Jour. Ind. Soc. Ag. Statistics
Vol. XXXVIII; No. 3 (1986), pp. 363-369

THE VALUE OF BLOOD GROUP INFORMATION IN PREDICTING BREEDING VALUE OF QUANTITATIVE TRAITS IN DAIRY CATTLE AND BUFFALOES

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(Received : January, 1981)

SUMMARY

The importance of blood group information in predicting breeding value of the quantitative traits in dairy animals has been studied in this investigation. From the accuracies of indirect selection obtained from the data on dairy cattle and buffaloes, it can be concluded that blood group information can be used with advantage for making preliminary selection only when the heritability of the trait is less than or equal to 0.1 and percentage genetic variation controlled by blood group loci is beyond 5 percent.

Keywords : Heritability; genetic variation; progeny performance.

1. Introduction

Information on blood groups, *inter alia* might be of use in selection of dairy animals either singly or in combination with information on quantitative traits provided there is a significant association between blood group antigens and the biometrical traits (Neimann-Sorensen and Robertson, [1]; Singh, [2]). When selection can be effected on the basis of blood group information alone then it would mean avoiding infructuous expenditure in maintaining the animals for long as this information is available right at the birth of the individuals. And when the quantitative character under selection is lowly heritable, information on blood antigens can suitably be combined in the form of an index to enhance the accuracy of selection. The aim of this paper is to evaluate the usefulness of blood group information in selection of dairy animals for quantitative traits.

2. Methodology

2.1 Selection on the Basis of Blood Group Information

Suppose the information from the blood group leads us to make a prediction, B, of the breeding value (A) of an animal for some quantitative character, X. We then consider the population to have been broken up into two groups, having and lacking the blood group antigens. Let σ_B^2 be the variance contributed by the blood group comparisons. The accuracy of this indirect selection for A on the basis of B is given by (Neimann-Sorensen and Robertson, 1961)

$$r_{AB} = \frac{h_b}{h} = \frac{\sigma_B}{\sigma_A}$$

where

$$h_b^2 = \frac{\sigma_B^2}{\sigma_X^2} \text{ and } h^2 = \frac{\sigma_A^2}{\sigma_X^2}$$

i.e. h_b^2 is the proportion of the total variance contributed by the blood group loci and h^2 is the heritability of the character X.

The accuracy of indirect selection relative to the selection based on individual's own performance, X, therefore is

$$E_1 = \left(\frac{\sigma_B}{\sigma_A}\right)\Big/ h \tag{1}$$

And the accuracy of indirect selection relative to selection based on mean performance of its n-progeny ($\bar{o}$) is

$$E_2 = \left(\frac{\sigma_B}{\sigma_A}\right)\Big/\sqrt{\frac{n}{n+a}},\ a = \frac{4-h^2}{h^2} \tag{2}$$

This comparison is important when the character is sex-limited as in case of males in dairy cattle.

The importance of blood group information in addition to h^2 and n depends upon the proportion of genetic variation contributed by the blood group loci i.e. σ_B^2/σ_A^2. Indirect selection is of value when σ_B^2/σ_A^2 approaches the heritability of the quantitative character in question.

2.2 Selection on the Basis of Index

The information on blood groups can be combined with that on production trait in the form of an index to enhance the accuracy of selection. That is, the selection can be based on the index

$$I_1 = a_1 B + a_2 X$$

where a's are the regression coefficients in the prediction of breeding value, A and are equal to (Neimann-Sorensen and Robertson, 1961)

$$a_1 = \frac{1 - h^2}{1 - h_b^2} \text{ and } a_2 = \frac{h^2 - h_b^2}{1 - h_b^2}$$

The accuracy of index selection is then given by

$$r_{AI_1}^2 = h^2 + \frac{h_b^2 (1 - h^2)^2}{h^2 (1 - h_b^2)}$$

For small values of h_b^2, this simplifies to

$$r_{AI_1} = h \left(1 + \tfrac{1}{2} \frac{h_b^2}{h^4} \right)$$

$$= h \left(1 + \frac{1}{2h^2} \frac{\sigma_B^2}{\sigma_A^2} \right)$$

Hence the increase in the accuracy of selection relative to individual selection is

$$\Delta_{r(I_1)} = \frac{1}{2h^2} \frac{\sigma_B^2}{\sigma_A^2} \tag{3}$$

For sex-limited character the selection can be based on the index

$$I_2 = b_1 B + b_2 \overline{O}$$

in which $\overline{O}$ is the mean performance of n progeny, and the b's are equal to

$$b_1 = \frac{ah^2}{(a + n)h^2 - nh_b^2}, \quad b_2 = \frac{2n(h^2 - h_b^2)}{(a + n)h^2 - nh_b^2}$$

The correlation between the index I_2, and the breeding value, A, can be shown equal to

$$r_{AI_2} = \frac{(a - n)\, h_b^2 + nh^2}{[(a^2 - 2n^2)\, h^2 h_b^2 + n\,(n - a)\, h_b^4 + n\,(n + a)\, h^4]^{1/2}}$$

$$\simeq \sqrt{\frac{n}{n + a}} \left[1 + \frac{a^2 h_b^2}{2n\,\{(n + a)\, h^2 - nh_b^2\}} \right] \text{ for small values of } h_b^2$$

$$= \sqrt{\frac{n}{n + a}} \left[1 + \frac{8}{n^2 h^4} \left(\frac{n}{n + a} \right) \left(\frac{\sigma_B^2}{\sigma_A^2} \right) \right]$$

So the increase in accuracy of index selection relative to that based on progeny performance is

$$\Delta_{r(I_A)} = \frac{8}{n^2 h^4} \left(\frac{n}{n+a}\right) \left(\frac{\sigma_B^2}{\sigma_A^2}\right) \quad (4)$$

3. Results and Discussion

In the study on association between blood group antigenic factors and biometrical traits, Singh *et al.* [3] reported the variance controlled by the blood group loci in four breeds of cattle and three breeds of buffaloes. The estimates of percentage genetic variation controlled by the blood group loci (σ_B^2/σ_A^2) obtained as per the procedure given in Neimann-Sorensen and Robertson [1] and the heritability (h^2) for different characters for the same herds are presented in Tables 1 and 2 respectively. Excepting in few cases the percentage genetic variation explained by blood

TABLE 1—GENETIC VARIATION (IN PERCENTAGE) CONTROLLED BY THE BLOOD GROUP LOCI (σ_B^2/σ_A^2)

Character	*Cattle*				*Buffalo*		
	Hariana	*Tharparkar*	*Sahiwal*	*Red Sindhi*	*Murrah*	*Nili*	*Surti*
Weight at birth	3.25	0	—	—	0	4.96	0
Age at first calving	10.55	6.11	3.76	0	0	7.76	8.97
Gestation period	1.92	0	0	0	6.13	0	0
Lactation length	1.77	4.89	0	6.14	5.71	0	0
Total milk yield of the lactation	8.68	0	2.82	11.63	0	0	2.66
First 300 days milk yield	8.74	0	2.02	11.36	—	—	—
Dry period	9.57	1.35	0	1.93	8 00	0	0
Fat content (%)	7.77	—	—	—	—	—	—

0 = negligible, — = not available

group loci in different characters is less than 7 per cent and almost all the estimates of heritability lie between 10 to 50 per cent. In case of Hariana breed the blood group loci are contributing in the genetic variation for

TABLE 2—ESTIMATES OF HERITABILITY OF DIFFERENT CHARACTERS FOR DIFFERENT BREEDS OF CATTLE AND BUFFALOES

Character	*Cattle*				*Buffaloes*		
	Hariana	*Tharparkar*	*Sahiwal*	*Red Sindhi*	*Murrah*	*Nili*	*Surti*
Weight at birth	.19 ± .14	.04 ± .12	—	—	.25 ± .17	.15 ± .14	.17 ± .13
Age at first calving	.30 ± .17	.41 ± .29	.46 ± .23	.33 ± .36	.68 ± .27	.42 ± .42	.08 ± .18
Gestation period	.04 ± .08	.01 ± .11	.21 ± .17	.17 ± .32	.16 ± .11	.19 ± .65	.17 ± .28
Weight of calf at birth	.02 ± .10	.21 ± .17	—	—	—	—	—
Lactation length	.16 ± .13	.59 ± .25	.31 ± .20	.39 ± .54	.26 ± .13	.16 ± .32	.18 ± .28
Total milk yield of the lactation	.34 ± .22	.47 ± .23	.37 ± .28	.42 ± .62	.34 ± .14	.44. ± .15	.39 ± .19
First 300 days milk yield	.32 ± .29	.59 ± .34	.56 ± .29	.45 ± .62	—	—	—
Dry period	.21 ± .17	.28 ± .20	.21 ± .18	.34 ± .36	.14 ± .10	.24 ± .35	.24 ± .57
Fat content	.33 ± .18	—	—	—	—	—	—

all the biometrical characters under study. In other breeds of cattle and buffaloes, no variation is being controlled by blood group loci in about 50% of the characters. No definite trend is seen in the variation in different characters for various breeds in both cattle and buffaloes, and the amount of variation was more or less of the same order among different breeds of dairy animals considered except that it was lowest for Sahiwal.

The values of accuracy of indirect selection based on the blood group information relative to the selection based on individual's own performance as well as relative to selection based on the mean performance of individual's progeny were estimated for different values of h^2, n and σ^2_B/σ^2_A. The examination of these values showed that the accuracy of indirect selection increases with the increase in the value of σ^2_B/σ^2_A and decreases with the increase in the value of either h^2 or n or both. For instance, when σ^2_B/σ^2_A is around 8% and $h^2 = 0.25$, the indirect selection is 56% as efficient as the individual selection and 70 to 40% as efficient as the progeny test based on 5 to 15 daughters. When h^2 is low (say, 0.1) the accuracy of indirect selection increases to 89% of that of individual selection and 80 to 50% of that of progeny test for the same value of σ^2_B/σ^2_A (= 8%). For lower values of σ^2_B/σ^2_A the accuracy of indirect selection based on blood group information is very much less than the two types of direct selection.

From the values of gain in accuracy due to index selection relative to selection based on own performance as well as on progeny performance computed for different values of the parameters involved it was seen that the blood group information is useful only in situations when the quantitative trait is lowly heritable, the size of sire family is small and the contribution of blood group loci controlling the genetic variation in the quantitative trait is moderately large. For instance, when h^2 is 0.1, the increase in accuracy of index selection relative to individual selection is 40% when σ^2_B/σ^2_A is 8% which decreases to 10% when σ^2_B/σ^2_A is 2%. When h^2 is moderate, say, 0.25 the increase in accuracy of index selection relative to individual selection is only 11% even when σ^2_B/σ^2_A is as high as 8%. Similar results hold for index selection relative to selection based on progeny test.

In conclusion, blood group information can be used with advantage for making preliminary selection only when the heritability of the trait is less than or equal to 0.1 and the percentage genetic variation controlled by blood group loci is beyond 5 per cent. Except among Surti buffaloes and that too for age at first calving these conditions are rarely true for other breeds of dairy cattle. This means that blood group information has very little value in predicting breeding value of any of the important quantitative trait in dairy cattle. This finding is in conformity with that of Neimann-Sorensen and Robertson [1].

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