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Overall life time statistics and replacement index in crossbred cattle

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Abstract
In this study we extracted data from History Sheet, Stock Register, Cattle-Register and Auction and Sales Register maintained at Instructional dairy farm G. B. pant University, Agriculture and technology Pantnagar, United Kingdom. 1495 cross bred cattle born between 1994 and 2022 (29-year period) kept at IDF, Nagla, United Kingdom. Analytical Equations formulated by different scientists were used for analysis of Overall life table statistics, Annual replacement index. Results showed that cows lost from herd completed 4.58 Lactation over their life time with average loss rate 0.32 Cents per Lactation. Life expectancy of cows at first Lactation was estimated to be 2.85 Lactation years. Overall replacement index 1.40 is considered to be acceptable and sustainable because it allows for herd renewal, maintains herd size and maintains productivity.

Keywords: Calf, crossbred, lactation, productivity, replacement index

Introduction
India is a predominantly agrarian country, with almost 54.6% of the population engaged in agriculture and cattle rearing. The livestock industry is a significant part of the economy in India. (The FAO, 2022), India has the largest cattle population in the world, with a population of 192.49 million. India has a population of 142.11 million Indigenous Bovine cattle, 50.42 million Crossbred Bovine cattle. Although crossbred cattle have a smaller population than the indigenous cattle, they play a more important role in the milk production. They contribute 27.68% to the total output of milk, while the indigenous cattle account for 9.63 %. India contributes approximately 24% to the world milk pool. In the last 40 years, the milk production in India has increased 6 to 7-fold.

High numbers of involuntary culls and deaths limit the genetic development of the farm as there are fewer replacements to increase the overall quality of the herd. Newborn calf survival is very important for the successful reproduction of the livestock. Addressing the issue of calf mortality is important for the long-term sustainability and the profitability of a dairy farm. The most effective ways to increase the size of the herd for genetic development and profitable dairy business is to reduce the number of heifers and calves that are disposed of during the prenatal and postnatal stages. Identifying the reasons for increased mortality and the unintentional disposal of heifers or calves is an important step in preventing genetic loss and financial loss.

According to Berry and Cromie (2006) [3], the need for lower sex ratios in dairy cattle increases when the replacement rate is high. Therefore, the aim of this study was to estimate the overall life time demographics and selection index of a cross-breed herd in a dairy farm in the state of Uttar Pradesh. The farm was located in the state of Maharashtra and the location of the farm was Instructional Dairy Farms, G. B. Pant University, Agriculture and Technology in Pantnagar, Uttarakhand.

Materials and Method
In this study, the data was extracted from the history sheet, stock register, calf-register, auction register and sales register kept at the Instructional Dairy farm of G. B. Pant University,

Agriculture and Technology Pantnagar, U.K. The data was collected from 2,128 female cross bred calves born between 1988 to 2019. The data was collected from 1000 cross bred cattle at the Instructional Dairy Farms, Nagla (IDF), U.K. The fallowing statistics were analysed using various formulas provided by various scientists.

A) Overall Life Table Statistics

The overall life table statistics procedures were used as given by Caughley (1966) [4] and Greer *et al.* (1980) [8]. The methods of estimating this were as follows:

The Caughley (1966) [4] estimated the following two life table statistics as:

a) Mean rate of loss per female per lactation ($\overline{q_x}$)

It is the average probability of a female animal being lost from the herd in each lactation. This was estimated as: ($\overline{q_x}$) = 1/ ΣL_x per female per year.

b) Average life expectancy at birth

This was estimated as the sum of survivorship at each lactation minus 0.5.

$$\sum_{i=1}^{n} L_x - 0.5$$

Gree *et al.* (1980) [8] estimated the following two life time parameters as:

c) Mean age of cows being lost (death and culling)

This parameter was calculated by multiplying each lactation (X) by proportion of cows lost from the herd (q_x) and adding the products i.e.

$$\sum L_x \times q_x$$

d) Mean age of cows present in the herd

This parameter was calculated by multiplying each lactation (X) by proportion of total cow's present in the herd (P_x) and adding the products i.e.,

$$\sum L_x \times p_x$$

B) Annual Replacement Index (ARI)

The annual replacement index was computed as suggested by Ram and Tomar (1993) [1].

$$\text{ARI} = \frac{\text{No. of heifer calving in a year}}{\text{No. of cows left the herd}}$$

Result and Discussion

Overall Life Time Statistics

The components of the overall life time statistics include the overall life time average lactation of the cow in the herd, the average lactation of cows that are lost from the herd and the average rate of loss per lactation and the average life expectancy of the cow at birth (table 1).

Table 1: Overall life time statistics of crossbred cattle

Sr. No.	Life table	Unit	Average value
1	Mean of cow present in herd	Lactation	3.73
2	Mean of cow lost from herd	Lactation	4.58
3	Mean rate of loss/cow/lactation	Proportion	0.32
4	Life expectancy for first lactation	Lactation	2.85

The average lactation of the cows in the herd was 3.73. The mean lactation value was similar to that of Tomar *et al.*, (1996) [19] in Tharparkar cattle; however, other researchers reported lower mean lactation values in which cows were present in the herd (Singh, 2001) [18] in Karan Fries cattle; (Atrey, 2003) [2] in Frieswal cattle; (Shahi, 2013) [17]; (Kumar, 1999) [9] in Sahiwal cattle; and (Goshu, 2014) [6] in HF cattle. (Kumar, 1999) [9], reported higher values in Hariana cattle.

On average, the cows lost in the herd completed lactation 4.58 years apart, suggesting that the majority of the herd was replaced at a later age after completing 4 lactations. This was very similar to the average of the cows reported by Kumar (1999) [9] in Hariana cattle, Goshu, 2014 [6] in HF cattle, and less than the average of Singh (2001) [18] in Karan Fries cattle, and Atrey, 2003 [2] in Frieswal cattle.

In present study mean rate of loss per cow per lactation was estimated as 0.32, which was similar to the results of Shahi and Kumar (2013) [17] in Sahiwal cattle and Goshu (2014) [6] in HF cattle. However, lower average of mean rate loss estimated by Tomar *et al.* (1996) [19] in Tharparker and Kumar (1999) [9] in Hariana cattle while maximum value reported by Atrey (2003) [2] in Frieswal cattle.

Life expectancy for first lactation in Sahiwal cattle herd was found to be 2.85. results supported by estimated of Shahi and Kumar (2013) [17] in Sahiwal cattle. Lower value presented by Atrey (2003) [2] in Frieswal cattle and Goshu (2014) [6] in HF cattle while higher value recorded by Kumar (1999) [9] in Hariana cattle.

Annual Replacement Rate (ARI)

The annual replacement index (ARI) was calculated by taking into account the number of heifers calving and the number of old cows that left the herd in a given year as a result of the death and culling of the herd (genetic death). The ARI determines the intensity of the selection and maintenance of the hero size. The ARI is used to evaluate the changes in the herd size over time. The total ARI for crossbred cattle averaged about 1.40 over the 29-year period (1994-2022) (Table 2). Similar findings also reported by Abbas (2005) [1] in Sahiwal cattle herd and Pandey *et al.*, (2016) [12] in crossbred cattle herd. However, many workers also reported lower annual replacement index i.e., Lathwal (1989) [10] in Red Sindhi cattle herd, and Mukherjee (1993) [11] crossbred cattle herd. In addition, Rawal and Tomar (1994a) [14] and Shahi (2004) [16] in Sahiwal cattle herds as well as Rawal and Tomar (1998) [15] in Tharparkar cattle herds.

Table 2: Annual replacement index in crossbred cattle

Years	Addition of heifer calving	Total loss of cow	Replacement index
1994	35	20	1.75
1995	33	19	1.74
1996	45	30	1.50
1997	69	34	2.03
1998	43	23	1.87
1999	49	43	1.14
2000	54	42	1.29
2001	43	21	2.05
2002	51	20	2.55
2003	62	60	1.03
2004	49	46	1.07
2005	51	32	1.59
2006	43	26	1.65
2007	56	29	1.93
2008	43	38	1.13
2009	51	36	1.42
2010	38	25	1.52
2011	49	29	1.69
2012	48	32	1.50
2013	53	33	1.61
2014	47	28	1.68
2015	59	25	2.36
2016	52	32	1.63
2017	38	36	1.06
2018	58	35	1.66
2019	38	52	0.73
2020	55	45	1.22
2021	48	39	1.23
2022	34	68	0.50
Total	1394	998	1.40

Conclusion

In this study, the average rate of per-cow loss per lactation was estimated at 0.32, and the average life expectancy of cows in their first lactation was 2.85 years. The total replacement index for crossbred cattle over a 29-year period (1994-2022) was about 1.40. Generally speaking, a replacement index of about 1.40 allows for the renewal of the herd and the maintenance of the herd's size and productivity.

Future Scope

In the future, the integration of technology, data analytics, and advancements in genetics could play a significant role in improving the efficiency and sustainability of livestock production. Precision management practices, coupled with a holistic approach that considers genetic, environmental, and economic factors, are likely to shape the future of mortality and culling management as well as replacement index strategies in the livestock industry. Additionally, increased awareness of animal welfare and ethical considerations may influence the development of new practices in these areas.

Conflict of Interest: No conflict of interest

Author contribution

Shashikant: Collection of data, contributed data and analysis tools, perform analysis, wrote the paper.
C.V. Singh: Conceived and designed the analysis, contributed data and analysis tools, perform analysis
R.S. Barwal: Contributed data and analysis tools, perform analysis

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