Non-genetic Factors Influencing Conception Rate of Vechur Breed of Cattle from Kerala

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ABSTRACT

Background: Vechur cattle, a native breed of Kerala, are known for their low maintenance requirements, disease resistance and adaptability to tropical climates. Fertility, particularly conception rate, is a crucial factor in livestock productivity and is influenced by both genetic and non-genetic factors. Non-genetic factors such as management practices, nutrition, health, month and year of breeding play a significant role in reproductive performance. Understanding the impact of these variables is essential for optimizing breeding strategies and improving fertility outcomes. This study aims to analyse the effect of non-genetic factors on the conception rate of Vechur cattle maintained at the Vechur Cattle Conservation Project, Centre for Advanced Studies in Animal Genetics and Breeding, Mannuthy.

Methods: A total of 868 breeding records spanning 14 years (2011-2024) were collected and analysed. The data included information on breeding time (forenoon or afternoon), month and year of breeding. The conception rate was calculated as the percentage of successful pregnancies relative to total breeding attempts. Statistical analysis was performed using SPSS v27, employing logistic regression to assess the influence of categorical variables on conception rate and chi-square tests to determine significant differences across different years, months and breeding conditions. Bulls used for natural service were periodically evaluated for seminal quality and their conception rates were compared to assess variations in male fertility.

Result: The overall conception rate during the study period was 51.40%. Year-wise analysis showed significant variations, with higher conception rates observed in 2012 and 2021, while lower rates were recorded in 2013 and 2024. Monthly analysis revealed that August had a significantly lower conception rate (32.10%) compared to other months. The time of breeding (forenoon vs. afternoon) had no significant effect on conception rate. No significant variation was observed in conception rates across different bulls used for natural service, suggesting consistent seminal quality and fertility across sires. These findings highlight the influence of environmental factors on reproductive performance and emphasize the need to incorporate these variables into breeding and improvement programs for Vechur cattle.

Key words: Conception rate, Month and year effects, Natural services.

INTRODUCTION

According to the 20th Livestock Census (2019), the cattle population in the country stands at 192.49 million, including indigenous cattle (both identified/descript and non-identified/ non-descript) as well as exotic and crossbred animals. Climate change has a significant impact on livestock, influencing growth, production and reproductive efficiency (Lees *et al.*, 2019; Mitchell *et al.*, 2018). Dwarfing serves as an adaptive response to high heat and humidity (Elayadeth-Meethal *et al.*, 2018). Cattle that have evolved in hot and humid environments tend to exhibit reduced growth (Pauler *et al.*, 2020; Elayadeth-Meethal *et al.*, 2018). A smaller body size, as observed in breeds like the dwarf Vechur, is regarded as an adaptation to rising temperatures. Evidence suggests that smaller animals possess greater metabolic efficiency and improved heat tolerance (Elayadeth-Meethal *et al.*, 2021). Vechur cow rearing is well-suited for a low-input, eco-friendly system, as these cattle require minimal amounts of grass and other feed materials. Additionally, they can be sustained on agricultural by-products, making them an efficient and sustainable choice for farming (Anjali and Senthilkumar, 2020). Given the significant contribution of livestock to India's GDP and rural livelihood systems (Gupta *et al.*, 2022), the conservation and reproductive improvement of breeds like Vechur are essential. As highlighted by Rai *et al.* (2023), an integrated approach combining genetic improvement with conservation is vital for sustaining these native breeds.

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Repeat breeding and anoestrus are major challenges in dairy animal breeding, resulting in prolonged calving intervals, higher culling rates and reduced farm profitability (Bartlett *et al.*, 1986; Lafi *et al.*, 1992). Reproductive performance in animals is influenced by various non-genetic factors. The changing climate underscores the importance of conserving locally adapted cattle breeds. Characterising these native breeds for thermo-tolerance is essential to uncover their inherent ability to thrive under challenging climatic conditions (Manoj *et al.*, 2017). Non-genetic factors play a crucial role in determining the reproductive and productive efficiency of indigenous cattle breeds. Patel *et al.* (2022) demonstrated this in Tharparkar cattle, where long-term data revealed that herd management practices and selection influenced reproductive traits. These insights emphasize the need to understand such influences in other native breeds like Vechur, especially under tropical conditions. Therefore, this study was conducted to assess the impact of these factors on conception rate in an organized herd of indigenous cattle raised under tropical climatic conditions.

MATERIALS AND METHODS

The present study was conducted at the Vechur Cattle Conservation Project, Centre for Advanced Studies in Animal Genetics and Breeding, Mannuthy, Kerala, to assess the influence of non-genetic factors on the conception rate of Vechur cattle. A total of 868 breeding records spanning from 2011 to 2024 were analysed. The dataset included information on the date of service, conception outcome and environmental factors such as time of service, month and year of breeding. The cattle were maintained under a uniform management system, with natural service as the predominant breeding method. Bulls used for breeding were periodically evaluated for seminal parameters to ensure optimal fertility levels.

The objective of the study was to analyse monthly variations in conception rates in order to identify trends potentially influenced by climatic conditions, availability of green fodder and other management-related factors. The year-wise analysis was carried out to assess long-term variations in reproductive performance over the 14 years.

The statistical analysis was performed using SPSS v27.0 software. The chi-square (χ^2) test was used to determine the association between non-genetic factors and conception success. The chi-square statistic was calculated using the formula,

$$X^2 = \Sigma \frac{(O_i - E_i)^2}{E_i}$$

Where,

O_i = Observed frequency.

E_i = Expected frequency.

In addition, logistic regression analysis was employed to assess the probability of conception based on the non-genetic factors considered. The logistic regression model was defined as:

$$\log (p/p - 1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

Where,

p = Represents the probability of conception.

β_0 = Intercept.

β_1 and β_2 = Regression coefficients.

X_1 and X_2 = Represent the independent variables (month and year).

The significance of each variable in predicting conception success was evaluated and odds ratios were calculated to interpret the likelihood of conception under different conditions.

RESULTS AND DISCUSSION

To ensure data integrity, records of repeat breeders and cows subjected to artificial insemination were excluded, retaining only natural service conception records. After refinement, 868 valid breeding records from 2011 to 2024 were analysed. It is important to note that data from 2024 was only available up to August, which may have introduced bias in year-wise comparisons.

Table 1 shows that the time of breeding-whether in the forenoon or afternoon-had no significant impact on conception rates, as indicated by the chi-square analysis

Table 1: Effect of time of breeding (Forenoon vs. Afternoon) on conception rates.

Time	Positive	Total breeding	Conception rate (%)
AN	115	225	51.1
FN	106	219	48.4

Non-significant: $p>0.05$.

Table 2: Monthly conception rates and their statistical significance (2011-2024).

Month	Positive	Negative	Total breeding	Conception rate (%)
Jan	43	35	78	55.1
Feb	45	48	93	48.4
Mar	50	31	81	61.7
Apr	33	29	62	53.2
May	29	34	63	46
Jun	41	43	84	48.8
Jul	36	33	69	52.2
Aug	26	54	80	32.5
Sep	26	26	52	50
Oct	38	30	68	55.9
Nov	42	27	69	60.9
Dec	37	32	69	53.6
Total	446	422	868	51.4*

Significant: $p<0.05$.

($p>0.05$). This lack of variation could be attributed to the controlled management conditions under which the breeding bulls were maintained. Regular health monitoring and reproductive evaluations ensured optimal fertility, while shade management and housing conditions helped mitigate the effects of diurnal temperature fluctuations.

A significant difference in conception rates was observed across months ($p<0.05$), with the lowest rate recorded in August (32.10%) and the highest in March (61.7%) (Table 2). This decline coincides with peak monsoon conditions in Kerala, where high humidity, reduced sunlight exposure and lower-quality fodder availability may negatively impact reproductive performance. No significant variations were found among the remaining months, suggesting that apart from August, monthly fluctuations do not play a major role in conception success.

Year-wise analysis showed significant variation ($p<0.05$) in conception rates across different years (Table 3). The highest rates were observed in 2012 and 2021, while 2013 and 2024 recorded the lowest. Favourable climatic conditions, improved herd management and optimized nutritional strategies could explain the higher conception rates in 2012 and 2021. Additionally, the lack of a consistently increasing trend in conception rates across years can be explained by the average inter-calving period of 514 days, meaning that cows do not calve every year, leading to natural fluctuations in breeding data. Moreover, nearly 30% of the recorded data corresponds to the last four months of the previous calving cycle, meaning that a significant proportion of animals from the later part of one year would not conceive again in the immediately following year. This pattern results in inherent variations in annual conception rates rather than a steady increasing trend.

Table 3: Year-wise conception rates of cattle and their statistical significance (2011-2024).

Year	Positive	Total	Conception rate (%)
2011	37	76	48.7
2012	39	58	67.2
2013	12	43	27.9
2014	36	69	52.2
2015	46	86	53.5
2016	34	57	59.6
2017	34	54	63
2018	20	33	60.6
2019	32	53	60.4
2020	18	44	40.9
2021	37	54	68.5
2022	33	73	45.2
2023	38	82	46.3
2024	30	86	34.9
Total	446	868	51.4*

Significant: $p<0.05$.

To ensure statistical reliability, bulls with fewer than five recorded breeding were excluded and only those with more than five breeding records were analysed (Table 4). The chi-square test showed no significant variation in conception rates across different bulls ($p>0.05$). This uniformity is likely due to the rigorous semen quality evaluations, which ensured that only bulls with optimal fertility parameters were selected and maintained for breeding.

Table 4: Conception rates across different bulls (Excluding bulls with ≤5 breedings).

Animal no.	Positive	Total breeding	Conception rate (%)
450	3	9	33.3
485	5	10	50
530	9	21	42.9
552	12	23	52.2
553	5	10	50
562	3	7	42.9
563	1	6	16.7
585	8	13	61.5
586	1	7	14.3
631	22	41	53.7
659	27	49	55.1
673	10	14	71.4
692	13	21	60
739	3	7	42.9
756	18	40	45
776	7	12	58.3
794	9	17	52.9
867	21	42	50
890	23	39	59
907	5	14	35.7
913	5	11	45.5
924	5	19	26.3
929	44	75	58.7
959	3	15	20
962	24	39	61.5
963	6	16	37.5
964	16	32	50
965	19	37	51.4
970	4	7	57.1
974	4	8	50
978	4	8	50
987	17	27	63
988	11	20	55
1003	7	10	70
1017	3	9	33.3
1025	16	33	48.5
1060	8	16	50
1122	17	29	58.6
1181	10	14	71.4
Total	428	827	51.8

Non-Significant: $p<0.05$.

Table 5: Logistic regression analysis of year-wise conception rate variations (Baseline: 2024).

Year	P value	Exp.
2011	.075	1.824
2012	.000	3.900
2013	.337	.667
2014	.032	2.070
2015	.022	2.090
2016	.004	2.829
2017	.003	3.096
2018	.027	2.600
2019	.006	2.906
2020	.514	1.290
2021	.000	3.913
2022	.212	1.514
2023	.085	1.770

Table 6: Logistic regression analysis of monthly conception rate variations (Baseline: December).

Month	P value	Exp.
Jan	.985	.994
Feb	.556	.819
Mar	.356	1.380
Apr	.983	1.008
May	.577	.817
Jun	.833	.931
Jul	.942	.974
Aug	.008	.397
Sep	.441	.744
Oct	.794	1.097
Nov	.574	1.221

Logistic regression was used to quantify the influence of non-genetic factors on conception probability. Using 2024 as the baseline year, the model estimated whether conception rates in previous years significantly increased or decreased (Table 5). Similarly, with December as the baseline month, the likelihood of significant variation in conception across different months was assessed (Table 6).

Heat stress negatively affects fertility by disrupting oestrous cycles, reducing oocyte quality, increasing embryonic loss, altering the uterine environment and lowering semen quality (Dash *et al*., 2016; Hansen, 2020; Roth, 2021). High temperatures suppress GnRH secretion, impair follicular development and increase oxidative stress, leading to lower conception rates (Wolfenson and Roth, 2019; Schüller *et al*., 2017). Bulls also experience reduced sperm motility and viability during heat stress (Yeste, 2016). To mitigate these effects, breeding programmes should aim mating during cooler months and provide shade, ventilation, misting and electrolyte supplementation to reduce heat stress. Nutritional adjustments, improved oestrus detection methods and genetic selection for heat resilience are essential strategies. Regular monitoring of semen quality and rotational use of bulls can further optimise fertility outcomes (Dash *et al*., 2016; Hansen, 2020).

CONCLUSION

The study revealed that the overall conception rate in Vechur cattle over a 14-year period was 51.40%. Among the non-genetic factors evaluated, significant variations were observed across months and years. The lowest conception rate was recorded in August, coinciding with the peak monsoon period in Kerala, suggesting that high humidity and associated climatic stress may adversely affect fertility. In contrast, no significant effect was observed for the time of breeding (forenoon vs. afternoon) and conception rates remained consistent across different breeding bulls, likely due to rigorous selection and regular evaluation of semen quality. These findings reveal the critical role of non-genetic factors in determining reproductive efficiency in dwarf indigenous cattle breeds. Aligning breeding schedules with favourable climatic windows and minimising heat and humidity stress through improved management practices can enhance fertility outcomes. Furthermore, the uniformity observed across bulls highlights the effectiveness of proper sire selection and monitoring programs. The insights from this study helps in formulating breeding strategies for Vechur cattle, supporting their sustainable conservation and improved productivity under tropical conditions.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal Care and handling techniques were approved by the University Animal Care Committee.

Conflict of interest

The authors declare that there is no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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