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Incidence of fertility and postpartum uterine health disorders with their genetic and non-genetic determinants in Karan fries cattle

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Abstract

Present investigation has been planned to study the incidence of indicators for functional traits and to determine the impact of both genetic and non-genetic determinants on several functional parameters in Karan Fries cattle kept at the Livestock Research Center, ICAR-NDRI, Karnal, using a traditional and logistic regression approach. The information included 3165 calving records from 1993 to 2016, a span of 24 years. Traits considered in present study were fertility traits-Repeat breeding, Anoestrus and Post calving uterine health trait Retention of fetal membrane. According to fertility health indicator features, the proportion of occurrence was 0.22 for anoestrus and 0.06 for repeat breeding. Fertility health features were significantly impacted ($p < 0.01$) by the calving period, season, and parity. For anoestrus and recurrent breeding, primiparous cows had a lower estimate of incidence. The incidence of retained placenta was determined to be 0.18 overall, and variations in incidence by season, period, and parity were found to be statistically significant ($p < 0.001$). First parity cows had the lowest rate of placenta retention (0.13), whereas fourth parity cows had the greatest incidence (0.25). These methods can help predict the impact of environmental and management factors on traits like culling, fertility, and production, ultimately leading to better herd management strategies.

Keywords: Karan fries cattle, fertility traits, anoestrus, repeat breeding, retained placenta

Introduction

Karan Fries cattle is a very important breed as it offer a balance of high milk production, adaptability, and resistance to diseases, making them a valuable breed for dairy farming in India and other regions with similar environmental conditions. In 1980, Holstein Friesian Bull (*Bos taurus*) and Tharparkar cow (*Bos indicus*) were crossed to create Karan Fries crossbred dairy cattle, which were then selected at ICAR-NDRI, Karnal. As of right now, selection is mostly dependent on 305DMY, and functional features are not given enough weight in the selection criteria (Gonge *et al.*, 2024) ^[6]. Higher production performance is determined by both the animal's superiority in terms of functional features and its function, which determines the dairy cattle's stronger stayability in the herd. Functional trait such as fertility, health and longevity are essential for improving dairy herd efficiency by reducing cost associated with disease, reproductive failure and involuntary culling (Miglior *et al.*, 2017) ^[9]. These traits primarily include uterine and udder health, female reproductive traits, and calving traits. Fertility performance in dairy cattle is influenced by multiple interacting factors, including management practice, environmental stressor and postpartum uterine health, which ultimately affect herd productivity and profitability (Crowe *et al.*, 2018) ^[4] and also both genetic and non-genetic elements, making it one of the most important factors affecting the biological and functional performance of the animal production system (Feugang *et al.*, 2009) ^[5]. Among the many factors influencing fertility, management is crucial for successful production and reproduction, which is a crucial component of contemporary dairy practices. To maintain the best genetic gain, organized selection strategies should be used (Mumtaz *et al.*, 2021) ^[12].

Materials and Methods

Karan Fries cattle kept at the ICAR-NDRI in Karnal, Haryana, were used in this study.

The study's data came from the Animal Genetics and Breeding Division, Livestock Production and Management Section, Artificial Breeding Research Center (ABRC), calving reports, health and general treatment registers, and history-cum pedigree sheets/registers. 3165 lactation records from 965 cows sired by 159 sires were used. The information covered a twenty-four-year span, from 1993 to 2016. In this study, cows that completed at least one lactation and up to six lactations were taken into account.

Classification of Data

Functional trait data were categorized by genetic group, parity order, calving period, and season of calving.

1. Calving season

The Karnal region's current climate was taken into consideration while dividing the entire year into four seasons (winter, summer, rainy, and autumn). The corresponding seasons were then coded as shown in Table 1.

Table 1: Categorization of calving season

Code	Length from	Season of calving
1	April to June	Summer
2	July to August	Rainy
3	September to November	Autumn
4	December to March	Winter

2. Parity

After the data was classified and coded, the impact of parity on performance was analyzed. The accessible production

and reproduction sheets showed the parity order up to the most recent lactation. However, because there were fewer animals above fifth parity in this study, fifth parity and above were grouped together.

3. Period

The study's data came from a 24-year span (1993 to 2016). Since the farm's management procedures changed over several years, any trait may be significantly impacted by the cumulative effect of these changes over a five to six-year period. In order to investigate this effect, the calving period was divided into the following groups:

Table 2: Period classification:

Code	Calving period
1	1993-95
2	1996-98
3	1999-01
4	2002-04
5	2005-07
6	2008-10
7	2011-13
8	2014-16

4. Genetic clusters/groups

The classification was based on the degree of Holstein Friesian blood inheritance in Karan Fries cows in order to investigate the impact of genetic group. Table 3 provides a thorough description of the classification.

Table 3: Genetic Group Categorization

Code	Sire breed	Dam breed	Genetic Group
1	Holstein Friesian	Zebu breed (Tharparkar)	Group I (F1 crosses)
2	Karan Fries	Karan Fries	Group II (interbred)
3	Holstein Friesian	Karan Fries	Group III (Higher crosses)

Statistical Analysis

Indicator/functional traits

The number of new cases of an illness during a given time

frame is known as its incidence. A relative scale is typically used to evaluate incidence.

$$\text{Incidence rate for the lactation or calving} = \frac{\text{Number of new cases of disease in the lactation}}{\text{Number of animals in the lactation}}$$

Season, period, parity, and genetic group were taken into account while calculating the incidence of several indicator features during lactation. The percentage of animals impacted by indicator traits during lactation or calving was used to calculate it.

Impact of genetic and non-genetic factors on various functional traits

The Chi-Squares method was used to examine the effects on different non-genetic parameters on functional features, including as season, period, parity of calving, and genetic group of Karan Fries (Snedecor and Cochran, 1994) [22].

$$\text{Chi-square} = \frac{\sum(O-E)^2}{E}$$

Where,

O = Observed frequencies

E = Expected frequencies

Expected frequencies were calculated as follows:-

$$E_{ij} = (R_i)(C_j)/GT$$

Where,

E_{ij} = Expected frequency in the jth column and ith row

R_i = Total number of rows

C_j = Total number of column

GT = Grand total

Logistic regression method analysis for functional traits

Finding genetic and non-genetic factors impacting different functional qualities in dairy animals using traditional analysis, which assumes residual error normalcy, is extremely challenging. In situations when the response variable is binary or discontinuous, logistic regression can be useful for both predicting the answer and investigating the relationship between the dependent and explanatory variables. Instead of using the proportion of data, the logistic regression approach uses odds. The chances are only the proportion of the two conceivable outcomes that are

mutually exclusive. The proportion for the second mutually exclusive outcome is $(1-p)$ if p is the proportion for the first outcome;

$$\text{ODDS} = p/(1-p)$$

The logistic regression model uses a linear function to connect the log of the odds to the explanatory variable.

$$\begin{aligned}\text{Log}[p_i/1-p_i] &= \beta_0 + \beta_1 X_i \\ 1/p &= [1 + \exp(\beta_0 + \beta_1 X_i)] / \exp(\beta_0 + \beta_1 X_i) \\ P &= \exp(\beta_0 + \beta_1 X_i) / [1 + \exp(\beta_0 + \beta_1 X_i)] \\ &= 1/[1 + \exp(\beta_0 + \beta_1 X_i)] \\ &= 1/[1 + \exp(-Z_i)]\end{aligned}$$

P_i is between 0 and 1, and Z_i is between $-\infty$ and $+\infty$. The two requirements for a probability model are satisfied since P_i and Z_i have a non-linear relationship.

The SAS 9.3 version of the following dichotomous logistic regression model was applied:

$$\ln[P/(1-P)] = \beta_0 + \sum \beta_i X_i$$

Where,

P = Incidence probability

β_0 = The intercept from the linear regression equation

β_i = Partial regression coefficient

Results and Discussion

The frequency of the functional trait indications

Tables 4-5 demonstrate the incidence of functional trait indicators in connection to different genetic and non-genetic factors as well as the chi-squares analysis results demonstrating the impact of different genetic and non-genetic factors on indicator characteristics. The proportion was used to measure the incidence of the functional trait indicators.

1. Incidence of fertility health indicator traits-Anoestrous and Repeat breeding

According to the current study on fertility health indicator features, the proportion of incidence was 0.22 for anoestrous and 0.06 for repeat breeding. In statistical study, the season period and parity of calving had a highly significant ($p < 0.01$) impact on those indicator features, however the genetic group had a non-significant influence.

Balasundaram (2008) [1] and Sharma (2011) [19] observed a nearly substantial occurrence of anoestrous in Karan fries, while Sharma and Luktuke (1983) [21] reported it in crossbred cattle. A review of the literature showed that the incidence of recurrent breeding in crossbreds varied between 0.07 and 0.28 (Kaikin *et al.*, 1983; Chourewar *et al.*, 2002; Kulkarni *et al.*, 2002; Selvaraj, 2003) [7, 3, 8, 18]. According to Urade (2001) [23], 8.08 percent of crossbred cows experienced recurrent breeding.

Season

The current results (Tables 4-5) showed that season had a substantial ($p < 0.01$) impact on the occurrence of repeat breeding and anoestrous. Compared to other seasons, autumnal calves had the lowest prevalence of reproductive issues. In the fall, it was 0.17 for anoestrous and 0.05 for repeat breeding. Chourewar *et al.* (2002) [3] discovered that the incidence of recurrent breeding in crossbred cows was

significantly influenced by the calving season. In a similar vein, Balasundaram (2008) [1] and Sharma (2011) [19] found that season had a major impact on the frequency of recurrent breeding and anoestrous in Karan Fries cows.

Period

Repeat breeding and anoestrous were significantly ($p < 0.01$) impacted by the calving period. Repeated breeding became more common between 1993 and 2007. Anoestrous was found to be most common between 2002 and 2004 (0.36) and least common between 1993 and 1995 (0.07). However, Balasundaram (2008) [1] found that period had no discernible impact on anoestrous and recurrent breeding.

Parity

According to the current study's results (Tables 4-5), primiparous cows had lower estimates of incidence (0.17 and 0.05) for anoestrous and repeat breeding than pluriparous cows (0.22-0.28 and 0.051-0.08). Over the parities, no discernible pattern was found. Similar to the current findings, Sharma and Luktuke (1983) [21] found a substantial difference and a rising tendency over the parities for anoestrous in Friesian-Haryana cows. According to Chourewar *et al.* (2002) [3], parity had no discernible impact on crossbred cow repeat breeding. According to Balasundaram (2008) [1], parity has no discernible impact on recurrent breeding and anoestrous in Karan Fries cattle.

Genetic Group

Genetic categories had no discernible impact on the prevalence of fertility issues, according to statistical analysis of the data. Similarly, for various genetic groups of Karan Fries cattle, Balasundaram (2008) [1] and Sharma (2011) [19] found non-significant variations in the incidence of anoestrous and repeat breeding. However, Kulkarni *et al.* (2002) [8] and Selvaraj *et al.* (2003) [18] found that the incidence of recurrent breeding in cows varied significantly among genetic groupings.

2. Incidence of post-calving uterine health indicator traits-Retention of placenta (ROP)

Out of 3165 calvings, 584 parturitions had placenta retention (ROP), indicating a proportion of 0.18 in Karan Fries cows (Table 4-5). In crossbreds (Satyapal, 2003; Balasundaram *et al.*, 2011a) [17, 2] and Karan Fries (Sharma, 2011) [19], the incidence of retained placenta was found to be 0.27 and 0.25, respectively. However, Mukherjee (1989) [10] found a decreased (0.15) prevalence of placenta retention in Karan Fries cattle.

Season

Seasonal variations in the herd's incidence of placenta retention (ROP) ranged from 0.13 to 0.23. The incidence estimates were greater during the rainy season (0.23) and lower during the fall season (0.13). The incidence of ROP varies statistically considerably ($p < 0.001$) between the calving seasons.

According to earlier studies (Pandit *et al.*, 1981; Saini *et al.*, 1988; Mukherjee, 1989; Satyapal, 2003) [13, 15, 10, 17], the season of calving significantly affected the incidence of retained placenta in crossbred and Karan Fries cows. However, Balasundaram *et al.* (2011a) [2] and Sharma (2011) [19] found that the season of calving had no discernible impact on the incidence of placenta retention in

Karan Fries cattle. Satyapal (2003) ^[17] discovered that in Karan Fries cows, the prevalence of retained placenta was greater during the summer calving season.

Period

The incidence of placenta retention peaked between 1996 and 2001 at 0.25, whereas it was 0.18 and 0.14 between 2002 and 2008 and 2014 and 2016, respectively. Over the period, it displayed a nearly declining trend. Additionally, statistical analysis showed that the calving period had a significantly significant effect ($p < 0.01$). Similarly, Mukherjee (1989) ^[10], Balasundaram *et al.* (20011a) ^[2], and Sharma (2011) ^[19] revealed that the incidence of retained placenta in Karan Fries cows was strongly influenced by the time of calving. Balasundaram (2008) ^[11] noted a declining pattern of incidence over the period, which is consistent with the current data. Nonetheless, Mukherjee (1989) ^[10] noted an upward tendency in Karan Fries cattle.

Parity

According to the current findings, primiparous cows had the lowest prevalence of placenta retention (0.13). In contrast, the incidence proportion for pluriparous cows was 0.21 in second parity, 0.20 in third parity, 0.25 in fourth parity, and 0.23 in fifth parity. It was discovered that variations in the incidence proportion of ROP among the parities were significantly significant ($p < 0.01$). The incidence of retained placenta in crossbred cows was also found to be significantly impacted by parity of calving, with a higher incidence in later lactations and a lower incidence during early lactation (Pandit *et al.*, 1981; Saini *et al.*, 1988; Mukherjee, 1989; Satyapal, 2003; Sharma, 2010) ^[13, 15, 10, 17]. According to research by Kaikini *et al.* (1983) ^[7] and Balasundaram *et al.* (2011a) ^[2], the incidence of retained placenta in various crossbred cattle was not significantly affected by parity.

Genetic group

The genetic group did not, however, significantly affect the

incidence of ROP, according to the statistical study. F1 and higher crosses had a lower incidence of ROP (0.16) than interbred cows (0.19). The current findings were consistent with those of Chourewar *et al.* (2002) ^[3] and Balasundaram *et al.* (20011a) ^[2], who found that genetic group had no discernible impact on the incidence of placenta retention in crossbred and Karan Fries cows.

Table 4: Incidence of post calving uterine health and fertility trait indicators with reference to different genetic and non-genetic factors

Effect	Calving	Fertility and post calving uterine health indicators		
		RB	AN	ROP
Overall	3165	0.06 (185)	0.22 (699)	0.18 (584)
Period				
1993-95	123	0.02 (3)	0.07 (9)	0.10 (12)
1996-98	513	0.03 (14)	0.14 (70)	0.25 (126)
1999-01	544	0.05 (29)	0.22 (122)	0.25 (135)
2002-04	572	0.09 (51)	0.36 (207)	0.18 (101)
2005-07	650	0.09 (59)	0.19 (125)	0.18 (119)
2008-10	311	0.03 (10)	0.16 (50)	0.13 (41)
2011-13	275	0.02 (5)	0.32 (89)	0.09 (25)
2014-16	177	0.08 (14)	0.15 (27)	0.14 (25)
Season				
Summer	727	0.06 (41)	0.21 (153)	0.15 (110)
Rainy	521	0.09 (48)	0.31 (163)	0.23 (118)
Autumn	722	0.05 (35)	0.17 (126)	0.13 (96)
Winter	1195	0.05 (61)	0.22 (257)	0.22 (260)
Parity				
1	1219	0.05 (61)	0.17 (211)	0.13 (164)
2	809	0.06 (50)	0.28 (224)	0.21 (167)
3	488	0.07 (33)	0.23 (113)	0.20 (99)
4	276	0.08 (23)	0.25 (69)	0.25 (70)
5	373	0.05 (18)	0.22 (82)	0.23 (84)
Genetic Group				
1	342	0.06 (19)	0.22 (76)	0.16 (56)
2	2634	0.06 (154)	0.22 (582)	0.19 (498)
3	189	0.06 (12)	0.22 (41)	0.16 (30)

Table 5: Chi-square value for post calving and fertility disorders

Effect	df	Pearson chi-square value		
		Repeat Breeding	Anestrous	Retention of Placenta
Period	7	47.42**	134.27**	57.75**
Season	3	13.29**	35.33**	32.86**
Parity	4	15.51**	32.61**	34.03**
Genetic group	2	0.14	0.02	2.17

*Significant ($p < 0.05$); **Significant ($p < 0.01$)

3. Impact of various non-genetic factors on incidence of post calving uterine health and fertility indicators in terms of ODDS values

The results of the multivariate logistic regression showed that the rainy season was when repeat breeding, anestrous, and placenta retention were most common. As indicated in Table 6 below, it also showed a greater ODDS ratio in favor of normal fertility and post-calving uterine health in animals calved during the fall season.

Period

In terms of repeat breeding, anestrous, and placenta retention at various times, the incidence of normal fertility and post-calving uterine health ranged from 5.086 to 1.00,

2.004 to 0.301, and 1.709 to 0.523. Repeated breeding and anestrous were found to be most common between 2002 and 2004, whereas placenta retention was most common between 1996 and 1998.

Parity

The incidence of repeat breeding, anestrous, and placenta retention were all strongly influenced by parity; second parity had the highest incidence of repeat breeding and anestrous, whereas fourth parity had the highest incidence of placenta retention.

Genetic cluster/group and stage of lactation:

Fertility and post-calving uterine health characteristics were not significantly impacted by genetic group or lactation

stage. As demonstrated in Table 7, the Wald chi-square estimates for various non-genetic parameters showed that parity and calving period had a highly significant ($p < 0.01$) impact on all fertility and post-calving uterine health features (repeat breeding, anestrus, and placenta retention). The season of calving has a highly significant ($p < 0.01$) impact on anestrus and placenta retention and a considerable ($p < 0.05$) impact on repeat breeding.

Table 6: Impact of various non-genetic factors on incidence of post calving uterine health and fertility indicators in terms of ODDS values

Effect	Calving	Fertility and post calving uterine health indicators		
		Repeat breeding	Anestrus	Retention of Placenta
Period	1993-95	2621	2.004	1.309
	1996-98	2.834	1.134	0.523
	1999-01	1.400	0.610	0.557
	2002-04	0.773	0.301	0.809
	2005-07	0.847	0.765	0.733
	2008-10	2.534	0.949	0.961
	2011-13	5.086	0.395	1.709
	2014-16	1.00	1.00	1.00
Season	Summer	0.900	1.037	1.572
	Rainy	0.563	0.614	1.016
	Autumn	1.145	1.324	1.945
	Winter	1.00	1.00	1.00
Parity	1	0.678	0.933	2.125
	2	0.385	0.541	1.186
	3	0.486	0.755	1.128
	4	0.427	0.691	0.847
	5	1.00	1.00	1.00
Genetic group	1	1.147	0.99	0.963
	2	1.053	0.96	0.786
	3	1.00	1.00	1.00
Stage of Lactation	1	0.823	0.98	0.731
	2	0.910	1.07	0.983
	3	1.00	1.00	1.00

Table 7: Wald Chi-square values for fertility and post calving disorder in KF cattle

Effect	df	Wald chi-sq values		
		Repeat Breeding	Anestrus	Retention of Placenta
Period	7	41.68**	123.74**	39.45**
Season	3	11.28*	31.69**	33.58**
Parity	4	15.65**	27.5**	31.27**
Genetic group	2	0.156	0.08	2.77
Stage of lactation	2	0.576	0.17	3.83

*Significant ($p < 0.05$); **Significant ($p < 0.01$)

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