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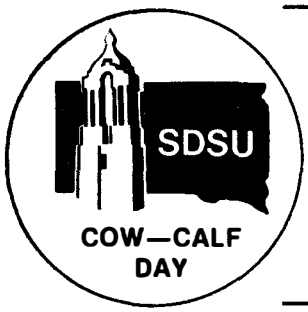

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Summary

A computer program has been developed that will aid producers in using selection index methods for evaluation of prospective replacement animals. Justification for use of selection index methods and a demonstration of the program are presented.

Introduction

The practical merit of an individual is determined by more than one characteristic of that individual. Therefore, when selecting replacements from a group of prospective individuals, some judgment is required to weigh the good and bad points of each. Selection index as proposed by Hazel (1943) is a mathematical approach to aid in this judgment. The use of selection index allows one to add up the worth of an individual resulting from each trait considered. This process yields a total score for each individual reflecting its overall merit. The purpose of this report is to present reasons for using selection index methods and to describe a computer program available to assist in the calculations required.

The collection of genes possessed by an individual is referred to as its genotype. Genes are important to livestock producers because they control the performance and appearance of each individual and are transmitted from parent to progeny. The observed performance and appearance of an individual is referred to as its phenotype. The words genetic and phenotypic relate to the genotype and phenotype, respectively.

Why use selection index? There are three reasons. First, not all traits are equally heritable. Therefore, not all traits respond equally well to selection pressure. Lowly heritable traits change hardly at all, even with intense selection. On the other hand, highly heritable traits show more rapid progress in response to selection. Second, selection index takes into account the genetic and phenotypic interrelationships among the traits. Failure to properly account for these interrelationships may lead to progress in one trait resulting in adverse change in another trait. Finally, the traits considered are rarely of equal economic importance. Traits where the economic value of a unit increase is large should have greater attention than traits where the economic value of a unit increase is small.

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[1] Present address: U.S. Meat Animal Research Center, Clay Center, Nebraska, 68933.

Program Demonstration

The first consideration in a selection program is which traits are important to the herd? For example, consider weaning weight and type score as they contribute to market value of feeder calves and birth weight as an indication of calving ease.

After the important traits have been identified, their heritabilities, standard deviations, relative economic values, phenotypic and genetic correlations must be found. Woldehawariat and co-workers (1977) have summarized many of the beef cattle breeding studies through the late 1970's which reported estimates of heritabilities, standard deviations and phenotypic and genetic correlations. The relative economic values are not easily summarized because they are dependent on a producer's management strategy and resources. Relative economic values for weaning weight and type score used in this example were from a study by Vesely and Robison (1971). The input information required for this example is contained in table 1. The index obtained in this example was a result of this information. (A more complete table of information is shown in appendix table 1.) More accurate economic values which will lead to a more appropriate index for a producer can be obtained by careful consideration of the particular operation.

Tables 2 through 5 contain the computer run for the selection index program containing weaning weight, type score and birth weight in the definition of net merit. The information supplied by the user is underlined; that supplied by the computer is in italics. After the information contained in table 1 was provided to the program, the computer did the mathematical manipulations resulting in the selection index (table 2): Net Merit = weaning weight - 3.2347 x type score - 3.3957 x birth weight.

For this example, the records of 14 prospective replacement heifers were used (table 3). Suppose the task at hand is to identify the six heifers to be kept as replacements. The selection index procedure identifies those heifers with greatest worth to the breeding program as numbers 6, 8, 14, 3, 1 and 4.

If minimum standards for selection as a replacement had been set as follows: (1) weaning weight at least 460 pounds, (2) type score of 12 or greater and (3) birth weight less than 82 pounds, then heifers 2, 3, 4, 6, 9 and 11 would have been saved. Three of the heifers with greatest worth would have been mistakenly culled and three less worthy individuals kept in their place.

The option is available to drop a trait from the index and evaluate the accuracy with which the reduced index predicts net merit (table 4). In this example, type score was dropped from the index and, as a result, a new index was calculated for predicting net merit using only weaning weight and birth weight. This index has a relative accuracy of 44.2% as compared to 44.3% for the index including type score. The question then is does the increased accuracy of the index which includes type score offset the work of scoring the cattle? In this example, probably not.

Two additional options permit changes in the relative economic values and traits which define net merit (table 5). Changes in relative economic values change the emphasis given to various traits in the breeding program. Changes of the traits which define net merit amount to a change in goals for the breeding program.

References

Hazel, L. N. 1943. Genetic basis for selection indexes. Genetics 28:476.

Vesely, J. A. and O. W. Robison. 1971. Conventional selection indexes for birth and weaning traits in beef calves. J. Anim. Sci. 33:537.

Woldehawariat, G., M. A. Talamantes, R. R. Petty, Jr. and T. C. Cartwright. 1977. A summary of genetic and environmental statistics for growth and conformation characters of young beef cattle. (2nd Ed.). Texas Agr. Exp. Sta. Tech. Rpt. No. 103.

TABLE 1. INPUT DATA FOR SELECTION INDEX PROGRAM EXAMPLE

Trait	Heritability	Standard deviation	Relative economic value	Correlations: Trait	Genetic	Phenotypic
Weaning weight (WWT)	.25	65.85	.63	WWT and TS	.24	.40
Type score (TS)	.38	1.45	3.60	WWT and BWT	.38	.54
Birth weight (BWT)	.45	10.40	-2.00	TS and BWT	.15	.33

TABLE 2. INPUT INFORMATION AND CALCULATION OF ORIGINAL SELECTION INDEX

```
INPUT THE NUMBER OF TRAITS CONTAINED IN THE MERIT OF AN INDIVIDUAL?
3
INPUT THE NAME OF THE FIRST TRAIT?
weaning weight
INPUT THE NAME OF THE SECOND TRAIT?
type score
INPUT THE NAME OF THE THIRD TRAIT?
birth weight
INPUT HERITABILITY AND PHENOTYPI , STANDARD DEVIATION OF WEANING WEIGHT?
.24,66.00
INPUT HERITABILITY AND PHENOTYPIC STANDARD DEVIATION OF TYPE SCORE?
.38,1.45
INPUT HERITABILITY AND PHENOTYPIC STANDARD DEVIATION OF BIRTH WEIGHT?
.45,10.43
INPUT PHENOTYPIC AND GENETIC CORRELATIONS OF WEANING WEIGHT AND TYPE SCORE?
.40,.24
INPUT PHENOTYPIC AND GENETIC CORRELATIONS OF WEANING WEIGHT AND BIRTH WEIGHT?
.38,.54
INPUT PHENOTYPIC AND GENETIC CORRELATIONS OF TYPE SCORE AND BIRTH WEIGHT?
.15,.33
INPUT THE RELATIVE ECONOMIC VALUE OF A UNIT INCREASE IN WEANING WEIGHT?
.62
INPUT THE RELATIVE ECONOMIC VALUE OF A UNIT INCREASE IN TYPE SCORE?
3.60
INPUT THE RELATIVE ECONOMIC VALUE OF A UNIT INCREASE IN BIRTH WEIGHT?
-2

      YOUR SELECTION INDEX IS
**********************************
*  WEANING WEIGHT                *
*  -   3.2347 * TYPE SCORE       *
*  -   3.3937 * BIRTH WEIGHT     *
**********************************

THE RELATIVE ACCURACY OF THIS INDEX IS 44.3 PERCENT
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TABLE 3. EVALUATION OF PROSPECTIVE REPLACEMENTS USING SELECTION INDEX METHODS

```
DO YOU WISH TO EVALUATE A GROUP OF ANIMALS BASED ON THIS INDEX (YES OR NO)?
yes
HOW MANY ANIMALS WILL THERE BE TO EVALUATE (LIMIT 100)?
14
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 1?
536,11,75
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 2?
532,12,78
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 3?
560,13,78
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 4?
493,12,64
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 5?
458,12,82
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 6?
566,13,70
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 7?
458,13,88
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 8?
505,11,60
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 9?
479,12,73
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 10?
495,9,70
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 11?
505,14,81
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 12?
456,15,88
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 13?
452,14,62
INPUT THE WEANING WEIGHT, TYPE SCORE AND BIRTH WEIGHT FOR INDIVIDUAL 14?
583,15,82

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ANIMAL NO.        INDEX      WEANING WEIGHT   TYPE SCORE   BIRTH WEIGHT
     1          + 245.9          536.0           11.0          75.0
     2          + 228.5          532.0           12.0          78.0
     3          + 253.2          560.0           13.0          78.0
     4          + 237.0          493.0           12.0          64.0
     5          + 140.9          458.0           12.0          82.0
     6          + 286.4          566.0           13.0          70.0
     7          + 117.3          458.0           13.0          88.0
     8          + 265.8          505.0           11.0          60.0
     9          + 192.4          479.0           12.0          73.0
    10          + 228.3          495.0            9.0          70.0
    11          + 184.8          505.0           14.0          81.0
    12          + 108.8          456.0           15.0          88.0
    13          + 196.3          452.0           14.0          62.0
    14          + 256.2          583.0           15.0          82.0
*******************************************************************************
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```

TABLE 4. OMITTING TYPE SCORE TO OBTAIN A REDUCED SELECTION INDEX

```
DO YOU WISH TO COMPUTE A NEW INDEX WITH ONE LESS TRAIT THAN IN
THE CURRENT DEFINITION OF MERIT (YES OR NO)?
yes
WHICH TRAIT IS TO BE DROPPED?
type score

      YOUR SELECTION INDEX IS
**********************************
*   WEANING WEIGHT               *
*   - 3.4921 * BIRTH WEIGHT      *
**********************************

THE RELATIVE ACCURACY OF THIS INDEX IS 44.2 PERCENT
```

TABLE 5. OPTIONS WHICH ALTER THE DEFINITION OF NET MERIT

```
DO YOU WISH TO CHANGE THE RELATIVE ECONOMIC VALUES (YES OR NO)?
no
DO YOU WISH TO CHANGE THE TRAITS IN THE DEFINITION OF NET MERIT
(YES OR NO)?
no
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APPENDIX TABLE 1. HERITABILITY ESTIMATES (H^2), STANDARD DEVIATIONS (SD) AND GENETIC AND PHENOTYPIC CORRELATIONS[a]

	H^2	SD	BWT	PWDG	WWT	WS	PG	FG	FWT	PWT	FS	PS	FTH
Birth weight (BWT)	.45	10.43	*	.34	.54	.33	.51		.60		.07		
Gain from birth to weaning (PWDG)	.30	.22	.23	*	.99	.35	.22		.67				
Weaning weight (WWT)	.24	66.00	.38	.98	*	.24	.32	-.06	.71	.67	.12	.02	
Weaning score (WS)	.38	1.45	.15	.34	.40	*	.17	-.02	.33	-.03	.68	.56	
Feedlot gain (FG)	.34	.24	.28	.12	.16	.00	*		.82		.34		.30
Pasture gain (PG)	.30	.15			.20	-.13		*		.81		.27	
Final feedlot weight (FWT)	.46	70.56	.43	.69	.70	.30	.74		*		.34		.31
Yearling pasture weight (PWT)	.44	57.33			.64	.21		.63		*		.30	
Final feedlot score (FS)	.36	1.76	.15		.20	.40	.41		.40		*		.22
Yearling pasture score (PS)	.30	1.20			.20	.35		.24		.40		*	
Fat thickness (FTH)	.58	.19			-.26		.14		.29				*

[a] Genetic correlations are given above the diagonal designated by *, phenotypic correlations are below.