ROBUSTNESS OF SELECTION INDEX AND IT'S PREDICTABILITY FOR LIFETIME PRODUCTION IN THARPARKAR CATTLE

Robustheit des Selektionsindexes und seine Voraussagbarkeit von der lebenslängliche Produktion in Tharparkar Rindvieh

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Selection of cows on the basis of a linear discriminant function or selection index is considered to be best for maximizing genetic gain in aggregate monetary value of the genotype of the animals. The selection index is likely to change with the changes in economic value and heritability of the traits as well as changes in phenotypic and genetic correlations among the traits. It was, therefore, considered useful to investigate the effect of variation in economic values and genetic parameters on the selection index to judge its reliability for wider and prolonged use. Further the efficacy of a selection index is generally judged by the extent of correlation (r_{HI}) between the selection index (I) and the net hereditary merit (H); the net hereditary merit being the sum of products of economic values and genotypes of various traits. It is, however, more important to judge the efficacy of the selection index as a basis of selection for maximizing gain in life-time profit of the cows. Therefore the second aspect considered was to judge the reliability of selection index as basis of selection for life-time economic value of the animals measured as life-time milk production.

The data for the present investigation were taken from the available records of Tharparkar cattle maintained at this Institute from 1931 to 1978. There were 1019 cows which had information on age at first calving, first lactation production and first calving interval. These were daughters of 88 sires. Information on milk yield upto six years of age was available for 557 cows borne to 61 sires. The number of cows which had milk records upto 10 years of age was 238. The estimates of heritability, genetic correlations and phenotypic correlations of the three early economic traits viz., age at first calving (AFC), first lactation milk production (FLP) and first calving interval (FCI) alongwith the relative economic values as obtained in earlier studies are given in Table-1. The estimates of phenotypic and genetic variances and covariances are given in Table-2 (a & b).

Considering the genetic variance-covariance matrices and the vector of relative economic values given above, the selection index was:

$$I = -17.52\ (AFC) + 0.187\ (FLP) - 1.566\ (FCI)$$

This index had accuracy (r_{HI}) of 0.5080. The expected genetic gain in net hereditary merit for culling level of 20% was Rs 81.50 per generation. In this index the weightages assigned to age at first calving (AFC) (months)

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and first calving interval (FCI) (days) were -94 times and -8 times the weightage given to first lactation production (FLP) (kg). The maximum weightage in the selection index is received by the trait AFC which has maximum relative economic value since differences in heritability estimates of the three traits are comparatively small as compared to differences in relative economic values. The selection indexes constructed by Singh et al.(1969) in Haryana cattle and Gurnani et al.(1977) on Tharparkar differ from the index found in this study due to differences in relative economic values and estimates of genetic and phenotypic parameters.

Robustness of selection index may be defined as the effect of variation in relative economic values and in genetic and phenotypic parameters on index coefficients and expected genetic gain in net hereditary merit (H).

Effect of variation in relative economic values upto 30% increase or decrease, at intervals of 10%, on index coefficients, accuracy of selection index (r_{HI}) and expected genetic gain (ΔH) in net hereditary merit was studied. Such variation did not alter the accuracy (r_{HI}) of the index. But it was found that when cost of rearing was low, resulting in lower relative economic value to age at first calving (AFC), the weight given to AFC in selection index was lower in absolute value, the expected genetic change in AFC was higher (lower in absolute value) and the expected genetic change in net hereditary merit (H) was lower.

Increase in relative economic value of first lactation production (FLP) upto 30% resulted in practically no change in accuracy (r_{HI}), but there was increase in expected genetic advance for FLP and increase in expected genetic change in net hereditary merit (H).

The increase in the relative economic value of first calving interval (FCI) resulted in practically no significant change in accuracy (r_{HI}), but there was increase in expected genetic gain for FLP and FCI and decrease in expected genetic gain in AFC. The results indicated that with the decrease in cost of maintaining a dry cow for an extra day, there would be decrease in expected genetic gain in net hereditary merit (H).

Among the three traits considered in this study, a given percent change in relative economic value of age at first calving (AFC) had more impact on change in net hereditary merit, followed by FCI and FLP. This seems to be due to initial higher economic value of AFC, followed by FCI and being least for FLP. Vandepitte and Hazel (1977) reported that errors in single economic weighting of $\pm 50\%$ reduced the relative efficiency of index by less than 1%. Present study also indicated the effect of variation in single economic weightages of $\pm 30\%$ on the accuracy of selection index was less than 0.50%.

Variation in heritability estimates of the three traits upto 30% indicated that with the increase in heritability of any trait in the index, the absolute value of weight in the index for that trait is increased, the absolute value of genetic gain for that trait increases and expected genetic gain in net hereditary merit (H) is increased. The gain in H was highest when heritability of FCI was increased followed by that for FLP and AFC. The expected genetic gain for FLP increased when heritability of either AFC or FLP or both was increased but decreased when heritability of FCI was increased.

Table-1: Estimates of heritability, genetic and phenotypic correlations among three traits and relative economic values.

Traits	AFC	FLP	FCI	Relative economic value (ai)(Rs.)
Age at first calving(months) (AFC)	0.105	-0.694	0.362	-100.00
First lactation milk production (kg) (FLP)	0.036	0.169	0.374	0.50
First calving interval(days) (FCI)	0.116	0.255	0.284	-5.00

Note: The underlined elements on principal diagonal are heritability estimates of the three traits; elements above principal diagonal are genetic correlations and elements below the principal diagonal are phenotypic correlations.

Table-2(a) : Genetic variance-covariance matrix.

	AFC	FLP	FCI
AFC	5.078	-438.88	45.91
FLP		78754.0	5907.0
FCI			3168.0

Table-2(b) : Phenotypic variance-covariance matrix.

	AFC	FLP	FCI
AFC	48.366	170.910	90.09
FLP		465998.000	19439.00
FCI			12471.00

Note: AFC : Age at first calving (months)
FLP : First lactation milk production (kg)
FCI : First calving interval (days)

Increase in genetic correlations between AFC and FLP resulted in decrease in absolute value of relative weights for AFC as well as that of FCI. The accuracy of the index (r_{HI}) was slightly increased. The absolute value of genetic gain for AFC and FLP increased whereas absolute value of genetic gain for FCI decreased. Effect of increase in genetic correlation between AFC and FCI and that between FLP and FCI on selection index and the genetic gain in H and the genetic gain in the component traits was similarly studied. Milk production as also the total gain in H increased to the greatest extent when there was increase in genetic correlation between AFC and FLP whereas increase in genetic correlation between FLP and FCI decreased the genetic gain in FLP and H.

Regression of life-time milk production (LTP) (upto 10 years) on AFC was -244.11 ± 26.685 kg/month, on FLP was 3.10 ± 0.28 kg/kg and on FCI was -4.44 ± 2.08 kg/day. The coefficient of determination (R^2%) of fitting these regression models was 26.4, 34.7 and 2.0% respectively. Fitting of multiple regression of LTP on the three independent traits taken two at a time and all the three at a time gave the maximum R^2-value of 52.0% for the three traits followed by 47.0% when AFC and FLP were considered as independent traits. The fitting of simple regression of LTP on selection index considering all the three traits in the index gave R^2-value of 30.7%. The regression of LTP on selection index considering the two traits AFC and FLP gave the highest R^2-value of 51.2%. It is, therefore, inferred that selection index based on age at first calving (AFC) and first lactation production would give the maximum response in lifetime production.

SUMMARY

Effect of variation in relative economic values, heritability and genetic correlations, on selection index coefficients, accuracy of selection index, genetic gain in individual traits and expected genetic gain in net hereditary merit due to selection being based on selection index was studied in Tharparkar cattle. Predictability of selection index for lifetime production (LTP) was compared with that for multiple regression method incorporating three early traits viz., Age at first calving (AFC), First lactation milk production (FLP) and First calving Interval (FCI) in all possible combinations. Among the three traits considered a given percent change in relative economic value of AFC had more impact on total genetic gain in net hereditary merit, followed by FCI and FLP. Gain in net hereditary merit was highest when the heritability of FCI was increased followed by that for FLP and AFC. Total gain in net hereditary merit was found to be maximum when there was increase in genetic correlation between AFC and FLP whereas increase in genetic correlation between FLP and FCI lowered the expected genetic gain in FLP and expected genetic gain in net hereditary merit. Predictability of selection index for lifetime milk production was generally low as compared to that obtained by fitting multiple linear regression equations on the three traits.

ZUSAMMENFASSUNG

Der EinfluB der Variation in relativen ökonomischen Werte, Voraussagbarkeit und genetische Korrelationen auf Selektionsindexkoeffiziente, Genauigkeit des Selektionsindexes, der genetische Gewinn in individuellen Erbmerkmalen und der erwartete genetische Gewinn an Nettoerbwert wegen der Selektion durch Selektionsindex wurde in Tharparkar Rindvieh untersucht. Die Voraussagbarkeit des Selektionsindexes für lebenslangliche Leistung wurde mit der für vielfache Regressionsmethode mit drei früheren Erbmerkmalen, nämlich, Lebensalter bei Erstabkalbung (LbE), Milchleistung in der ersten Laktation (MeL) und erste Abkalbungszwischenzeit (AzZ) mit allen möglichen Kombinationen verglichen. Unter den drei betrachteten Erbmerkmalen hatte ein gegebener Prozentwechsel in relativem ökonomischem Wert des LbE einen größeren EinfluB auf den gesamten genetischen Gewinn an Nettoerbwert, danach kommen die erste AzZ und die MeL. Der Gewinn an Nettoerbwert war am höchsten, wenn die Erblichkeit der AzZ erhöht wurde, danach kamen der für MeL und der LbE. Der gesamte Gewinn an Nettoerbwert war maximal, wenn es eine Zunahme in genetischer Korrelation zwischen LbE und MeL gab. Aber eine Zunahme in genetischer Korrelation zwischen MeL und AzZ verringerte den erwarteten genetischen Gewinn an MeL und den erwateten genetischen Gewinn an Nettoerbwert. Die Voraussagbarkeit des Selektionsindexes für die lebenslängliche Milchproduktion war gewöhnlich niedrig, im Vergleich zu der Voraussagbarkeit, die durch das Einpassen der mehrfachen linearen Regressionsgleichung auf die drei Erbmerkmale gewonnen war.

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