

Comparative Assessment of Critical Prepartum and Postpartum Reproduction Challenges among Selected Dairy Farms

Rahul Bhatt^{1*}, Dr Naresh Kore², Ramkumar Krishnamoorthy³

¹Assistant Professor, School of Engineering and Computer, Dev Bhoomi Uttarakhand University, Dehradun, Uttarakhand, India, Email Id- socse.rahul@dbuu.ac.in, Orcid Id- 0009-0004-0486-9413

²Professor, Department of Kayachikitsa, Parul Institute of Ayurved and Research, Parul University, Vadodara, Gujarat, India, Email Id- naresh.kore86275@paruluniversity.ac.in, Orcid Id- 0000-0002-5228-5912

³Assistant Professor, Department of Computer Science and Information Technology, Jain (Deemed to be University), Bangalore, India, Email Id- ramkumar.k@jainuniversity.ac.in, Orcid Id- 0000-0003-1164-6504

Abstract

A study was conducted in two selected dairy farms in pune city municipality to identify the main prepartum and postpartum reproductive issues in dairy cattle. A retrospective examination of data, collectively with a study on significant reproductive issues before and after childbirth, was conducted through frequent clinical monitoring. An investigation was conducted on clinical data obtained from 713 cows across two dairy farms. It was observed that 46.1% of the cows experienced significant reproductive issues before and after giving birth. In the retrospective analysis, the most significant reproductive issue was postpartum anestrus, affecting 11.8% of the issues. It was followed by repeat breeding, which affected 10.2% of the issues. Clinical monitoring was conducted on 106 cows, of which 31.6% (n = 37) were found to have one or more clinical reproductive abnormalities. The most common reproductive problems in postpartum cows were postpartum anestrus (12.7%), prolapse (1.8%), retained placenta (3.7%), metritis (7.6%), dystocia (2.6%), abortion (5.6%) and repeat breeding (11.3%). A systematic evaluation was performed to evaluate the discrepancy in the prevalence of important reproductive problems depending on parity and body condition score (BCS). Accordingly, we examined the impact of increased parity on the occurrence of reproductive problems. The results of our study show a strong connection between increasing parity and the development of these illnesses. There is an important and significant difference ($P < 0.01$) between first-time mothers and cows that have given birth multiple times. A robust inverse relationship exists between BCS and the prevalence of reproductive problems, demonstrating an important variation ($P < 0.01$).

Keywords: Reproductive Problems, Postpartum, Prepartum, Anestrus, Repeat Breeder.

INTRODUCTION

A dynamic and complex sector of society, dairy farming is dependent on the health and welfare of its animals (1). The prepartum and postpartum stages are critical to the reproductive cycle of dairy cows and they are important in determining the total output and profitability of a dairy farm (2). The weeks preceding lactation are referred to as the prepartum phase, while the period immediately following lactation is known as the postpartum phase (3). Both stages are crucial because they have an immediate effect on the cow's health, the success of breastfeeding and the eventual ability to reproduce (4). Keeping their cows as healthy and fed as possible during the prepartum period is a challenge for dairy farmers. The cow's body goes through physiological changes at this time as it prepares for the impending lactation event (5). Providing suitable housing and care, keeping an eye on body composition and planning nourishment are important aspects of pre-partum care (6). Prepartum care must address problems such as metabolic abnormalities and facilitate the easy adjustment to lactation (7). The cow's capacity to lactate easily and transition into the postpartum phase in good health depends on the way the prepartum phase proceeds (8). The start of lactation and the beginning of milk production define the postpartum phase (9). During this crucial time, the cow's comfort, diet and overall health must be prioritized. To ensure a successful transition into the milking herd, dairy farmers must regularly evaluate aspects including udder health, milk output and the general well-being of the cow. A herd's health and total output are influenced by effective postpartum care in addition to the health of the individual cow (10).

Study (11) aimed to investigate the correlation between the nutritional and physiological characteristics of nursing dairy cows during the early postpartum period and their prospective pregnancy outcomes, including gestation after the first “artificial insemination (AI), pregnancy by 150 days in milk (DIM) and baby loss following the initial AI”. Study (12) presented a survey of the most recent research on the microbial communities found in the cells and reproductive tract of cows as well as to examine the specific and combined functions of these microorganisms in determining cattle fertility. Study (13) established the significance of postpartum blood levels of specific metabolic markers as potential risk variables for developing “subclinical endometritis (SE)”. The findings demonstrated a positive correlation between the increase in blood levels of “ β -hydroxybutyrate acid (BHBA)” and the rise in the percentage of “polymorphonuclear neutrophils (%PMN)”. Study (14) evaluated, the relationship between skeleton muscular and abdominal fatty stores, as assessed through ultrasound imaging and their impact on postpartum wellness, reproductive processes, along with milk manufacturing features. Study (15) demonstrated that certain herd management procedures, such as retaining old and unproductive cows, lack of awareness about body condition score before breeding, absence of record preserving, continuous breeding throughout the year and a low ratio of bulls to cows, were linked to observed reproduction efficiency standards in the small-scale farm. Study (16) examined the following parameters during late pregnancy and the “postpartum period (PPP), blood glucose, total protein (TP), calcium (Ca), phosphorus (P), magnesium (Mg), iron (Fe) and triiodothyronine (T3)”. The findings serve as a means of diagnosis to prevent metabolic abnormalities that arise during the latter stages of pregnancy and the PPP, as well as indicators of the nutritional health of milking cows. The study (17) conducted a systematic investigation to find and gather works that evaluated the connections between postpartum oral calcium supplements administered as an injection and milk production, as the risk of childbirth to initial assistance. It utilized meta-analytical methods to determine these interactions. Study (18) aimed to assess variations in pre-partum metabolites, minerals, cytokines and hormones among different postpartum disease categories. Additionally, it aimed to identify the minimum quantities of prepartum analyzers that were linked to postpartum disease in a sample of “229 cattle from 11 commercial dairies in Alberta, Canada”. Study (19) examined the connections between postpartum health and pregnancy as well as pregnancy loss (P-LOSS) in breastfeeding Hereford cows, including from day 19 to day 40 after the first “postpartum artificial insemination (AI)”. Study (20) aimed to evaluate the performance of cows that were grown on natural pastures in terms of BCS. Among the key variables determining a cow's ability to reproduce the BCS has an impact on the “PPI, conception rate (CR) and calving interval (CI)” in cattle cows.

Even though postpartum and prepartum care are essential to a dairy farm's survival, producers nonetheless face obstacles and constraints. Variations in individual cow reactions, environmental stressors and financial limitations are some examples of factors that can affect the efficient management practices as adults. Developing flexible and long-term prepartum and postpartum management solutions regarding modern dairy production requires an understanding of these constraints. This study aimed to discover significant prepartum and postpartum reproductive issues in dairy cattle on the chosen farmland.

METHODS

Study space

The study was conducted at Pune city, situated 47 km to the southeast of Maharashtra, India. The village is situated in the coordinates of location of 8 degrees north and direction of 43 degrees east, with an elevation of 1953 meters above sea level. The precipitation pattern exhibits bimodality, the yearly precipitation amounts to 1143.7 mm, while the majority, 86%, occurs around the extended rainy period. The period from July to October is followed by the remaining portion of the brief rainy season, which lasts from February to April. The duration of the dry season spanned from September to March. The average highest and lowest temperatures in the region are 36.9 and 9.7°C, respectively, while the average relative humidity is 62.5%. The area follows a mixed farming strategy, where crop and livestock production are conducted intensively.

Study animals

All animals that delivered offspring from October 1, 2021, to March 31, 2023, were included in this study. The cows utilized in this investigation were Jersey cows of varying parity, although they were maintained under comparable production conditions on chosen farms in Pune town.

Research Methodology

The study consisted of two sections. The first section involved collecting and analyzing retrospective data to determine the prevalent and identifying the main reproduction problems in the chosen farmland. The subsequent sections of the study included conducting regular clinical check-ups on selected dairy cows residing at the specified dairy farm.

Data gathering

The study gathered secondary data from the farms' record books spanning three years, from February 2021 to January 2023. The objective was to identify the primary reproductive issues occurring before and after childbirth, as well as to evaluate their incidence in the chosen farmland.

Clinical check-up

Information regarding the main reproductive problems experienced by dairy cows before and after giving birth was gathered during regular checks on the farm. The learning cows were identified depending on their distinct breed, tag number/ID and equality. They were monitored throughout their gestation period until birth and for 85 days after delivery. The time of delivery was determined by referencing their case record. Throughout pregnancy, as well as before and after giving birth, the cows were carefully examined. Their body temperature was recorded and their food intake was closely tracked. After giving birth, cows were examined during the first 24 hours to check on any retained fetal membrane extending from the uterus, as effectively for potential irregular vaginal discharge. Vaginoscopy was conducted on cows with atypical uterine elimination to determine the precise nature and features of the substance. However, parturient cows were categorized based on their birthing status. Without any difficulty and those experiencing complications during childbirth based on the following definitions.

Dystocia: Dystocia is defined as a marked prolongation, more than six hours, of the initial, more specifically, the 2nd phase of childbirth, requiring the cow to be assisted or intervened upon during lactation.

Abortion: The extraction of a dead baby from a cow at any stage of gestation, identifiable by its size, is known as abortion. It is caused by influential infections, nutritional deficiencies, or stressful environments, which creates problems for the dairy industry's finances and reproductive health.

RFM: Retained Fetal Membranes (RFM) refers to the placenta's inability to be discharged in a certain amount of time following lactation, which is specified as 12 to 24 hours in cattle.

Metritis: Metritis in cows refers to an inflammatory condition of the uterus surface, which is identified by the presence of reddish-brown, white, or pale to yellow mucopurulent menstrual discharges accompanied by a disagreeable smell. When examined through the abdomen, the uterine interior can be felt to be stronger.

Repeating breeders: Repeat breeders refer to female individuals who face difficulties in achieving pregnancy after many efforts, caused by factors such as reproductive tract disorders or hormonal irregularities. It is imperative to identify and treat these aspects to enhance fertility in animals and humans.

Anestrus: Anestrus is defined as the lack of observable symptoms of heat in cows for 90 days or longer after giving birth, suggesting a time of reproductive inactivity.

Uterine prolapse: Uterine prolapse is a disorder in which the uterus protrudes through the vulva. It usually happens after giving birth and it is defined by the inner surface of the uterus that is exposed externally.

Vaginal prolapse: Vaginal prolapse is the abnormal displacement of the vagina and uterus through the vulva, resulting in their protrusion. This condition is observed in female animals.

Body condition scoring (BCS): BCS is a technique employed to assess the nutritional status of animals in a study task. The process involves classifying animals into several ratings (ranging from 0 to 5) according to their physical state, therefore improving the evaluation of their general well-being and the occurrence of reproductive complications postpartum.

RESULTS

For the retrospective analysis, a total of 713 reported data on pregnancy and pregnancies cows were analyzed throughout the previous three-year period. Among individuals, 46.1% (n=317) were classified as experiencing substantial reproductive difficulties before and following childbirth. The highest occurrence of 12.7% was seen in postpartum anestrus, followed by repeat breeding, RFM, abortion, metritis and vaginal/uterine prolapse, dystocia, which made up 10.2%, 6.5%, 5.1%, 4.6%, 4.7% and 1.5% correspondingly, between the two dairy farms. During the research, which included regular monitoring, a total of 37 cows, accounting for 31.3% of the sample, were found to have at minimum one type of illness. One of the main elements related to reproduction before and after childbirth is of significant importance. Metritis, anestrus, abortion, dystocia, RFM, prolapse and recurrent breeding are encountered difficulties during the regular assessment, it was found that the two farms. The values are 7.6%, 12.7%, 5.6%, 2.6%, 3.7%, 1.8% and 11.3%, respectively. Out of the 37 cows that were affected, a total of 17 (46.8%) were identified as having multiple ailments and problems with reproductive.

An analysis was conducted to assess the occurrence of abortion according to the different stages of pregnancy. The results showed that the percentages of abortion in the first, second and third periods were 15.2%, 27.5% and 56.0%, respectively. The findings indicate that more than 50% of abortion cases occur during the third period. All the dairy cows included in this study were of exotic breeds (HF) and they were managed using the same intensive management strategy. Nevertheless, other risk variables such as parity (the number of times a cow has given birth) and BCS at gestation were considered to assess their correlation with the possibility of reproductive diseases. The study examined the potential impact of increasing parity on the occurrence of postpartum reproductive complications. The findings demonstrated a significant and significant correlation between enhancing parity and the incidence of these issues ($P < 0.01$) (Table (1)). A study was done to investigate the correlation between BCS during nursing and the occurrence of serious reproductive issues postpartum. The findings, as depicted in Table (1) and Figure (1-3), demonstrated a negative correlation between physical condition and the occurrence of various reproductive problems.

Table (1). Prepartum and postpartum reproductive problems and their correlation with factors of risk

Factors of risk	The number of cows	The number of cows along with the RP	The number of cows that give birth normally	% of cows impacted	χ^2 Value	DF	P-value
Sanitation							
well	69	20	49	28.7	2.49	2	0.117
weak	37	16	21	44.2			
Total	106	36	70	33.7			
Parity							
Primiparous	32	17	15	54.9	8.89	2	0.004
Pluriparous	74	19	55	24.8			

Total	106	36	70	33.7			
BCS							
0	4	3	1	66.8			
1	12	9	3	66.8			
2	28	11	17	51.0	18.72	6	.003
3	34	8	26	23.6			
4	22	4	18	13.7			
5	6	1	5	1			
Total	106	36	70	33.7			

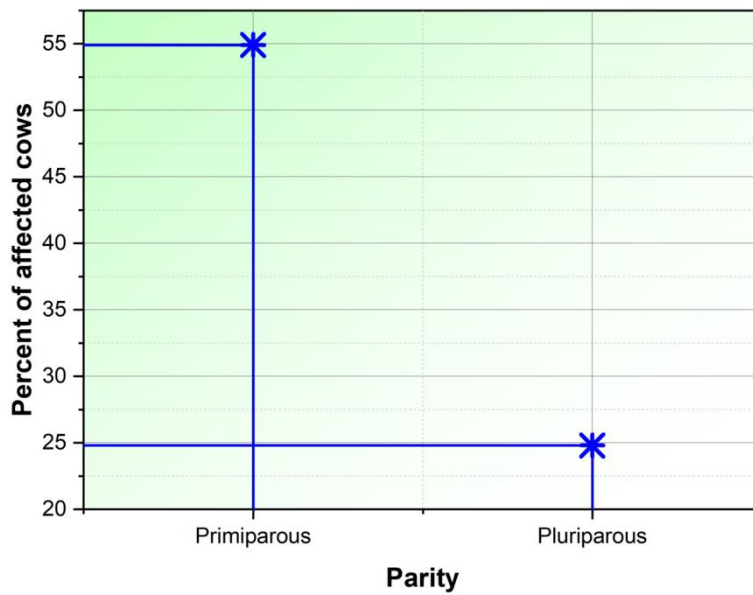


Figure (1). Results of parity

(Source: Author)

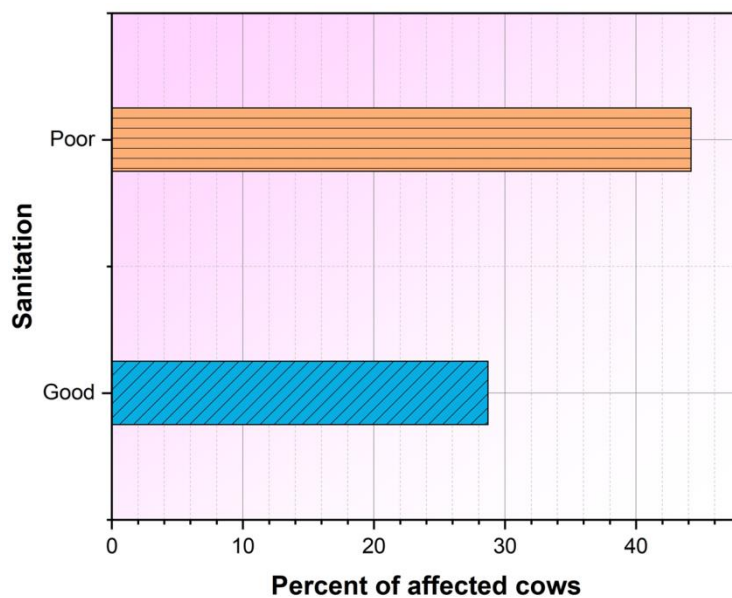


Figure (2). Results of sanitation

(Source: Author)

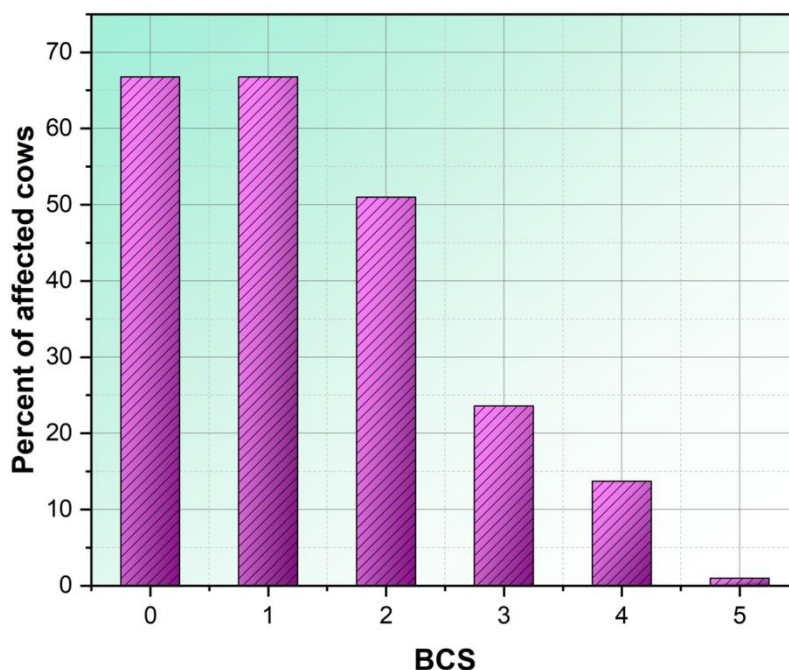


Figure (3). Results of BCS

(Source: Author)

The incidence exhibited substantial variation across different physical conditions, with a high level of statistical significance ($P < 0.01$). Although an attempt was made to examine the possible connection between farm cleanliness and reproductive problems, the findings did not indicate any significant correlation ($P > 0.05$).

A study was performed to assess the correlation between occurrences of clinical metritis and other relevant factors. Based on the results, 7 out of the total sample size, which accounts for 76.6%, were diagnosed with clinical metritis. This condition was shown to be caused by abortion, RFM and dystocia in 2 (23.3%), 1 (12.2%) and 2 (23.3%) cases, respectively. Out of all the cases, 3 (24.4%) occurred after a normal childbirth. The statistical analysis investigated the correlation between metritis and abortion, dystocia and RFM. The findings indicated that there was no significant correlation ($P > 0.05$) between metritis and the predisposing characteristics mentioned in Table (2) and Figure (4).

Table (2). Correlation between clinical metritis and other contributing factors in cows on the chosen farms

(Source: Author)

Predisposing factors	Abortion	Dystocia	RFM	Total
Cases with clinical metritis	4 (42.10)	2 (33.4)	4 (76.0)	10 (51.0)
Cases without clinical metritis	5 (57.2)	3 (66.8)	1 (26.0)	9 (51.0)
Total	9	5	5	19

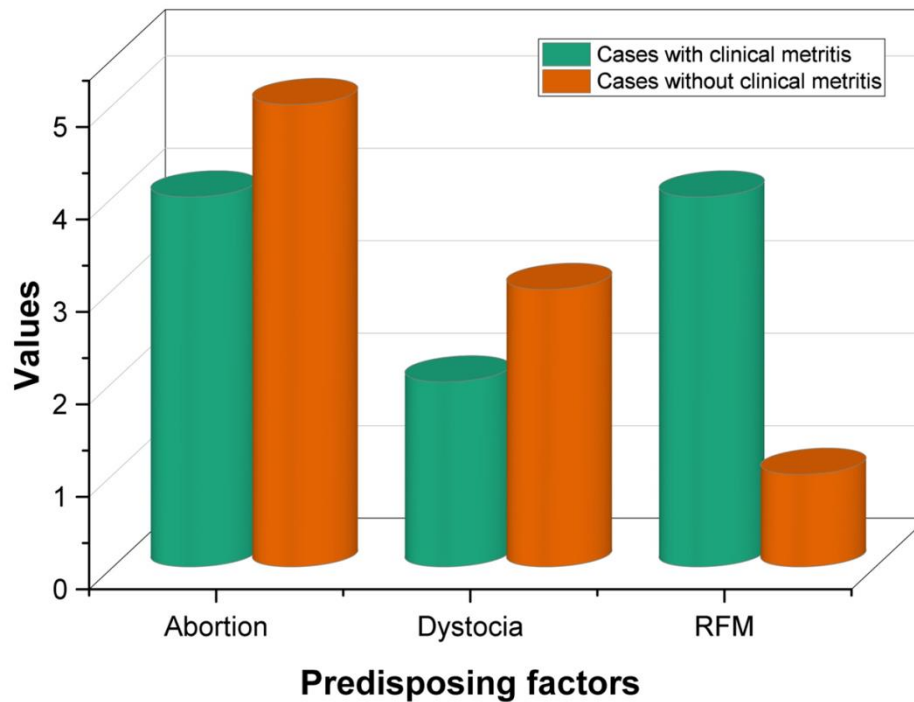


Figure (4). Correlation between clinical metritis and other contributing factors
(Source: Author)

DISCUSSION

The study found that the occurrence of anestrus was between 0.6% to 21.2% in “International Lactation Consultant Association (ILCA)” herds in Pune city and 10.4% at Agarwal Dairy Farm. The reported percentage of crossbred dairy cows in Pune city and central India falls below the suggested limits of 15.6% and 26%, respectively. The proportion of repeated breeding in this study, which stands at 11.3%, aligns with previous data. Cows that have given birth multiple times, known as pluriparous cows, have a greater occurrence rate (64.4%) of repeat breeding compared to cows that have given birth once, known as primiparous cows (34.6%). This corresponds with previous research that suggests a decrease in fertility as the number of births increases. Repeated breeding problems can occur from inadequate identification of the female's fertile period, incorrect timing of fertilization and challenges related to the handling of cells coupled with the techniques used for fertilization. The incidence of metritis in this study (7.6%) correlates with the results; however, it is comparatively lower than that has been reported. Variations in breed and management systems can account for the observed variances. The study found that abortion accounted for 5.6%, which is consistent with findings from other locations. The illness vaccination can be responsible for the reduced abortion rate. Additional reproduction issues taken into account included 2.6% dystocia, 3.7% RFM and 1.8% prolapse, all of which are decreased compared to previous findings. The incidence of dystocia corresponds, to but is lower than that has been reported. The occurrence of dystocia varies as a result of factors such as the age of the mother, the number of previous pregnancies it had been and the breed of the father. The prevalence of RFM is 3.7%, which is lower than that has been reported. The lower occurrence observed in this study can be attributed to decreased rates of dystocia and variations in treatment practices, such as feeding and sanitation protocols. This study validates prior research by demonstrating that cows that have given birth multiple times, known as pluriparous cows, encounter a greater number of reproductive issues after giving birth compared to cows that have given birth once, known as primiparous cows. This could be attributed to the recurrent exposure of the reproductive system to environmental hazards, resulting in uterine infections. Furthermore, there exists a strong and significant

negative correlation ($P < 0.01$) between the occurrence of postpartum reproductive issues and the physical condition of the cows. Inadequate physical condition can diminish the force of ejection, causing challenges in the removal of the placenta or unaided childbirth, which can lead to additional issues. Cows that are in good physical shape have a higher capacity to fulfill their energy needs for giving birth, producing milk and recovering their uterus, which makes them more resilient to infections. Ultimately, there was no significant link between metritis and other reproductive issues such as abortion, dystocia and retained fetal membranes (RFM) as predisposing variables ($P > 0.05$). Contrary to earlier reports indicating a strong correlation, the results of this investigation are divergent. The study found that 76.1% of RFM cases resulted in the development of metritis and 78.6% of metritis cases experienced postpartum anestrus. This suggests that prolonged RFM is a significant factor in causing metritis, which in turn leads to anestrus in dairy cows.

CONCLUSION

The findings of the current investigation revealed that the most prevalent reproductive issues are postpartum anestrus and recurrent breeding, with metritis and abortion that are the subsequent concerns. In general, the study farms have a high rate of significant reproductive issues that exceed the economically acceptable range. It can be attributed to inadequate management during lactation, insufficient farm cleanliness procedures and a lack of consistent clinical monitoring by medical professionals on the farms. Consequently, it is imperative to improve the sanitary circumstances of the farms and provide proper care, supervision and treatment of cows during the parturition procedure. Regular and systematic inspection of cows during the postpartum period is crucial, as the majority of cows get uterine infections during this time. The significant initial cost and requirement for specialized training can reduce the broad implementation of modern reproductive technologies in smaller dairy farms. Utilizing sophisticated reproductive technologies and precision farming approaches to optimize reproductive efficiency in dairy farms.

Reference

1. Macmillan, K., Gobikrushanth, M., Helguera, I.L., Behrouzi, A. and Colazo, M.G., (2020). Relationships between early postpartum nutritional and metabolic profiles and subsequent reproductive performance of lactating dairy cows. *Theriogenology*, 151, pp.52-57. <https://doi.org/10.1016/j.theriogenology.2020.03.034>
2. Mee, J.F. and Boyle, L.A., (2020). Assessing whether dairy cow welfare is “better” in pasture-based than in confinement-based management systems. *New Zealand Veterinary Journal*, 68(3), pp.168-177. <https://doi.org/10.1080/00480169.2020.1721034>
3. Sammad, A., Khan, M.Z., Abbas, Z., Hu, L., Ullah, Q., Wang, Y., Zhu, H. and Wang, Y., (2022). Major nutritional metabolic alterations influencing the reproductive system of postpartum dairy cows. *Metabolites*, 12(1), p.60. <https://doi.org/10.3390/metabo12010060>
4. Pascottini, O.B., Leroy, J.L. and Opsomer, G., (2020). Metabolic stress in the transition period of dairy cows: Focusing on the prepartum period. *Animals*, 10(8), p.1419. <https://doi.org/10.3390/ani10081419>
5. Mohtashampour, F., Dirandeh, E., Ansari-Pirsaraei, Z. and Colazo, M.G., (2020). Postpartum health disorders in lactating dairy cows and its associations with reproductive responses and pregnancy status after first timed AI. *Theriogenology*, 141, pp.98-104. <https://doi.org/10.1016/j.theriogenology.2019.09.017>
6. Menta, P.R., Machado, V.S., Pineiro, J.M., Thatcher, W.W., Santos, J.E.P. and Vieira-Neto, A., (2022). Heat stress during the transition period is associated with impaired production, reproduction, and survival in dairy cows. *Journal of Dairy Science*, 105(5), pp.4474-4489. <https://doi.org/10.3168/jds.2021-21185>
7. Marshall, N.E., Abrams, B., Barbour, L.A., Catalano, P., Christian, P., Friedman, J.E., Hay Jr, W.W., Hernandez, T.L., Krebs, N.F., Oken, E. and Purnell, J.Q., (2022). The importance of nutrition in pregnancy and lactation: lifelong consequences. *American Journal of Obstetrics and Gynecology*, 226(5), pp.607-632. <https://doi.org/10.1016/j.ajog.2021.12.035>
8. Mann, S., Sipka, A.S. and Grenier, J.K., (2019). The degree of postpartum metabolic challenge in dairy cows is associated with peripheral blood mononuclear cell transcriptome changes in the innate immune system. *Developmental & Comparative Immunology*, 93, pp.28-36. <https://doi.org/10.1016/j.dci.2018.11.021>

9. Sandhi, A., Lee, G.T., Chipojola, R., Huda, M.H. and Kuo, S.Y., (2020). The relationship between perceived milk supply and exclusive breastfeeding during the first six months postpartum: a cross-sectional study. *International Breastfeeding Journal*, 15(1), pp.1-11. <https://doi.org/10.1186/s13006-020-00310-y>
10. Caixeta, L.S. and Omontese, B.O., (2021). Monitoring and improving the metabolic health of dairy cows during the transition period. *Animals*, 11(2), p.352. <https://doi.org/10.3390/ani11020352>
11. Tolosa, F., Netsere, M. and Habtamu, Y., (2021). Assessment of major reproductive disorders in dairy cattle in and around Bale robe, Oromia regional state, Ethiopia. *Veterinary Medicine International*, 2021. <https://doi.org/10.1155/2021/8855718>
12. Luecke, S.M., Webb, E.M., Dahlen, C.R., Reynolds, L.P. and Amat, S., (2022). Seminal and vaginouterine microbiome and their individual and interactive effects on cattle fertility. *Frontiers in Microbiology*, 13, p.1029128. <https://doi.org/10.3389/fmicb.2022.1029128>
13. Yáñez, U., Herradón, P.G., Becerra, J.J., Peña, A.I. and Quintela, L.A., (2022). Relationship between postpartum metabolic status and subclinical endometritis in dairy cattle. *Animals*, 12(3), p.242. <https://doi.org/10.3390/ani12030242>
14. Siachos, N., Oikonomou, G., Panousis, N., Tsiamadis, V., Banos, G., Arsenos, G. and Valergakis, G.E., (2022). Skeletal muscle and adipose tissue reserves and mobilization in transition Holstein cows: Part 2 association with postpartum health, reproductive performance, and milk production. *animal*, 16(9), p.100626. <https://doi.org/10.1016/j.animal.2022.100626>
15. Nkadameng, M., Van Marle-Köster, E., Nengovhela, N.B., Ramukhithi, F.V., Mphaphathi, M.L., Rust, J.M. and Makgahlela, M.L., (2022). Assessing reproductive performance to establish benchmarks for small-holder beef cattle herds in South Africa. *Animals*, 12(21), p.3003. <https://doi.org/10.3390/ani12213003>
16. Mohammed, S.E., Ahmad, F.O., Frah, E.A. and Elfaki, I., (2021). Determination of blood glucose, total protein, certain minerals, and triiodothyronine during late pregnancy and postpartum periods in crossbred dairy cows. *Veterinary Medicine International*, 2021. <https://doi.org/10.1155/2021/6610362>
17. Valdecabres, A., Branco-Lopes, R., Bernal-Córdoba, C. and Silva-del-Río, N., (2023). Production and reproduction responses for dairy cattle supplemented with oral calcium bolus after calving: Systematic review and meta-analysis. *JDS communications*, 4(1), pp.9-13. <https://doi.org/10.3168/jdsc.2022-0235>
18. Macmillan, K., Gobikrushanth, M., Behrouzi, A., López-Helguera, I., Cook, N., Hoff, B. and Colazo, M.G., (2020). The association of circulating prepartum metabolites, minerals, cytokines, and hormones with postpartum health status in dairy cattle. *Research in veterinary science*, 130, pp.126-132. <https://doi.org/10.1016/j.rvsc.2020.03.011>
19. Bruinjé, T.C., Morrison, E.I., Ribeiro, E.S., Renaud, D.L. and LeBlanc, S.J., (2023). Associations of inflammatory and reproductive tract disorders postpartum with pregnancy and early pregnancy loss in dairy cows. *Journal of Dairy Science*. <https://doi.org/10.3168/jds.2023-23976>
20. Lan, L. and Kenas, S., (2022). Research Article Effects of Low Pasture Quality on Body Condition Score and Reproductive Performance of Beef Cattle. *Int. J. Dairy Sci*, 17(1), pp.13-23. [10.3923/ijds.2022.13.23](https://doi.org/10.3923/ijds.2022.13.23)