INTRODUCTION

The calf production is an important factor in dairy farming affecting the overall economy of the herd and the genetic gain. Higher frequency of male birth, abnormal births, higher mortality rate in calf born, reproductive disorder in dairy herd accounts to a great loss to the dairy industry in terms of economic and genetic gain. If the frequency of male calf, abortion, still births, mortality and culling rate in female calf born are higher then fewer replacements are available, which would further reduce the genetic gain as well as the economic return. The replacement rate is an important parameter in dairy cattle breeding. The replacement affects the exploitation of genetic variability of animals because an increase in the number of female replacements increases the intensity of selection which bring more rapid genetic improvement or vice varsa. But even that information is scanty on these aspects. The present investigation was therefore, carried out to study the effect of non genetic factors on some components of replacement rate in crossbred cattle. The culling of low producing cows depends upon the number of heifer replacements becomes available in any 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 crossbred cattle are not available. Formulation and operating the breeding plan for genetic improvement require such information. It was therefore planned to study the replacement index in a herd of crossbred cattle.

 Factors Affecting Replacement Rate and its Components in Crossbred Cattle

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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 components of replacement rate. The sex ratio (% male birth) was found to be 51.49%. The chi square test indicated that the deviation in sex ratio from the normal expected ratio was significant. The differences in frequency of male birth due to sire, season and period of calving were non significant. The incidence of abortion was observed to be 7.77% and the frequency was significantly affected by season and period of calving, while sires have non significant effect. The still birth, was found to be 4.73%, and their frequency were affected by sire and season of calving, while non significantly affected by period of calving. Mortality and culling rate were found to be 45.60% and 18.18% respectively. The effect of season, period and sire were highly significant on mortality rate, while on culling season effect was significant. Percentage of calf reaching to milking herd were found to be 26.62% and 36.49% based on the basis of total pregnancies and on the female calf born basis. The effect of season was recorded significant on the replacement rate on both the basis, while sire causing significant effect only on the replacement rate on the basis of total calf born. The effect of period was recorded non significant in both the cases. Out of total losses about 71.50 per cent of the cows died and 28.50 per cent were culled during the entire period of study. 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.

Keywords: Replacement index, Still birth, Sex ratio, Crossbred
MATERIALS AND METHODS
The data used in this study was collected from records of 1480 crossbred cows maintained at the Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar, during the period of 9 years (1994 to 2002). The management practices regarding feeding schedule, housing and breeding policy were more or less standardized at the farm. All the cows were kept under similar feeding and management practices.

The death and culling records of adult cows and the age at first calving of heifers were recorded from various registers. The mortality and culling rates in different lactations and in different years were worked out. The data were classified into 9 years and each year was again divided into three seasons viz. Winter (Nov-Feb), Summer (March-June) and Rainy (July-Oct) based on climatologically conditions. The different components of the replacement rate were considered as losses due to abnormal birth, frequency of male birth and mortality from birth to age at first calving.

The effect of sire, season and year of calving on the different components of replacement rate were studied by the analysis of variance. The deviation in sex ratio within each level for each effect was also tested separately by the chi square methods. The replacement index was worked out after Ram and Tamar (1993) from the following formula:

\[
\text{Replacement Index} = \frac{\text{No. of heifer calving in any year or period}}{\text{No. of cows which left the herd in any year or period}}
\]

RESULTS AND DISCUSSION
Abortion
The overall incidence of abnormal birth was quite close to the reports of Singh et al. (2002) in case of crossbred cows. However, lower incidence of abortion than in the present investigation was observed by Tomar and Verma (1988b), in different genetic groups of crossbred cows. The analysis of variance indicated that the incidence of abortion was significantly affected by season and period of calving. However, effect due to sire was non significant (Table-2).

It was observed in the present study that incidence of abortion was less among cows which calved during summer (6.34%) than those calved during rainy season (7.87%) and winter season (9.10%) respectively. Tomar and Verma (1988a & b) and Singh et al. (2002) reported that the incidence of abortion was less during winter season than those calved during summer, rainy and autumn season respectively. The differences in the results of present study and reported values of different workers might be due to difference in management practices and genetic make up of the herds under the study.

Still birth
Among 1480 total births the average incidence of still birth was found to be 4.73% (Table 1). Similar incidence of still births have been reported by Tomar and Verma (1988b) and Lathwal et al. (1993). Analysis of variance showed that the incidence of still birth was significantly affected by sires and season of calving (Table 2). While non significant effect of period of calving was observed on incidence of still birth (Table 2). Similar reports have been reported by Tomar and Verma (1988a & b) and Singh et al. (2002).

Sex Ratio
The overall sex ratio (frequency of male calves) among calves in the herd was observed 51.49% (Table 1). The chi square test indicated that the deviation in sex ratio from the normal expected ratio of 50 : 50 was significant. This was in agreement with the findings of Tomar and Verma (1988a). The analysis of variance indicated that sex ratio was not affected by sires (Table 2). A similar result was also reported by Singh et al. (2002).

The sex ratio in the present study varied from 47.03 to 56.03% in different seasons (Table-1). However, the season of calving had no significant effect on the sex ratio in the present study (Table 2). Our findings are in close agreement with the findings of Singh et al. (1983), Lathwal (1993) and Singh et al. (2002) in case of Zebu and crossbred cows. On the other hand, significant effect of season of calving on the sex ratio has been reported by Tomar and Verma (1988a). The year of calving was not a source of variation in sex ratio. The sex ratio of male births born during first to ninth period ranged from 45.2 to 58.19% among progeny of different sires. These results are in close agreement with those reported by Tomar and Verma (1988b).
Singh et al. (1991) and Singh et al. (2002). On the other hand, significant effects of year of calving on sex ratio have been reported by Arun et al. (1992b) and Lathwal et al. (1993). The chi square test showed that the difference in different periods was non-significant for sex ratio. The pregnancy of male births among different periods did not differ significantly. These results are in close agreement with those reported by Tomar and Verma (1988a) who reported that sex ratio was significantly higher during certain years but the percentage of male births among years did not differ significantly.

Mortality rate

It was observed that 45.60% of the total calves born died up to age at first calving (Table 1). A very low mortality rate among crossbred calves (2.2 to 6.0%) has been reported by Tomar and Verma (1988a). Tomar and Verma (1988b) and Lathwal et al. (1993) have been reported to be lower (6.6 to 16.3%). The lower mortality rate (8.3 to 15.4%) than this herd have also been reported by Reddy & Nargar (1989) and Lathwal (1993) for Red Sindhi. While Singh et al. (2002) reported higher mortality rate (40.88%) in Sahiwal & crossbred cows.

The analysis of variance showed that the differences among seasons were highly significant (Table 2). The results of present study showed that mortality rate was highest among calves born during summer (52.27%) and lowest value in winter season (47.45%). The analysis of variance showed that the differences among seasons were highly significant (Table 2). The results of present study showed that mortality rate was highest among calves born during summer (52.27%) and lowest value in winter season (47.45%). The effect due to sire was highly significant on mortality rate. The differences in mortality rate among the calves of different periods were found non-significant (Table 2). The mortality rate varied significantly from 29.79 to 58.19% among different periods. However, significant effect of year on mortality rate has been reported by Tomar and Verma (1988a & b), Rawal & Tomar (1994), Kulkarni et al. (1997) and Singh et al. (2002) for crossbred & Zebu cattle.

Culling rate

It was observed that 18.18% of the total calves born were culled up to age of first calving in the present study (Table 1). While Reddy and Nagar Cenkar (1989) reported culling among calves was 10.64% to 15.36% in Sahiwal & crossbred cows.

Table 1: Effects of genetic and non-genetic factors on components of replacement rate

<table>
<thead>
<tr>
<th>Effects</th>
<th>Total births</th>
<th>Abortion</th>
<th>Still birth</th>
<th>Total normal</th>
<th>Male births</th>
<th>Female births</th>
<th>Chi-square (sex ratio)</th>
<th>Mortality</th>
<th>Culling</th>
<th>Reaching to herd*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No %</td>
<td>%</td>
<td>No %</td>
<td>No %</td>
<td>%</td>
<td>No %</td>
<td></td>
<td>No %</td>
<td>%</td>
<td>A</td>
</tr>
<tr>
<td>Overall</td>
<td>1480</td>
<td>115 (7.77)</td>
<td>70 (4.73)</td>
<td>1295 (86.49)</td>
<td>718 (48.51)</td>
<td>1.308 (1.000)</td>
<td>675 (45.60)</td>
<td>269 (28.5)</td>
<td>394 (26.62)</td>
<td>540 (36.49)</td>
</tr>
<tr>
<td>Season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994 I</td>
<td>47 (6.77)</td>
<td>1 (2.13)</td>
<td>20 (26.52)</td>
<td>21 (4.46)</td>
<td>21 (4.46)</td>
<td>0.541 (1.000)</td>
<td>44 (14.88)</td>
<td>14 (29.79)</td>
<td>5 (10.64)</td>
<td>24 (51.06)</td>
</tr>
<tr>
<td>1995 II</td>
<td>18 (10.43)</td>
<td>6 (3.26)</td>
<td>168 (90.48)</td>
<td>91 (51.09)</td>
<td>227 (128.04)</td>
<td>0.086 (1.000)</td>
<td>56 (30.43)</td>
<td>57 (30.97)</td>
<td>56 (30.43)</td>
<td>71 (38.58)</td>
</tr>
<tr>
<td>1996 III</td>
<td>255 (17.44)</td>
<td>8 (3.2)</td>
<td>224 (45.2)</td>
<td>137 (54.8)</td>
<td>132 (56.49)</td>
<td>2.304 (1.000)</td>
<td>128 (51.2)</td>
<td>27 (10.8)</td>
<td>76 (30.4)</td>
<td>97 (38.8)</td>
</tr>
<tr>
<td>1997 IV</td>
<td>161 (7.34)</td>
<td>1 (0.24)</td>
<td>152 (78.45)</td>
<td>83 (51.55)</td>
<td>49 (30.43)</td>
<td>0.160 (1.000)</td>
<td>49 (30.43)</td>
<td>29 (18.02)</td>
<td>58 (36.02)</td>
<td>83 (51.55)</td>
</tr>
<tr>
<td>1998 V</td>
<td>206 (12.77)</td>
<td>1 (0.24)</td>
<td>186 (8.52)</td>
<td>98 (47.57)</td>
<td>107 (51.94)</td>
<td>0.086 (1.000)</td>
<td>56 (30.43)</td>
<td>27 (10.8)</td>
<td>76 (30.4)</td>
<td>97 (38.8)</td>
</tr>
<tr>
<td>2000 VII</td>
<td>143 (11.09)</td>
<td>9 (6.29)</td>
<td>121 (78.45)</td>
<td>67 (46.85)</td>
<td>73 (51.05)</td>
<td>0.086 (1.000)</td>
<td>48 (29.21)</td>
<td>52 (30.43)</td>
<td>48 (29.21)</td>
<td>20 (6.62)</td>
</tr>
<tr>
<td>2001 IX</td>
<td>48 (2.41)</td>
<td>2 (4.17)</td>
<td>44 (23.74)</td>
<td>25 (52.08)</td>
<td>18 (37.5)</td>
<td>0.084 (1.000)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Table 1: Effects of genetic and non-genetic factors on components of replacement rate

*Reaching to herd A, based on the female calf born and B, on the bases of total pregnancies.

The table shows the effect of genetic and non-genetic factors on components of replacement rate. The chi square test showed that the difference in different periods was non-significant for sex ratio. The pregnancy of male births among different periods did not differ significantly. These results are in close agreement with those reported by Singh et al. (1991) and Singh et al. (2002). On the other hand, significant effects of year of calving on sex ratio have been reported by Arun et al. (1992b) and Lathwal et al. (1993).

The data indicate that the mortality rate varied significantly from 29.79 to 58.19% among different periods. The analysis of variance showed that the differences among seasons were highly significant. The effect due to sire was highly significant on mortality rate. A very low mortality rate among crossbred calves (2.2 to 6.0%) has been reported by Tomar and Verma (1988a). The lower mortality rate (8.3 to 15.4%) than this herd have also been reported by Reddy & Nargar (1989) and Lathwal (1993) for Red Sindhi. While Singh et al. (2002) reported higher mortality rate (40.88%) in Sahiwal & crossbred cows.

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on total pregnancies is \( \frac{1}{4} \), that is to replace one cow 4 pregnancies are required. Tomar and Verma (1988a) reported the replacement rate as 33.8% and 77.1% on the two basis for a herd of Tharparkar and crossbred calves, while Tomar and Verma (1988b) reported 32% and 65% in Karanfries calves. Tomar and Rawal (1998) observed that 33.7% of them turn into replacement heifers. Lathwal and Kumar (1994) reported the replacement rate as 27.5% and 59.6% respectively on the two basis. These results suggest that 3 pregnancies are needed to produce one replacement heifer. The analysis of variance showed that sire had non significant effect on female calf bases and significant effect on the bases of total pregnancies (Table-2).

Subjecting the data to statistical analysis showed that season of birth affected the replacement rate on two bases. The differences due to period was non significant. This supported by findings of Tomar and Verma (1988a) for Tharparkar and crossbred cows and Tomar and Verma (1988b) for Karanfries cows. Out of total loss of 944 cows, 269 (28.5%) cows were culled due to various reasons, (Table-1). Reddy and Nagarcenkar (1989) reported 4.23%, Tomar and Verma (1988a) observed 8.24%, Ram and Tomar (1993) reported culling rate ranged from 4.2 to 46.8% and Mukherjee and Tomar (1998) reported 27.1% culling of female calves from birth to age at first calving. The analysis of variance showed that effect due to sire and period were non significant while effect due to season was highly significant. The differences in culling rate of present study and reports available in the literature might be due to managemental reasons as well as condition of heifers from birth to age at first calving.

Replacement rate

The percentage of female calves reaching milking herd was found to be 36.49% and 26.62%, based on the female calves born and on total pregnancies respectively (Table 1). It was observed from the present study that 26.62% of the total pregnancies would result into successful heifers to reach the milking herd. The total losses in terms of abnormal births, male births, death and culling of calves amounted to 4.50%, 51.49%, 45.60% and 18.18% of total calving respectively. This indicates that the replacement rate based on total pregnancies is \( \frac{1}{4} \), that is to replace one cow 4 pregnancies are required. Tomar and Verma (1988a) reported the replacement rate as 33.8% and 77.1% on the two basis for a herd of Tharparkar and crossbred calves, while Tomar and Verma (1988b) reported 32% and 65% in Karanfries calves. Tomar and Rawal (1998) observed that 33.7% of them turn into replacement heifers. Lathwal and Kumar (1994) reported the replacement rate as 27.5% and 59.6% respectively on the two basis. These results suggest that 3 pregnancies are needed to produce one replacement heifer. The analysis of variance showed that sire had non significant effect on female calf bases and significant effect on the bases of total pregnancies (Table-2).

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reported 19 per cent of the total losses in adult cows due to the death in Sahiwal cows. Rawal et al. (1994) reported that out of the total losses during a period of 39 years, 13.1 per cent were attributed to the death of cows and 86.9 per cent were due to their culling in Sahiwal herd.

The average mortality rate was observed 42.66 percent which ranged between 29.79 to 58.19 per cent over the years. However, the differences were not significant. The average culling rate was observed 16.28 per cent in this herd and ranging from 0 to 30.97 per cent among periods. The variation in culling rates due to periods was not significant. Lathwal (1989) reported the annual mortality and annual culling rate as 2.1 and 20.7 per cent, respectively in a herd of Red Sindhi cows for a period of 36 years with significant effect of years on culling rate. It can also be further seen that the total losses including death and culling of cows amounted 59.12 per cent. 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 overall replacement index has been reported as 0.84 in Red Sindhi herd by Lathwal (1989) and overall replacement index was nearly one reported by Rawal et al. (1994). The replacement index in this study during different periods ranged from 0.90 (1999) to 2.39 (2002).

REFERENCES