disposal of undesired animals would increase the annual rate of genetic progress in economically important. traits. For lambs, birth, four -month, and yearling body weights, and first greasy fleece weight were considered as important traits fro efficiency of production. All of the four traits are expressed in the first year of lambs life, and are frequently recorded on the farm where few and simple records are usually kept.

Index selection was proved in several studies to be more efficient and never less efficient than other methods of selection when two or more traits are involved (Hazel and Lush, 1943; Young, 1960; and Finney,1962). The aggregate genotype selected for by an index was defined by Hazel (1943) as the sum of several genotypes of an individual, assuming a distinct genotype for each economic trait, each genotype being weighed according to the relative economic value of that trait. A selection index that includes several traits is rather complex. In practical breeding, it is frequently found that traits of

economic importance are not recorded. Some traits are not expressed at young ages or hardly observed while the animals are on the farm or still alive.

The primary aim of the study is to measure the reduction in the efficiency of a set of reduced indexes, compared to a basic index, when one or more of the economic traits that may not be recorded on the farm was ignored. The relative contribution of each trait to the genetic progress is a defined aggregate genotype could than be computed,

Material and Methods

Data

Four traits were chosen to be included in the selection indexes : birth, four-month, and yearling body weights, and first greasy fleece weight. The data used in computing the specific information needed for the construction of the selection indexes were collected for three succesive years starting in 1969 under farm flock conditions from five farms belonging to the Meat and Milk Organization in Egypt. Records of 3855 Fleisch Merino lambs having observations on all of the four traits were included in the study.

At birth, pedigree information, date of birth, sex and type of birth were recorded for each lamb. Keeping lambs for replacement in the breeding stock or preparing them for marketing was based on four month body weight. As the lambs became one year old, they were usually sheared and the first greasy fleece weight was recorded. Management of the flocks was described by Abdel-Aziz *et al.* (1977a).

Estimation of the genetic and phenotypic parameters

Least squares analysis of variance (Harvey, 1960) was performed to assess the effects of farm, sex, type, season and year of birth on the four studied traits. For fleace weight, regression on age at shearing was also computed. Data were then corrected for the effects of the non genetic sources of variation, and estimates of heritability of the four traits, genetic and phenotypic correlations among them were obtained from the usual one-way analysis of variance and covariance among and within sires (Abdel-Aziz *et al.*, 1977b).

Estimation of the relative economic values

The economic values assigned to the economic characters included in the basic index could be defined as the relative effect of a unit change on net profit. The value of a unit change is a function of market prices, whith were taken as the mean price per kg of each trait during the years 1974 and 1975 at the Meat and Milk Organization.

The average price of a kg of live weight of a four-month or a yearling lamb was L.E. 0.50, while it was L.E. 1.25 for a kilorgram of greasy fleece weight. The price of a kilogram of live weight at birth was calculated from information on the estimated value of a newly born lamb and average birth weight. The overall mean birth weight was 2.959 kg and the estimated value of the lamb was L.E.3.0. The price of a kilogram of birth weight was set to be equal to L.E.1.0. The relative economic values used in constructing the selection indexes were therefore, 4:2:2:5 for a kilogram of live weight at birth, 4-months, 12-months of age and for first greasy fleece weight respectively.

Construction of selection indexes

The basic index including the four traits was calculated using the matrix technique as describd by Cunningham (1972). Beside the basic index, ten reduced indexes were computed using all combinations of three or two traits.

The relative efficiencies of the reduced indexes

The relative efficiency (EF) of each of the reduced indexes derived in this study was estimated by the usual method of comparing it to the basic index by means of the correlations with the aggregate genotype, since genetic progress is proportional to these correlations.

Results and Discussion

In constructing a selection index many aspects of genetics, biometry and economics should be put together in a correctly balanced form to maximise the correlation between the aggregate genotype (T) and the index (I).

Under farm conditions, where few and simple records are usually kept, information on some economic traits may not be recorded. Including only the most important traits in the definition of the aggregate genotype was questioned. Giedrem (1972) indicated the advantages of including all economically important traits, and conculded that such traits should be considered in the index even they were not recorded . This would never decrease, but would frequently increase, the total genetic gain when selection is applied . Further, correlated traits of little or no economic importance might increase the efficiency of the index.

The problem discussed in this paper is how the effieciency of an index is affected by ignoring one or more of the economically important traits. The study involved the construction of a set of reduced indexes which were compared to a basic index including all traits in question.

The performance of a lamb during its first year of life was considered in terms of four economically important traits which can lead to profit in a farm enterprise by producing meat and wool : birth weight (BW), 4-month weight (WW), yearling weight (YW) and first greasy fleece weight (FL). Greasy fleece weight rather than clean fleece weight, on which the economic value of wool is usually based, was included in the definition of the aggregate genotype fecause information on it was more readily obtained on the farm. However, estimates of the genetic correlation between greasy and clean fleece weight were found to be positive and high in several studies (Morely, 1955; Battie, 1962; Brown and Turner, 1968 and Mullaney *et al*; 1970). Including in this study information subsequent to the first shear would have resulted in 91·3% reduction in the number of records on which all required information were recorded

Estimates of heritability for the four traits, and genetic and phenotypic correlations among them are presented in Fig. 1 in the form of a path diagram. The values on the double arrowed paths between the G's are genetic correlations (r_g) and between the P's are phenotypic correlations (r_p). The values on the single arrowed paths connecting the G-s and P-s the are the square roots of the estimates of heritability.

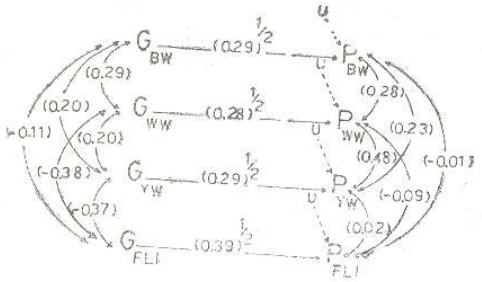

Fig. 1. Path diagram of biometrical relationships among traits.

P 's are phenotypic values,
G's are genic values, and
U's are undefined sources of variation
BW, WW, YW, and FL are birth weight, weaning weight, yearling weight, and first greasy fleece weight, respectively.

A basic index involving all of the four traits was constructed (index 1). All possible combinations of three and two traits were used to calculate ten reduced indexes. Indexes 2,3,4, and 5 were 3-trait indexes, while 6, 7, . . ., and 11 included only two traits. Vectors of weighing factors (b values) for the eleven indexes are given in Table 1. The reduced indexes were arranged in the table according to the magnitude of their correlations with the aggregate genotype

(R_{TI}) within every category of indexes. For each index, the vector of b values was expres sed in terms of the b value of the earliest trait appearing on the lamb.

TABLE 1. The selection indexes.

Index No.	b Values				(1) δI	(2) R_{TI}	(3) EF
	Birth weight (BW)	4-Month wt. (WW)	Yearling wt. (YW)	1st. fleece wt. (FL1)			
I. Basio Index							
1	1	0.4168	0.5131	—3.5177	3.361	0.551	100.0%
II. Three-Trait Indexes							
2	—	1	1.1464	—7.7599	3.314	0.543	98.5%
3	1	0.4492	0.4788	—	3.217	0.527	95.6%
4	1	—	0.4826	—2.9299	3.178	0.521	94.5%
5	1	0.2840	—	—1.8682	3.127	0.512	92.9%
III. Two-Trait Indexes							
6	—	1	1.0081	—	3.139	0.514	93.2%
7	—	—	1	—5.6734	3.025	0.496	90.0%
8	1	—	0.4717	—	2.938	0.481	87.3%
9	—	1	—	—4.1685	2.791	0.457	82.9%
10	1	0.6443	—	—	2.757	0.451	81.9%
11	1	—	—	—1.7856	1.975	0.323	58.6%

(1) δI = The standard deviation of the index.

(2) R_{TI} = The correlation between the index and the aggregate genotype

(3) EF = The efficiency of the index relative to the basic index.

Negative b values for FL were obtained. This resulted mainly from the negative genetic correlations between body weight traits and FL, and the high relative economic value assigned to it. However, FL had largest absolute

numerical value of b in any vector of b's involving that trait (indexes 1,2,4,5,7,9 and 10). Among body weight traits, BW was given more weight than WW or YW whenever it was considered (indexes 1,3,4,5,8,10 and 11). Relatively low values of b were obtained for WW and YW in all indexes involving any or both of them (index 1—10), with YW having slightly higher b's than WW when both traits were involved (indexes 1,2,3, and 6).

Values of R_{TI} are given in Table 1. The highest value was obtained for the basic index (index 1). No tind was observed in the R_{TI} values of the reduced indexes that could be explained by the size of heritabilities or genetic correlations of the traits involved in the index.

An extremely low value of EF was obtained when only BW and FL were involved (index 11). Except for that index, values of EF did not fell below 81.9% when information on one or two traits was not considered. The contribution of each index to the overall progress in T could be observed from Table 1 (columns d_I R_{TI} and EF). These results show the advantage gained in the genetic improvement by including all traits in the index (index 1). When BW is dropped from the index, the efficiency will be reduced by 1.5% only. When lambs are marketed before shearing, index 3 would be used with a loss of 4.4% in efficiency. When both BW and FL are dropped (index 6), EF will be reduced to 93.2% of the efficiency of index 1.

In practical breeding, flocks may undergo changes in their genetic constitution. Indexes, therefore, need periodic revision of estimates of genetic and economic parameters.

References

Abdel-Aziz, A.S., Ragab, M.T., Sharafeldin, M.A., and Imam, S.A. (1977a) Some non-genetic sources of variation in body weight in six commercial flocks of Merino sheep in Egypt. *Egypt. J. Anim. Prod.* **17** (in press).

Abdel-Aziy, SA., Ragab, M.T., and Iman, S.A., (1977)b. Phenotypic and genetic parameters of three body weight trouts and the first fleece weight in fleisch Merino sheep in Egypt. *Egypt. J. Anim. Prod.* 17 (in press).

Battie, A.W., (1962) Relationships among productive characters of Merino sheep in North Western Queensland. II. Estimates of genetic parameters with particular reference to selection for wocl weight and crimp frequency *Qd. J. Agric. Sci.* **19**, 17.

Brown, G.H. and Turner, Helen Newton (1968) Response to selection in Australian Merino sheep. II. Estimates of phenotypic and genetic parameters for some productive traits in Merino ewes and analysis of possible effects of selection on them. *Aust. J. Agric., Res.* **19**, 303.

Cunningham, E.P. (1972) Theory and application of statistical selection methods. XlV. British Poultry Breeders Round. Table. Birmingham, Nov. 14-16, 1972.

Finney, D·J. (1962) Senetic gains under three methods of selection. *Senet. R.* 3,417.

Giedrem, T., (1972) Study on the definition of the aggregate genotype in a slecetion index. *Acta Agriculture Scandinavica,* 22,11.

Harvey, W.R. (1960) Least-squares analysis of data with unequal subclass numbers. *Mimeograph* U.S. *Dept.* Agric., ARS, 20-80.

Hazel, L.N. (1943) The genetic basis for constructing selection indexes. *Genetics*, 28, 476.

(1943) The effciency of three methods of selection *J. Heredity*, 33,393.

Morley, F.H.W., (1955) Selection for economic characters in Australian Merino sheep. V. Further estimates of phenotypic and genetic parameters. *Aust. J. Agric. Res.* 6, 77.

Mullaney, P.D., Young, S.S.Y. and Hayland, P.G. (1970) Genetic and phenotypic parameters for wool charctieriticsin fine-wool Merino, Corriedale, and Polwarth sheep. II. Phenotypic and genetic correlations, heritability and speatability. *Aust. J. agic. Res.* 21, 526.

Young, S.S.Y. (1960) A further examination of the relative effciency of three methods of selection for genetic gains under less restricted conditions. *Genet. Res.* 2, 106.

الكفاءة النسبية للأدلة الإنتخابية المحسوبة من السجلات المزرعية للأغنام

احمد سعيد عبد العزيز ، سيد احمد امام ، محمد توفيق رجب ، وممدوح عبد الوهاب شرف الدين

كلية الزراعة ، جامعة القاهرة

حسبت تقديرات للمعاملات الوراثية لصفات : (١) وزن الميلاد ، (٢) الوزن عند عمر أربعة أشهر ، (٣) الوزن عند عمر السنة ، (٤) وزن الجزة الأولى الخام وكذلك معاملات الارتباط الوراثى والمظهرى بينها من ٣٨٥٥ سجلا لأغنام المرينو التى تربى فى مزارع الشركة العامة للحوم والألبان بعد ازالة أثر المزرعة والجنس ونوع الميلاد (مفرد أو توأم)،وفصل وسنة الميلاد ، باستعمال طريقة الحد الأدنى للمربعات فى تحليل التباين . وقد أستعملت التقديرات لحساب ١١ دليلا انتخابيا : دليل أساسى يحتوى على الصفات الأربع ، وعشرة أدلة مختزلة تحتوى على كل التوافيق الممكنة لصفتين أو ثلاثة ، ثم قيست الكفاءة النسبية للأدلة المختزلة بمقارنة معاملات ارتباط كل من هذه الأدلة بالقيمة الوراثية الكلية بالمعامل الخاص بالدليل الأساسى .

وقد أوضحت نتائج الدراسة تفوق الدليل الأساسى اذا توفرت معلومات عن كل الصفات . أما فى غير هذه الحالة ، فان الانتخاب طبقا لدليل يحتوى على الصفات (٢) ، (٣) و (٤) يضمن معدلا عاليا من التحسين فى القيمة الوراثية الكلية . واذا سوقت الحيوانات قبل الجز ، فينصح باستعمال الدليل الذى يضم الصفات (١) ، (٢) و (٣) يليه الدليل المحتوى على الصفتين (٢) و(٣) .وقد بلغت كفاءة هذه الأدلة منسوبة الى الدليل الأساسى:٩٨ر٥٪، ٩٥ر٦٪ ، ٩٣ر٢٪ على التوالى . وقد أشارت النتائج الى تدهور الكفاءة النسبية للدليل (٥٨ر٦ ٪) اذا لم تؤخذ الصفتين (٢) ،(٣) فى الاعتبار وباستثناء هذا الدليل فان الكفاءة النسبية لم تقل فى أى حال عن ٨١ر٩٪ عند حذف صفة واحدة أو أثنتين من الدليل الأساسى .