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Influence of Seasonal Meteorological Factors on Infertility of Cross Bred Dairy Cattle

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ABSTRACT

Seasonal changes significantly influence the reproductive performance of dairy animals. In Kerala, temperature, relative humidity, and rainfall are the major determining meteorological factors. An exploratory study was conducted at ICAR–Krishi Vigyan Kendra, Kollam utilizing the season wise meteorological data from District Agro-Met Unit (DAMU) supported by India Meteorological Department (IMD) to assess infertility problems mainly anoestrus, repeat breeding, and prolonged oestrus, in dairy cattle of Kollam district, Kerala. Data were collected for a period of three years (January 2022–January 2025) from the Infertility Veterinary Hospital register maintained at Krishi Vigyan Kendra and meteorological parameters from the District Agro-Met Unit's Automatic Weather Station. Weather patterns were classified into four quarters: South-west Monsoon, North-east Monsoon, Winter, and Summer. The weather parameters were analysed for monthly, seasonal, and yearly patterns, and the findings are discussed. A total of 1009 cycles of crossbred dairy cattle were monitored to examine the association between various seasons and infertility conditions. Repeat breeding (52.69 per cent of the cases), was the most predominant infertility condition observed in both cows and heifers in Kollam district. Significantly higher cases of prolonged oestrus (39.2 per cent) were recorded during the South-west Monsoon season. The peak occurrence of repeat breeding (51.93 per cent) and anoestrus (52.70 per cent) was reported during the summer months, along with significantly higher ($p < 0.01$) maximum temperature (35.80 ± 1.90 °C) and average temperature (28.55 ± 0.91 °C) values. These findings suggest that meteorological parameters, particularly temperature, is the major factor associated with infertility problems in the dairy sector.

HIGHLIGHTS

- Repeat breeding was the most common infertility condition in both cows and heifers.
- Highest incidence of repeat breeding and anoestrus occurred during summer.
- Increased infertility during summer is strongly associated with meteorological factors.

Keywords: Infertility, Repeat breeding, prolonged oestrus, Anoestrus, Meteorological parameters

Reproductive efficiency in dairy cows is the foundation of profitable milk production and sustainable herd management. India, which contributes 24 per cent of global milk production (Economic Review, 2023), owes this achievement primarily to the vast population of dairy cattle rather than their high individual productivity. Infertility is one of the major constraints affecting dairy production, where cross-bred cattle dominate. The most commonly reported infertility conditions are repeat breeding, anoestrus and prolonged oestrus in tropical regions. Repeat breeding in cattle is considered to be one

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of the most serious reproductive disorders which lead to extended inter-calving interval, thereby causing greater economic loss to the dairy farmers. Arun *et al.,* 2020 and Aruna *et al.,* 2021) reported an occurrence of 25.96 per cent and 23.60 per cent of repeat breeding respectively among the crossbred dairy cows in Kerala. Prolonged oestrus is a condition in which the duration of oestrus and the interval between the onset of oestrus and ovulation interval both are exceeding the normal range. In some cases, the duration of oestrus has been reported to be greater than 36 hrs, which can vary from 2-7 days (Bage *et al.,* 2002; Bloch *et al*., 2006).

Prolonged oestrus has been reported to be observed in 50 per cent of repeat breeder cows (Cummins *et al.,* 2012; Ghuman *et al*., 2014; Arun *et al.,* 2020). The conception rate in cows showing prolonged oestrus decreased drastically as the duration of oestrus increased (Nebel *et al*., 2000). Parvathy (2015) reported that 21.78 per cent of prolonged oestrus conditions prevailed among the crossbred cows reared under farm conditions of Kerala. Incidence of anoestrus has been reported higher in indigenous (25-67 per cent) cattle than the exotic or crossbred (2-20 per cent) cattle (Singh *et al.,* 2003; Pandit 2004). The incidence of anoestrus in cows reported by different researchers reveal that, it ranges from 5.01 (Selvaraju *et al.*, 2005) to 65.00 per cent (Kutty and Ramachandran, 2003) in different states of India.

The fertility traits in dairy animals show a very low heritability value, and this indicates that most of the variations in the fertility are determined by non-genetic factors or environmental factors as suggested by Thiruvenkadan *et al.,* 2010. Photoperiod formed the major regulator of circannual rhythm of breeding activity, ambient temperature (AbT) regulated the circadian and seasonal rhythms through the influence on endocrine and molecular mechanisms of reproductive events (Marai *et al.*, 2008). The main environmental factors affecting livestock systems include air, temperature, relative humidity (RH), solar radiation, atmospheric pressure, and wind speed (WS). According to Hahn *et al.,* 2003, these environmental factors collectively contribute to heat stress in animals, which is defined as any combination of environmental variables that produce conditions exceeding the animal's thermo neutral zone (TNZ).

Seasonal changes in Kerala are the key factor influencing the various infertility conditions in dairy cattle. Different classifications of seasons in Kerala are being used in various studies and the classification most often used is with four months under Southwest monsoon (June to September), two months under North East monsoon (October and November) and three months each under winter (December to February) and summer (March to May). This classification is mainly based on the occurrence of monsoon rainfall and direction of wind causing the rain (Kumar, 2013; Rao, 2013). The climate change phenomena have been found to cause major threats for enhancement of animal productivity especially at the tropical regions contributed by increasing atmospheric temperature (AtT) and is being projected up to 0.2 degree Celsius (^{o}C) per decade, reaching 1.5 degree Celsius above the level of pre-industrial period, between 2030 and 2050 (IPCC, 2018). Hence, the present study aimed to identify the occurrence of various infertility cases associated with dairy cattle under farm and field conditions and its relation with various seasons prevailing in Kerala.

MATERIALS AND METHODS

An exploratory study was conducted at ICAR-Krishi Vigyan Kendra, Kollam, in collaboration with the District Agro-Met Unit's Automatic Weather Station (AWS) installed at station premises to evaluate the seasonal infertility problems namely repeat breeding, prolonged oestrus and anoestrus, in dairy cattle of Kollam District. The study covers from January 2022 to January 2025 over a period of 3 years with total of 1009 cycles of animals were screened (278 cows and 147 heifers) and data were collected from breeding registers maintained at ICAR Krishi Vigyan Kendra, Kollam and from the software data regarding the meteorological parameters collected from Automatic Weather Station under District Agro-Met Unit by India Meteorological Department (IMD) maintained at ICAR Krishi Vigyan Kendra Kollam.

The study area, Kollam District, Kerala is located at a latitude of 8.893212° N and longitude of 76.614143° E, widely experienced by a typical tropical humid climate influenced by four different seasons with southwest monsoon (June to September) contributes the highest rainfall followed by the northeast monsoon (October to December), which brings intermittent showers and the summer season (March to May) is generally hot and humid with maximum temperature ranging between

32°C and 36°C, while the winter months (December to February) remain comparatively cooler, averaging 22°C to 28°C. These marked seasonal variations in temperature, humidity and rainfall can significantly influence the reproductive performance of dairy cattle, contributing to infertility problems such as anoestrus, repeat breeding, and prolonged oestrus. Information regarding the occurrence of various infertility problems in all breed-able crossbred cattle during the period January 2022 to January 2025 were compiled. Cows exhibiting oestrus duration longer than 36 hours were categorized as having prolonged oestrus, those that failed to conceive after three consecutive artificial inseminations (AI) performed at regular intervals were classified as repeat breeders; and animals showing no oestrus symptoms for two consecutive cycles were considered anestrous. A retrospective infertility dataset collected over three years (2022–2025) was compared with corresponding climatic data on a monthly, seasonal, and yearly basis, obtained from the Automatic Weather Station, to identify the most common infertility conditions prevailing in the district. All the collected data were systematically tabulated and statistically analyzed using Chi-square tests and ANOVA to assess the influence of seasonal and climatic variations on infertility patterns in dairy cattle of Kollam District.

RESULTS AND DISCUSSION

Occurrence of various infertility conditions

Analysis of data was carried out on 1,009 screened estrous cycles of crossbred dairy cattle, comprising 639 cows and 370 heifers, over a three-year study period. Statistical analysis indicated a significantly higher occurrence of repeat breeding and anoestrus were reported among heifers compared to cows.

The results revealed that repeat breeding was observed in 52.89 per cent of cows and 61.79 per cent of heifers, with an overall incidence of 51.34 percent. The occurrence of repeat breeding in present study was in accordance with the findings of Harichandan *et al.,* 2018 observed an occurrence of repeat breeding of 51.94 per cent in cross bred dairy cattle and this was contrary, with the findings of Arun *et al.,* 2020, Aruna *et al.,* 2021 and Guruvandana *et al.,* 2025 who reported an occurrence of 25.96 per cent, 23.60 and 21.08 per cent of repeat breeding respectively among the crossbred dairy cows in Kerala.

The incidence of prolonged oestrus was 25.03 per cent in cows and 24.32 per cent in heifers, with an overall occurrence of 24.77 per cent. Similar results have been reported with 26.6 per cent and 21.62 per cent of prolonged heat among crossbred cattle in Kerala maintained under field and farm conditions respectively (Jeba-Sujana, 2005) and an occurrence of prolonged oestrus 21.62 per cent was reported by Dhas, 2005 and 21.78 per cent of prolonged oestrus conditions among the crossbred cows reared under farm conditions as suggested by Parvathy (2015). Bedi *et al.,* 2007, observed that out of 1332 oestrus in crossbred cows, 21.9 per cent of crossbred cows exhibited oestrus period for less than 24 hrs, whereas 48.9 per cent of cows exhibited oestrus period for 24-36 hrs and 30.05 per cent of cows exhibited oestrus period for more than 36 hrs. Study conducted on crossbred cattle by Das (2017) recorded that the incidence of prolonged oestrus was about 14.24 per cent , and 7.60, 8.04 and 1.06 per cent of cows showed oestrus for 2, 3 and 4 days duration, respectively.

Similarly, anoestrus was recorded in 22.06 per cent of cows and 27.02 per cent of heifers, with an overall occurrence of 23.88 per cent. A high incidence of anoestrus in cows was also reported by Singh *et al.,* 2003 and Pandit, 2004, ranging from 49.70 to 67.11 per cent in Andhra Pradesh, Punjab, and Madhya Pradesh. Kutty and Ramachandran

Table 1: Occurrence of Infertility conditions during the period from January 2022 to January 2025

Animal	No. of cycles screened	Repeat breeding		Prolonged oestrus		Anoestrus	
		Number	Per cent (%)	Number	Per cent	Number	Per cent
Cow	639	338[a]	52.89	160[a]	25.03	141[a]	22.06
Heifer	370	180[a]	61.79	90[a]	24.32	100[a]	27.02
Total	**1009**	**518**	**51.34**	**250**	**24.77**	**241**	**23.88**

Values having same superscripts in columns shows no significant difference.

(2003) also reported that 65 per cent of infertility cases were due to anoestrus in crossbred cattle in Kerala. In contrast, Das *et al.,* 2004 reported a lower occurrence of 15.97 per cent anoestrus cases in Cuttack and Bhubaneswar. The variation in incidence might be attributed to differences in nutrition and environmental factors.

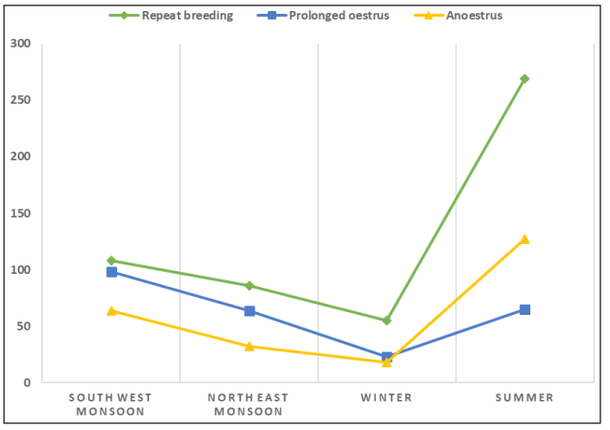

Fig. 1: Occurrence of infertility conditions with respect to season from January 2022 to January 2025

In Kerala, similar to other tropical regions, higher infertility rates in heifers compared to cows are commonly observed due to a combination of nutritional, managemental, and physiological factors. Heifers are often reared on low-protein fodders that are inadequate for proper growth and reproductive development. On the other hand, a higher occurrence of prolonged oestrus is reported among cows than in heifers, which may be attributed to negative energy balance after calving, parturient and post-parturient complications and lactation stress.

Out of the total repeat breeding cases, 51.93 per cent were reported during the summer season, which was observed to be the maximum incidence among dairy cattle, while the lowest occurrence 10.62 per cent was recorded during the winter months. This may be attributed to heat stress, as elevated ambient temperature and humidity during summer adversely affect both the hypothalamo–pituitary–ovarian axis and the uterine environment. In accordance with the findings of Singh *et al.,* 2012, heat stress was found to decrease estrus intensity and increase repeat breeding in high-yielding Holstein Friesian crossbreds. Similarly, Dash *et al.,* 2016 noted that embryonic mortality was a

Table 2: Occurrence of infertility conditions with respect to season from January 2022 to January 2025

Seasons	Repeat breeding		Prolonged oestrus		Anoestrus	
	Number	Per cent	Number	Per cent	Number	Per cent
South west Monsoon	108[a]	20.85	98 [a]	39.2	64[a]	26.56
North East Monsoon	86[b]	16.60	64[b]	25.6	32[b]	13.28
Winter	55[c]	10.62	23[c]	9.2	18[c]	7.47
Summer	269[d]	51.93	65[d]	26	127[d]	52.70
df	3		3		3	
Chi-square value	209.13		45.6		117.06	
Chi-square crit	7.81		7.81		7.81	

Values having different superscripts in columns differ significantly at 1 per cent level.

Table 3: Meteorological Parameters with respect to the various seasons

Seasons	Meteorological Parameters (Mean ± S.E.)				
	Rainfall (mm)	Min. AbT (ºC)	Max. AbT (ºC)	Average Temp (ºc)	Relative Humidity (per cent)
South west Monsoon	9.51± 4.36[a]	22.09 ± **1.78**[a]	32.12 ± 0. 99 [a]	27.04±1.04[a]	83.05 ± 3.30 [a]
North East Monsson	6.03± 5.40 [b]	21.55± 1.68[b]	33.07± 0.41 [b]	26.94±1.11[b]	86.24 ± 2.06 [b]
Winter	0.68 ±1.13[c]	19.14 ± 1.70[c]	34.54±1.36 [c]	27.29±0.85[c]	83.73 ± 2.36 [c]
Summer	5.50± **5.66** [d]	21.87 ± 2.05[d]	35.80± 1.90[d]	28.55±0.91[d]	80.61 ± 3.24 [d]
F - value	7.75	6.86	18.99	6.82	8.19
p- value	0.000289	0.000684	0.0000	0.0007	0.0001

Means with different superscripts vary significantly within a column at 1 per cent level.

major reason for repeat breeding during summer, due to elevated uterine temperature.

Maximum cases of prolonged oestrus were reported during south west monsoon (39.2 per cent). Higher occurrence during south-west monsoon may be due to climatic stress prevailing during the season. During cold weather, cows exhibit more mounting activity (Youngquist and Threlfall, 2007), which also might be a reason for reporting of more cases during this season.

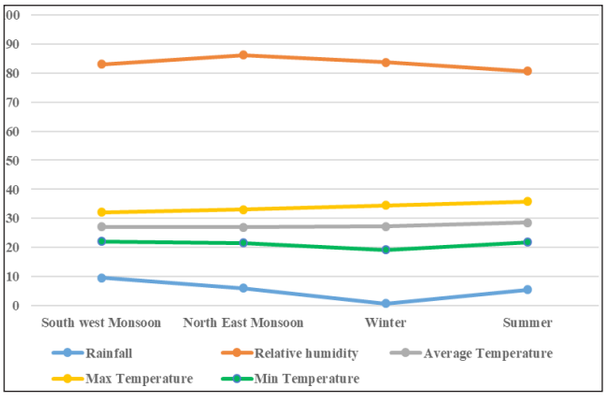

Fig. 2: Meteorological Parameters with respect to the various seasons

Maximum anoestrus cases were reported in summer months with 52.70 per cent. During hot season, in order to maintain body temperature, imbalances in energy metabolism occurs. This would lead to suppressed activity of aromatase enzyme in granulosa cells that retard the functionality of dominant follicles (Wolfenson *et al.,* 2000). Roth *et al.,* 2000 stated that follicular micro environment was adversely affected by elevated exposure of temperature and will lead to deterioration of functioning dominant follicles. Thus, the ovulatory follicle might require more time and a larger size for attaining ovulation under heat stress and such follicles would be of inferior quality that led to yield poor quality oocytes and subsequent infertility (Hansen 2009).

SUMMARY

In the present study, we report the association between various seasons and infertility conditions in crossbred dairy cattle. Repeat breeding was the most predominant infertility condition observed in both cows and heifers in Kollam district, with the highest incidence of repeat breeding and anoestrus reported during the summer months. Significantly higher occurrence of prolonged oestrus was recorded during the South-West monsoon season. The peak occurrence of repeat breeding and anoestrus during summer, along with significantly higher maximum and average temperature values, suggests that meteorological parameters particularly average and maximum temperatures are related to infertility. This is mainly due to heat stress-induced endocrine imbalance, poor oocyte quality, reduced estrus expression, nutritional deficiencies, and a compromised uterine environment. Preventive strategies should therefore focus on improving thermal comfort, ensuring balanced nutrition, and strengthening reproductive management to reduce economic losses during high-temperature periods.

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

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REFERENCES

Arun, H.D., Becha, B.B., Jayakumar, C., Unnikrishnan, M.P., Ajith, K.S. and Kurien, M.O. 2020. Occurrence of repeat breeding and prolonged oestrus in crossbred cattle. *J. Vet. Anim. Sci.*, **51**: 132–135.

Aruna, S. 2021. Management of infertility in repeat breeder cows using Ovsynch protocol initiated during early and mid-luteal phases of the oestrous cycle. *M.V.Sc. thesis*, Kerala Veterinary and Animal Sciences University, Pookode, 108p.

Bage, R., Gustafsson, H., Larsson, B., Forsberg, M. and Rodryguez-Martynez, H. 2002. Repeat breeding in dairy heifers: follicular dynamics and estrous cycle characteristics

in relation to sexual hormone patterns. *Theriogenology*, **57**: 2257–2269.

Bloch, A., Folman, Y., Kaim, M., Roth, Z., Braw-Tal, R. and Wolfenson, D. 2006. Endocrine alterations associated with extended time interval between estrus and ovulation in high-yield dairy cows. *J. Dairy Sci.*, **89**: 4694–4702.

Cummins, S.B., Lonergan, P., Evans, A.C.O. and Butler, S.T. 2012. Genetic merit for fertility traits in Holstein cows: II. Ovarian follicular and corpus luteum dynamics, reproductive hormones, and estrus behavior. *J. Dairy Sci.*, **95**: 3698–3710.

Das, R.K., Ray, S.K.H., Mohanty, D.N., Das, S. and Jena, J.C. 2004. Preliminary studies on the incidence of gynaeco-clinical disorders of bovine. *Livest. Int.,* 8: 6-9.

Das, N. 2017. Study on prolonged oestrus in crossbred cattle. *M.V.Sc. Thesis*, Assam Agricultural University, Khanapara, Guwahati, Assam.

Dash, S., Chakravarty, A.K., Singh, A., Upadhyay, A., Singh, M. and Yousuf, S. 2016. Effect of heat stress on reproductive performances of dairy cattle and buffaloes: A review. *Vet. World*, **9**(3): 235–244.

Ghuman, S.P.S., Honparkhe, M., Dadarwal, D. and Dhaliwal, G. 2014. Optimizing estrous period characteristics of crossbred cows exhibiting prolonged estrus using a PGF-α analogue. *Indian J. Anim. Sci.*, **84**: 15–17.

Guruvandana, P., Chacko, L., Abdul Azeez, C.P., Promod, K., Lekshmi Bhai, K., Pramod, S. and Prasad, A. 2025. Occurrence of subclinical endometritis and oestrus characteristics in repeat breeder cows. *J. Vet. Anim. Sci.*, **56**(1): 60–67.

Hahn, G.L., Mader, T.L. and Eigenberg, R.A. 2003. Perspectives on development of thermal indices for animal studies and management. In: *Proceedings Symposium: Interactions between Climate and Animal Production.* EAAP Technical Series No. 7, pp. 31–44.

Harichandan, P.P., Barik, A.K., Mishra, P.C., Patra, B.K., Jena, B., Patra, R. and Kund, A.K. 2018. Prevalence of reproductive disorders in Niali and Kantapara block of Cuttack district, Odisha, India. *Int. J. Curr. Microbiol. Appl. Sci.*, **7**: 1683–1689.

IPCC. 2018. Summary for policymakers. In: Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels. Available at: www.ipcc.ch.

Jeba-Sujana, D. 2005. Fertility trials on induced oestrus in repeat breeding cattle with prolonged oestrus. *M.V.Sc. Thesis*, College of Veterinary and Animal Sciences, Mannuthy.

Kumar, M.S. 2013. Indian climatology. *In:* Rao, G.S.L.H.V.P. and Varma, G.G. (Eds.), *Fundamentals of Livestock Meteorology*, Vol. 1. Centre for Animal Adaptation to Environment and Climate Change Studies, Kerala Veterinary and Animal Sciences University, pp. 72–98.

Kutty, J.C. and Ramachandran, K. 2003. Bovine infertility – a field-oriented categorisation based on investigation among crossbred cattle in a district of Kerala. *Indian J. Anim. Sci.*, **73**: 155–157.

Marai, I.F.M., El-Darawany, A.A., Fadiel, A. and Abdel-Hafez, M.A.M. 2008. Reproductive performance traits as affected by heat stress and its alleviation in sheep – a review. *Trop. Subtrop. Agroeco.*, **8**: 209–234.

Nebel, R.L., Dransfield, M.G., Jobst, S.M. and Bame, J.H. 2000. Automated electronic systems for the detection of oestrus and timing of AI in cattle. *Anim. Reprod. Sci.*, **60**: 713–723.

Pandit, R.K. 2004. Incidence of different kinds of reproductive disorders in livestock. *Indian J. Anim. Reprod.*, **25**: 35–36.

Parvathy, S. 2015. Effect of prostaglandin administration on progesterone levels during oestrus cycle in crossbred cattle showing prolonged oestrus. *M.V.Sc. Thesis*, Kerala Agricultural University, Thrissur.

Rao, G.S.L.H.V.P. 2013. Introduction to livestock meteorology. *In:* Rao, G.S.L.H.V.P. and Varma, G.G. (Eds.), *Fundamentals of Livestock Meteorology*, Vol. 1. Centre for Animal Adaptation to Environment and Climate Change Studies, Kerala Veterinary and Animal University, Pookode, pp. 1–11.

Selvaraju, M., Veerapandian, C., Kathiresan, D. and Chandrahasan, C. 2005. Incidence of bovine reproductive disorders. *Indian Vet. J.*, **82**: 556.

Singh, P., Singh, M., Jaiswal, R.S. and Verma, M.L. 2003. Nutritional availability of livestock from different feed resources in Kumaon hills of Uttaranchal. *Indian J. Anim. Nutr.*, **20**(3): 285–290.

Singh, J., Ghuman, S.P.S., Honparkhe, M., Dadarwal, D. and Dhaliwal, G.S. 2012. Risk factor for prolonged estrus in crossbred dairy cattle. *Indian J. Anim. Sci.,* **82**: 20-23.

Thiruvenkadan, A. K., Panneerselvam, S., Rajendran, R. and Murali, N. 2010. Analysis on the productive and reproductive traits of Murrah buffalo cows maintained in the coastal region of India. *Appl. Anim. Husb. Rural Dev.*, **3**: 1-5.

Youngquist, R.S. and Threlfall, W.R. 2007. *Current Therapy in Large Animal Theriogenology* (2nd Ed.). W.B. Saunders Company, Philadelphia, pp. 524.