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Abstract: The primary objective of this study was to improve the reproductive efficiency of indigenous cattle of Azad Jammu and Kashmir at Livestock Development Research Center (LDRC) by crossing with European breeds. The indigenous heifers were impregnated with Jersey semen and F₁ crossbred were produced. The F₁ offspring were crossed among themselves (inter se mating) to obtain the F₂ offspring and simultaneously the F₁ cows were crossed with Friesian bull to produce three-breed crossbred cows. The number of cows for each group were 37 for indigenous, 25 for F₁ (Indigenous × Jersey) cross, 8 for F₂ (F₁ × F₁) cross and 14 for F₁ × Friesian cross. The highest breeding efficiency was observed in F₁ (93.68 ± 1.85 %) and F₂ (93.71 ± 2.74 %) and increased highly significantly (P < 0.0001) compared to indigenous cows (73.46 ± 2.50 %). The mean breeding efficiency of F₁ × Friesian (65.62 ± 3.05 %) did not differ significantly from that of indigenous cows (P = 0.0870). The Jersey breed was found to be suitable for improving the breeding efficiency of indigenous cows of hilly areas of Azad Jammu and Kashmir.

Keywords: Subtropical, highland type, breeding efficiency, indigenous cows, crossbred cows

1. INTRODUCTION
The productivity of indigenous cattle of Azad Jammu and Kashmir is very low. This may be because of poor genetic makeup. Reproductive performance in dairy cattle is of paramount importance. To maintain efficient production, it is necessary that cows reproduce regularly [1]. It has been reported that lowered breeding efficiency may be associated with high production [2, 3] and contradictorily, that there is little relationship between production and breeding efficiency [4, 5, 6, 7]. The economic returns from dairy animals are not only based on milk production alone but also on their reproductive efficiency [8]. Everett et al [9] reported that breeding efficiency and production were essentially interdependent. Reproductive efficiency is proposed as a measure of the net biological accomplishment of all reproductive activities and phenotypic expression of the interplay of genetic and environmental factors [10]. Indicators of reproductive efficiency are service period affecting in turn, the calving interval. However, the breeding efficiency in addition to accommodating the number of calving also takes care of age at first calving and total number of days from first to last lactation. Reproductive efficiency represents the overall performance of the herd with respect to age and reproductive traits [11]. Age of dairy cows at first parturition and the lengths of her subsequent calving intervals are usually considered of primary importance in measuring breeding efficiency [12]. Low reproductive efficiency due either to delayed first service, missed estrus, or multiple services per conception continues to be.
a major problem in dairy herds. Poor reproductive performance results in excessively late age at first calving and long lactations. Both are costly to the dairy producers because of the veterinarian breeding expense, high reproductive replacement costs and fewer calves being born [13]. Several reports had indicated that poor reproductive performance, manifested as prolonged calving intervals, can result in reduced milk yield and increased culling rates and replacement cost [14–16].

Although the crossbreeding has been adopted as a tool to improve traits of economic importance of indigenous cattle in canal irrigated areas of Punjab and other part of Pakistan, however, such adoptability studies are missing in AJK, therefore this study was planned to improve the overall productivity of indigenous cattle along with reproductive efficiency traits by crossing with European breed of Jersey and Friesian and to assess the adoptability of crossbred dairy cattle in local environmental conditions.

2. MATERIALS AND METHODS

2.1 Animals and Farms

LDRC is located at the bank of river Jhelum 6 kilometers away from the main city of Muzaffarabad which is the capital of Azad Jammu and Kashmir. This farm was established in 1990 by the Government of Azad Jammu and Kashmir by purchasing of 66 indigenous cattle. The animals were maintained in brick closed sheds throughout the year. The milking cows, dry cows and young calves were kept in separate shed with roof constructed from asbestos sheet and iron bar, the floor is of concrete. During the summer months the animals were showered with cold water and electric fan were provided in the shed to beat the heat.

2.2 Breeding Program

A breeding program with the introduction of Jersey and Holstein Friesian was started in July 1990. In first cross F₁ offspring from crosses between indigenous and Jersey were produced. Calving of F₁ offspring occurred from July, 1991 to April, 1998. In second type of cross F₁ female were crossed with F₁ male, as a result of which F₁ × F₁ (F₂) offspring were produced during the period of May, 1994 to April, 1999. In third type of cross the F₁ female were crossed with pure Friesian bull to produce 25 % indigenous + 25 % Jersey + 50 % Friesian offspring during May 1994 to April 1999.

The diagrammatic presentation of breeding program is illustrated below:

1. Indigenous × Jersey
   \[ \rightarrow \]
   F₁ (Indigenous 50 % + Jersey 50 %)

2. F₁ (Indigenous 50 % + Jersey 50 %) × F₁
   \[ \rightarrow \]
   F₂ (Indigenous 50 % + Jersey 50 %)

3. F₁ (Indigenous 50 % + Jersey 50 %) × Friesian
   \[ \rightarrow \]
   Indigenous 25 % + Jersey 25 % + Friesian 50%

2.3 Feeding Regime

All the animals were stall fed on farm raised green fodder. The ration was formulated to provide the recommended quantity of nutrients according to body weight and status of animals as given in Table 1. The composition of the feed varied according to the fodder crop available during the year. Elephant grass and maize were mainly fed during the months of May to October and from November to April green berseem and wheat straw were fed to these animals. Green fodder was chaffed and offered to these animals. Roughages comprised of wheat straw and stoves of maize. The concentrate mixture composed of wheat bran, oil seed cake (rape seed cake and cotton seed cake) and molasses. Lumps of common salts (sodium chloride) were placed in mangers and cows were free to lick with accessibility of clean drinking water.

2.4 Data Collection

It was a retrospective study, carried out over a period from 1990–2010. The data regarding
reproductive records of 84 cows out of which 37 were indigenous, 25 were F1 (Indigenous × Jersey), 8 were F1 × F1 (F2) and 14 were F1 × Friesian cows. Among reproductive parameters, service period, calving interval, and breeding efficiency were studied in the present research work. Although, the other parameters of reproductive performance such as sex ratio, age at first calving, number of services per conception were also recorded for indigenous and crossbred groups in this breeding program. However, the data for these traits has not been included in this research paper.

2.5 Service Period

Service period of each cow was calculated by the difference between the date of calving and the date of subsequent fertile conception.

2.6 Calving Interval

Calving interval was calculated by the interval between the dates of two successive calving.

2.7 Breeding Efficiency

The breeding efficiency of each cow was calculated by using the following formula suggested by Wilcox et al [17].

Breeding Efficiency (%) = \( \frac{365 \times (N-1) \times 100}{D} \)

Where N= Total number of parturitions, D= Number of days from first to last parturitions.

2.8 Statistical Analysis

The difference in the mean breeding efficiency among the four breed groups were worked out through analysis of variance. Graph Pad Prism 5 package was used for statistical analysis.

3. RESULTS

Mean breeding efficiency of indigenous and crossbred dairy cow is given in Table 2. Mean breeding efficiency increased highly significantly in F1 (P<0.0001) and F2 (P=0.0007) hybrid cows compared to that of indigenous cows. Crossing of F1 females with Friesian bull decreased the breeding efficiency highly significantly in F1 × Friesian cows compared to that of F1 (P<0.0001) and F2 (P<0.0001) hybrid cows. Mean breeding efficiency of F1 and F2 cows did not differ significantly from each other (P=0.9933). Statistically no significant difference of mean breeding efficiency was observed in F1 × Friesian and indigenous cows (P=0.087).

Mean service period of F1 × Friesian cows was highest (266.7 ± 16.56 days) and the lowest (81.81 ± 11.19 days) mean service period was observed in F1 × F1 (F2) cows. Crossbreeding of indigenous cows with Jersey decreased the service period highly significantly in F1 (P < 0.0001) and F2 (P < 0.0001) hybrid cows compared to that of indigenous cows and service period of F1 and F2 did not differ significantly (P = 0.37) from each other. Crossing of F1 female with Friesian bull increased the service period in F1 × Friesian cows and it was similar to that of indigenous cows (P = 0.549). Mean calving interval of indigenous and crossed dairy cows are given in Table 2.

Mean calving interval of indigenous and

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Table 1. Daily nutrient fed to cows per 500 kg body weight and according to their productive and reproductive status maintained at LDRC, AJK.

<table>
<thead>
<tr>
<th>Status</th>
<th>Total Dry Matter (kg)</th>
<th>Nutrients (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TDN*</td>
</tr>
<tr>
<td>Early Lactation</td>
<td>11.91</td>
<td>7.05</td>
</tr>
<tr>
<td>Lactating and Pregnant</td>
<td>11.41</td>
<td>6.27</td>
</tr>
<tr>
<td>Dry Non Pregnant</td>
<td>8.41</td>
<td>4.23</td>
</tr>
<tr>
<td>Pre-calving (60-90 days before calving)</td>
<td>10.32</td>
<td>5.59</td>
</tr>
</tbody>
</table>

*TDN = Total Digestible Nutrients; CP = Crude Protein; Ca = Calcium; P = Phosphorus
Table 2. Mean breeding efficiency, service period and calving interval of indigenous and crossbred cows.

<table>
<thead>
<tr>
<th>Breed Group</th>
<th>Breeding Efficiency (%)</th>
<th>Service Period (days)</th>
<th>Calving Interval (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indigenous</td>
<td>73.46±2.50</td>
<td>256.0±8.67</td>
<td>518.6±9.54</td>
</tr>
<tr>
<td>Indigenous × Jersey</td>
<td>93.68±1.85***a</td>
<td>92.60±5.04***a</td>
<td>368.8±5.32***a</td>
</tr>
<tr>
<td></td>
<td>(25)</td>
<td>(121)</td>
<td></td>
</tr>
<tr>
<td>F₁ × F₁ (F₂)</td>
<td>93.71±2.74***a</td>
<td>81.81±11.19***a</td>
<td>359.8±11.68***a</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
<td>(26)</td>
<td></td>
</tr>
<tr>
<td>F₁ × Friesian</td>
<td>65.62±3.05***bc</td>
<td>266.7±16.56***bc</td>
<td>540.9±22.39***bc</td>
</tr>
<tr>
<td></td>
<td>(14)</td>
<td>(34)</td>
<td></td>
</tr>
</tbody>
</table>

1Mean ± SE; 2Values in parenthesis ( ) are Number of cows
a = Indigenous vs F₁, F₂ & F₁ × Friesian;  b = F₁ vs F₂ and F₁ × Friesian;  c = F₂ vs F₁ × Friesian
P ≤ 0.05*, P ≤ 0.01**, P ≤ 0.001***

Crossbreeding dairy cows is given in Table 14. Mean calving interval of indigenous cows was highest (518.6 ± 9.543 days) and lowest (359.8 ± 11.68 days) was observed in F₂ cows. Crossbreeding of indigenous cows with Jersey decreased the calving interval highly significantly in F₁ (P < 0.0001) and F₂ hybrid cows (P < 0.0001) compared to that of indigenous cows. Calving interval of F₁ hybrid did not differ significantly (P = 0.482) compared to F₂ hybrid cows. When F₁ hybrid cows were crossed with Friesian bull, then in F₁ × Friesian cows the calving interval increased to that of indigenous cows (P = 0.289).

4. DISCUSSION

In present study long service periods and subsequently long calving intervals of indigenous and F₁ × Friesian cows might have contributed to the low breeding efficiency. The long service period might be due to delayed resumption of ovarian activity after calving. The breeding efficiency varied among indigenous and crossbred cows in this study.

The breeding efficiency of indigenous cows (73.46 ± 2.50 %) in this study increased as a result of their crossbreeding with Jersey in F₁ and F₂ crossbred cows. The high breeding efficiency of F₁ (93.68 ± 1.85 %) and F₂ (93.71 ± 2.74 %) crossbred cows was due to their short service period and calving interval. Mean breeding efficiency of F₁ and F₁ × F₁ (F₂) was higher than that of breeding efficiency of Jersey cows in different countries as 87.01 ± 1.73 % in Pakistan [18] and in India it was 88.20 ± 0.55 % [19]; 91.66 ± 1.25 % [20] and 83.98 ± 9.90 [21].

The breeding efficiency of Holstein Friesian cows was 73.12 ± 2.29 % [18] in Pakistan, 74.9 % in Sudan [22]; 87.28 % in USA [17]. In this study when F₁ crossbred cows were crossed with Friesian bull the breeding efficiency decreased in F₁ × Friesian crossbred cows (65.62 ± 3.05 %) compared to F₁ and F₂ crossbred cows. This decrease in breeding efficiency attributed to long service period and calving interval. The long service period of F₁ × Friesian cows might be due to the reason that the these cows did not resume the ovarian cycle at an early time after calving. The breeding efficiency of 50 % Friesian inheritance cows in this study was similar to that of 50 % Friesian inheritance cows (66.3 ± 0.49 %) in Ethiopia [23].
5. CONCLUSIONS

The high breeding efficiency of Indigenous × Jersey (F, ) crossbred cows compared to F 1 × Friesian crossbred cows in present study is an indicative of better adaptation of Jersey crossbred cow to climatic conditions of Muzaffarabad, Azad Jammu and Kashmir.

6. Acknowledgements

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7. REFERENCES
