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Selective Value, Quantification and Genetic Parameters of Components of Replacement Traits in Crossbred Cattle

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ABSTRACT

A total of 1480 calving records from crossbred cattle maintained at Instructional Dairy Farm of the University covering a period of 9 years (1994-2002) were used to study the genetic parameters of replacement rate and its components. The Heritability estimates for sex ratio, abortion, still birth, mortality, culling, replacement rate on female calf bases and on total pregnancies bases were observed very low for all the traits. The genetic and phenotypic correlations among all these traits were observed from medium to very high. Out of total losses about 71.50% of the cows were died and 28.50% were culled during the entire period of study. Quantification of different components of replacement rate showed that range of incidence of prenatal losses was 0.0-17.18 and 0.0-11.69% respectively. In case of male birth, mortality and culling were ranged from 0.0-100%. Quantification of replacement rate on the bases of female calves born and on the bases of total pregnancies were observed 0.0-60%. The replacement index in this study during different periods ranged from 0.90 (1999) to 2.39 (2002). The replacement index was found more than one during all periods from 1994 to 2002 except 1999 which indicate that the herd size increased during these periods. This showed that the number of heifers calving compensated the loss of cows from the herd. However, the ratio of the number of heifers calving to the number of cows lost was found to be little higher than one (i.e. 1.37) which showed addition in the herd size.

KEYWORDS: Replacement rare; Sex ratio; Culling; Mortality; Heritability; Quantification; Replacement index.

INTRODUCTION

The replacement rate is an important parameter in dairy cattle breeding. It is function of number of births, sex ratio, prenatal losses and loss of young females due to their death and culling till they attain maturity. Replacement rate in a cow herd is the function of calf production, which is influenced by incidences of abnormal births, sex ratio, post natal mortality and culling of heifers from birth to the age at first calving.[1] The number of replacements heifers is the most important aspect to the advantage of culling inferior females. The genetic gain to a great extent depends on the heritability of the trait and intensity of selection which mainly depends on the number of replacement heifers entering the herd.[2]

The culling of low producing cows depends upon the number of heifer replacements becomes available in many years. The number of cows lost from the herd due to their death and culling for various reasons should be replaced each year by equal number of heifers entering in the milking herd so as to maintain the herd size. The information on the maintenance of herd size in an organized herd of zebu cattle is not available. Formulation and operating the breeding plan for genetic improvement require such information. But even that information is scanty on these aspects. The present investigation was therefore, conducted to study the genetic parameters of replacement components, quantification of replacement rate and replacement index in a herd of crossbred cattle.

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METHODS AND MATERIALS

The data used in this study was collected from records of 1480 crossbred cows maintained at the Instruction Dairy farm of the University during the period of 1994 to 2002. The management practices regarding feeding schedule, housing, and breeding policy were more or less standardized at the farm. The data were classified into 9 years and each year was again divided into three seasons *viz*. winter (November-February). Summer (March-June) and Rainy (July-October) based on climatic conditions. The different components of the replacement rate were considered as losses due to abnormal births, frequency of male births, mortality, culling rate and reaching to herd. The animals expressing the trait, i.e. showing susceptibility to reproductive disorder were assigned the value of one, while to those which were not affected to the reproductive disorder/ components of replacement rate were assigned the value as zero. The data were analyzed to study the effect of different factors on all the components of replacement rate through the least squares analysis of variance.[3] The Heritability, genetic and phenotypic correlations were estimated from paternal half sib correlation method.[4] For Quantification of the traits all the calves were grouped sire wise. The chi square test was used to test the significance of differences for observed frequency of sires among different classes. The replacement index was worked out after Ram and Tomar from the following formula:[5]

$$\text{Replacement Index: } \frac{\text{Number of heifer calving in any year or period}}{\text{Number of cows which left the herd in any year or period}}$$

RESULTS

The Heritability estimate for the sex ratio was found to be very low (0.020±0.031). The heritability estimates for abortion and still birth were found to be 0.031±0.033 and 0.063±0.039 (Table 1) respectively. The heritability estimate for mortality rate upto age at first calving was found very low (0.096±0.046). The heritability estimate for culling rate was found to be very low (0.038±0.034). The heritability estimates for replacement rate on two bases, first is on female calf basis and second on total pregnancies bases were found to be 0.087±0.044 and 0.047±0.036, respectively.

The genetic correlation of sex ratio with abortion was observed positive with higher standard error (Table 1). The genetic correlation of sex ratio with still birth was also observed positive. The genetic correlation of sex ratio with mortality upto age at first calving was recorded negative with lower magnitude and with higher standard error. The genetic correlation of sex ratio with culling rate was recorded positive with high standard error. The genetic correlation of sex ratio with replacement rate on female calf bases was positive while on total pregnancies bases were observed negative.

The genetic correlation of abortion with still birth was found negative, which indicates that abortion do not have association with still birth. The genetic correlation of abortion and mortality and culling rate were observed positive with low magnitude, while the genetic correlation of abortion with replacement rate on female calf basis and on total calf bases were observed negative.

The genetic correlations of still birth with mortality and calling were found positive, while with replacement rate on female calf basis and on total pregnancies bases were highly negative. The genetic correlations of mortality with culling and replacement rate on female calf bases and on total pregnancies basis were observed negative. The genetic correlations of culling rate with replacement rate on female calf bases and on total pregnancies bases were observed negative with high standard error. The genetic correlations between replacement rate on female calf basis and on total pregnancies basis were positive.

The phenotypic correlations of sex ratio with abortion, mortality and replacement rate on the bases of female calf and on the basis of total pregnancies were found to be positive. While with still birth and culling rate, the phenotypic correlations were observed negative (Table 1). The phenotypic correlation of abortion with still birth, culling rate and replacement rate were found negative with low magnitude, while with mortality was found positive with medium magnitude. Still birth has negative phenotypic correlations with culling and replacement rate (Table 1), however, with mortality phenotypic correlation was observed positive. The phenotypic correlations of mortality with culling rate and replacement rate were observed negative. The phenotypic correlations between culling rate and replacement

Traits		Sex ratio	Abortion	Still birth	Mortality	Culling	Reaching to herd	
							A	B
Sex ratio		**0.020±0.031**	0.910±1.217	1.074±0.922	-0.184±0.642	0.187±1.00	-0253±0.720	0.089±0.641
Abortion		0.097±0.157	**0.031±0.033**	-0.448±0.643	0.060±0.525	0.142±0.752	-0.377±0.734	-0.151±0.571
Still birth		-0.027±0.158	-0.087±0.158	**0.063±0.039**	0.555±0.334	0.216±0.573	-0.298±0.528	-0.563±0.433
Mortality		0.021±0.158	0.319±0.149	0.234±0.154	**0.096±0.046**	-0.100±0.526	-0.524±0.576	-0.843±0.497
Culling		-0.370±0.147	-0.145±0.156	-0.116±0.157	-0.418±0.144	**0.038±0.034**	-0.612±0.752	-0.328±0.579
Reaching to herd	**A**	0.528±0.134	-0.162±0.156	-0.107±0.157	-0.512±0.136	-0.261±0.153	**0.047±0.036**	0.853±0.165
	B	0.318±0.149	-0.215±0.154	-0.151±0.156	-0.680±0.116	-0.356±0.148	0.746±0.105	**0.087±0.044**

Table 1: Heritability (on the diagonal), genetic (above the diagonal) and phenotypic (below the diagonal) correlations among different components of replacement rate.

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rate were observed negative with medium magnitude. The phenotypic correlation between replacement rate on the female calf bases and on total pregnancies bases was observed positive.

The results presented in the Table 2 showed that the mates of 21 sires out of 42 total sires (50%) used for breeding had incidence of abortion. The incidence of abortion among the mates of 21 sires averaged 7.77% with a range from 0.0-17.18%. The overall birth was observed to be 4.73 with a range from 0.0-11.69% among the progeny of different sires. The overall sex ratio (% male birth) was observed to be 100% with a very wide range from 0-100% among the progeny of different sires. The mates of 38 sires out of the total 42 sires (90.48%) used for breeding had incident of mortality. The mortality among the mates of 38 sires averaged 45.60% with a range from 0.0 to 100%. The mates of 31 sires out of the total 42 sires (73.81%) used for breeding had showed incident of culling. The average culling rate among the mates of 31 sires was 18.18% with a range from 0 to 100%. The overall replacement rates on bases of female calves born and on total pregnancies were observed as 26.60 and 36.49% with range of 0 to 60% and 0 to 60% respectively.

The average mortality rate was observed 42.66% which ranged between 29.79 to 58.19% over the years. However, the differences were not significant. The average culling rate was observed 16.28% in this herd and ranging from 0.0 to 30.97% among periods.

The overall replacement index in the herd over 9 years period based on 1295 heifers calving and 944 cows which left the herd due to their death or culling was found to be 1.37. However, the ratio of the number of heifers calving to the number of cows lost was found to be little higher than one (i.e. 1.37). The reduction in herd size was observed only during the period 1999. (Table 3)

DISCUSSION

The heritability estimates for the sex ratio was found to be very low (0.020±0.031) and hence the additive genetic variability was very less in this trait and sex ratio cannot be changed by genetic manipulation. The low estimate of heritability of sex ratio cannot be changed by genetic manipulation. The low estimate of heritability of sex ratio has also been reported by Arun *et al*., Rawal, Arun *et al*., Lathwal and Arun and Singh and Singh in case of cattle.[6-10] The heritability estimates for abortion and still birth were found to be very low (0.031±0.033 and 0.063±0.039) respectively. These estimates indicated that there was no additive genetic variability in abortion and still birth. The low heritability estimates of abortion and still birth have also been reported by Rawal and Singh and Singh in crossbred cattle.[7,10]

The heritability estimate for mortality rate upto age at first calving was found very low (0.096±0.046). Parekh and Singh and Singh *et al* also reported zero heritability of mortality during calf hood and Lathwal and Arun from birth to age at first calving.[9,11,12] Rawal for Sahiwal and Tharparkar, and Singh

Traits		No. of sires whose progeny/mates				No. of records			Range of incidence (%) among progeny of different sires
		Expressed the traits		Not Expressed the traits		Expressed the traits		Not Expressed the traits	
		No	%	No	%	No	%		
Abortion		1	50.0	21	50.0	115	7.77	1365	0.0-17.18
Still birth		8	42.86	24	57.14	70	4.73	1410	0.0-11.69
Male birth		2	100.0	00	00	762	51.49	718	0.0-100.0
Mortality		8	90.48	4	9.52	675	45.60	805	0.0-100.0
Culling		1	73.81	11	26.19	269	18.18	1211	0.0-100.0
Reaching to herd	A	5	17	17	40.48	394	26.62	1086	0.0-60.0
	B	9	13	13	30.95	540	36.49	940	0.0-60.0

Table 2: Selective value and quantification of different components of replacement traits.

Period	Heifer calving	Total normal birth	No. of cows		Total loss	Replacement Index
			Died	Culled		
1994	40	47	14(29.79)	5(10.69)	19(40.43)	2.11
1995	168	184	56(30.43)	57(30.97)	113(61.41)	1.49
1996	224	250	128(51.2)	27(10.8)	155(62.0)	1.46
1997	152	161	49(30.43)	29(18.02)	78(48.45)	1.95
1998	186	106	107(51.94)	47(22.82)	154(74.76)	1.21
1999	169	232	135(58.19)	52(22.41)	187(80.60)	0.90
2000	121	143	73(51.05)	25(17.48)	98(68.53)	1.23
2001	192	209	95(45.45)	27(12.92)	122(58.37)	1.57
2002	43	48	18(37.5)	0(0)	18(37.5)	2.39
Overall	1295	1480	675	269	944	1.37

Figures in parenthesis are the percentage

Table 3: Average rate of mortality and culling of adult crossbred cows, calvings of heifer and replacement index in different periods.

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and Singh for crossbred and Sahiwal cattle were also reported low heritability of mortality while Mukherjee and Tomar and Kulkarni *et al* reported moderate heritability of mortality in case of crossbred cows.[10,13,14] The heritability estimate for culling rate was found to be very low (0.038±0.034). Mukharjee and Tomar and Lathwal and Arun Goshu and Singh reported higher heritability estimates than the present study.[9,13,15]

The heritability estimates for replacement rate on two bases, first is on female calf bases and second on total pregnancies bases were found to be 0.087±0.044 and 0.047±0.036, respectively. Lathwal and Arun reported that the heritability estimate for replacement rate based on female calf bases was higher (0.235) than based on total pregnancies (0.103) for Red Sindhi herd. Mukharjee and Tomar also reported same trend.[9,13]

The genetic correlation of sex ratio with abortion was observed positive with higher standard error, which indicates that type of sex affected the incidence of abortion. The genetic correlation of sex ratio with still birth was also observed positive. The genetic correlation of sex ratio with mortality upto age at first calving was recorded negative with lower magnitude and with higher standard error. The genetic correlation of sex ratio with culling rate was recorded positive with high standard error. The genetic correlation of sex ratio with replacement rate on female calf basis was positive while on total pregnancies basis was observed negative.

The genetic correlation of abortion with still birth was found negative, which indicate that abortion do not have association with still birth. The genetic correlation of abortion with mortality and culling rate were observed positive with low magnitude, which indicates that abortion have positive association with these traits while the genetic correlations of abortion with replacement rate on female calf basis and on total calf bases were observed negative.

The genetic correlations of still birth with mortality and calling were found positive while with replacement rate on female calf basis and on total pregnancies bases were negative. The genetic correlations of mortality with culling and replacement rate on female calf basis and on total pregnancies bases were observed negative. The genetic correlations of culling rate with replacement rate on female calf basis and on total pregnancies basis were observed negative with high standard error. The genetic correlations between replacement rate on female calf bases and on total pregnancies bases were positive. These results are in close agreement with the reports of Singh and Singh.[10]

The phenotypic correlations of sex ratio with abortion, mortality and replacement rate on the basis of female calf and on the bases of total pregnancies were found to be positive. While with still birth and culling rate, the phenotypic correlations were negative.

The phenotypic correlations of abortion with still birth, culling rate and replacement rate were found negative with low magnitude, while with mortality was found positive with medium magnitude. Still birth have negative phenotypic correlations with culling and replacement rate. However, with mortality phenotypic correlation was observed positive. The phenotypic correlations of mortality with culling rate and replacement rate were observed highly negative. The phenotypic correlations between culling rate and replacement rate were observed negative with medium magnitude. The phenotypic correlations between replacement rate on the female calf basis and on total pregnancies basis were observed highly positive. These results indicate that mostly components of replacement rate have negative correlation which reveals that these traits do not have influence on each other. Singh and Singh, Sneha *et al* and Singh *et al* also reported that out of total loss of 675(28.5%) cows were culled due to various reasons.[10,16,17] Reddy and Nagarcenkar reported 19 percent of the total losses in adult cows due to the death in Sahiwal cows.[18] Rawal *et al* reported that out of the total losses during a period of 39 years, 13.1% were attributed to the death of cows and 86.9% were due to their culling in *Sahiwal* herd.[19]

The average mortality rate was observed 42.66% which ranged between 29.79 to 58.19% over the years. However, the differences were not significant. The average culling rate was observed 16.28% in this herd and ranging from 0 to 30.97% among periods. The variation in culling rates due to periods was not significant. Lathwal reported the annual mortality and annual culling rate as 2.1 and 20.7%, respectively in a herd of *Red Sindhi* cows for a period of 36 years with significant effect of years on culling rate.[20] It can also be further seen that the total losses including death and culling of cows amounted 59.12%. Menjo et al concluded that 25% of the Holstein Friesian cattle born on the Kenyan large scale farms were lost before reaching to a productive age, indicating the limitations of such animals' adaptability to the prevailing environmental conditions.[21] Moreover, Moran reviewed 17 studies documented on mortality of calves in Asia, tropical Africa and south America and summarized that pre-weaning calf mortality ranged from 15 to 25% and often as high as 50%.[22] This showed that about half of the total cows left the herd each year due to their death or culling.

The overall replacement index in the herd over 9 years period based on 1295 heifers calving and 944 cows which left the herd due to their death or culling was found to be 1.37. This showed that the number of heifers calving compensated the loss of cows from the herd. However, the ratio of the number of heifers calving to the number of cows lost was found to be little higher than one (i.e. 1.37) which showed addition in the herd size. The reduction in herd size was observed only during the period 1999. The replacement index in this study during different periods ranged from 0.90 (1999) to 2.39 (2002). However, the overall replacement index has been reported as 0.84 in *Red Sindhi* herd by Lathwal and overall replacement index was nearly one reported by Rawal *et al* and Sneha *et al*.[16,19,20]

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CONCLUSION

The Heritability estimates for sex ratio, abortion, still birth, mortality, culling, replacement rate on female calf bases and on total pregnancies basis were observed very low for all the traits. The genetic and phenotypic correlations among all these traits were observed from medium to very high. Out of total losses about 71.50% of the cows were died and 28.50% were culled during the entire period of study. Quantification of different components of replacement rate showed that range of incidence of prenatal losses were 0.0-17.18 and 0.0-11.69% respectively. In case of male birth, mortality and culling were ranged from 0.0-100%. Quantification of replacement rate on the bases of female calves born and on the bases of total pregnancies were observed 0.0-60%. The replacement index during different periods ranged from 0.90 (1999) to 2.39 (2002). These results indicate that mostly components of replacement rate have negative correlation which reveals that these traits do not have influence on each other.

CONFLICTS OF INTEREST: None.

REFERENCES

1. Banik S, Naskar S. Effect of non-genetic factors on replacement rate and its components in Sahiwal cattle. *Indian J Anim Sci*. 2006; 76(4): 34-345.

2. Rawal SC, Tomar SS. Population analysis for loss of cows and replacement index in Tharparkar cattle. *Indian J Anim Sci*. 1998; 68(2): 183-184.

3. Harvey WR. Least squares analysis of Data with unequal subclass numbers. Revised Monograph, Res. Service, U.S.A.D. Maryland. H.4, 1975.

4. Becker W A. Manual of Procedures in quantitative genetic. Washington State University**.** 1964.

5. Ram R C, Tomar S S. Replacement index in Murrah buffaloes. *Indian J Dairy Sci*. 1993; 3: 135-136.

6. Kumar A, Lavania GS, Tomar S S. Genetic variability in the rate of abnormal parturitions in crossbred cattle. *SARRASJ Livest and Poult Prod*. 1991; 7: 34-39.

7. Rawal SC. Coefficient of gene replication in zebu cattle. Thesis, M.Sc. Kurukshetra Univ. Kurukshetra. 1991

8. Kumar A, Lavania GS,Tomar SS. Genetic parameters of sex ratio in crossbred cattle. *Indian J Dairy Sci.* 1993; 27: 41-42.

9. Lathwal SS, Kumar A. Genetics of replacement rate and its components in Red Sindhi Cows. *Indian Vet J*. 1994; 71(9): 892-896.

10. Singh CV, Singh RV. Genetic parameters of different reproductive disorders in crossbred and Sahiwal cattle. *Indian J Anim Sci*. 1998; 68: 494-495.

11. Parekh HKB, Singh A. Mortality pattern in crossbreds of Gir with Friesian and Jersey sire. *Indian J Anim Sci*. 1981; 51: 419-424.

12. Singh A, Taylor CM, Gurung BS, Singh K P. Factors affecting secondary sex ratio in Gir cattle. Livestock Adv. 1983; 8(1): 5-9.

13. Mukherjee K, Tomar SS. Genetics of female calf losses upto maturity and replacement rate in crossbred cattle. *Indian J Dairy Sci*. 1997; 50: 473-476.

14. Kulkarni MB, Narawade VE, Deshmukh VD, Kaledhonkar DP. Evaluation of sire on the basis of mortality in offspring and its heritability estimates in (BFC) triple crosses. *Indian J Anim Res*. 1997; 31: 59-60.

15. Goshu G, Singh H. Genetic and non-genetic parameters of replacement rate component traits in Holstein Friesian cattle. *Springerplus*. 2013; 2: 581. doi: 10.1186/2193-1801-2-581

16. Pandey S, Singh CV, Barwal RS, Singh CB. Factors Affecting Replacement Rate and its Components in Crossbred Cattle. *Indian J Dairy Sci*. 2012; 65(3): 234-238.

17. Singh CV, Dhirendra K, Kumar D, Harpal S. Genetic and non genetic variations in components of replacement rate in crossbred and Sahiwal cattle. *Indian J Dairy Sci*. 2002; 55(4): 244-246.

18. Reddy KM, Nagrcenkar R. Studies on disposal pattern in sahiwal calves. *Indian J Dairy Sci*. 1989; 42: 280-288.

19. Rawal SC, Tomar SS, Sachdeva GK. Replacement index in a herd of Sahiwal cows. *Indian J Ani Res*. 1994; 28: 97-100.

20. Lathwal SS. Lifetime calf production traits of Red Sindhi cows. M.Sc. Thesis, Kurukshetra University, Kurukshetra. 1989.

21. Menjo DK, Bebe BO, Okeyo AM, Ojango JMK. Survival of Holstein-Friesian heifers on commercial dairy farms in Kenya. *Appl Anim Husb Rural Dev*. 2009; 2: 14-17.

22. Moran JB. Factors affecting high mortality rate of dairy replacement calves and heifers in the tropics and strategies for their reduction. *Asian-Australian J Anim Sci*. 2011; (24)9: 1318-1328. doi: 10.5713/ajas.2011.11099