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Pregnancy Diagnosis: An Essential Factor in Evaluating Farm Breeding Efficiency

V Haripriya[1]*, Ankita Agarwal[2], Sachin Sharma[3]

*[1]Assistant Professor, Department of Computer Sceince and Information Technology, Jain (Deemed to be University), Bangalore, India, Email Id- v.haripriya@jainuniversity.ac.in , Orcid Id- 0000-0003-0392-4367
[2]Assistant Professor , Maharishi School of Engineering & Technology, Maharishi University of Information Technology, Uttar Pradesh, India, Email Id- agarwalankita.lko@gmail.com, Orcid Id- 0000-0001-7539-8592
[3]Assistant Professor, School of Engineering and Computer, Dev Bhoomi Uttarakhand University, Dehradun, Uttarakhand, India, Email Id- socse.sachin@dbuu.ac.in, Orcid Id- 0009-0000-7449-5809

Abstract

The purpose of the research is to assess the organized farm's conception rate (CR) and pregnancy diagnosis-positive rate (PD-PR) to make appropriate management decisions. An analysis was conducted on a one-year record of PD and Artificial Insemination (A.I.) of dairy animals (N=1325, consisting of 298 buffaloes and 1027 cows). Buffaloes and cows were diagnosed with per rectal pregnancy after an average of 73.85 and 74.89 after A.I. The total PD-PR value of cattle is greater than that of buffaloes (71.92% and 62.95%, respectively). Buffaloes have a greater overall CR tendency in comparison to cattle, with rates of 42.65% and 50.29%, respectively. The PD-PR values in buffaloes and cattle were 14.31% and 25.60% lower, respectively, when compared to the farm standard of 85%. During the winter season, cattle and buffaloes exhibited greater PD-PR and CR values, with cattle showing values of 61.50% and 38.08%, respectively and buffaloes showing values of 59.55% and 60.91%, respectively. However, cattle exhibited lower values of PD-PR (70.34%) and CR (23.44%) during rainy seasons, while buffaloes showed lower values of PD-PR (60.25%) and CR (61.84%) during summer seasons. High humidity and heat stress had an essential impact on the development of CR and oestrus symptoms.

Keywords: Cattle, pregnancy diagnosis-positive rate (PD-PR), buffaloes, conception rate (CR), oestrus

INTRODUCTION

Maintaining cattle numbers and creating an efficient agricultural environment in the complex structure of agricultural operations depends on the efficacy of farm breeding (1). Accurately and efficiently identifying an animal's pregnancy is an essential element for managing cattle. Accurate detection of pregnancy is crucial for ensuring the long-term success and maintenance of farms, as well as for promoting the execution of reproductive techniques (2).

Pregnancy diagnosis is an essential component of livestock management, which involves determining the exact stage of pregnancy in a female animal and assessing the probability of pregnancy (3). Diagnostic procedures have significant effects on extensive and intensive farming operations. Farmers can optimize their decision-making on feeding, medical care and general herd management by rapidly obtaining accurate information about the gestational stage of their animals (4).

Implementing effective techniques for identifying pregnancy in cattle can result in financial benefits for farmers. Optimizing resource allocation in farming can be achieved by adjusting feeding schedules to meet the specific needs of pregnant animals, which can be identified. By ensuring the well-being of pregnant animals and improving the allocation of resources, the execution of this particular approach leads to a reduction in future expenses (5). Farmers can enhance breeding cycles by rapidly detecting pregnancies and optimizing the number of newborns during periods of increased cattle demand. The connection between breeding seasons and market conditions enhances the financial strength of the agricultural sector (6).

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Ensuring the welfare and safety of animals are fundamental aspects of every sustainable farming strategy. Assessing the reproductive condition of animals allows for continuous monitoring of their general health and enables farmers to address any potential issues swiftly. Early detection of possible problems, such as inadequate nutrition or reproductive deviations, allows farmers to quickly start treatments, ensuring the welfare of the developing fetus and the mother (7).

Furthermore, accurate pregnancy identification can reduce unnecessary stress in non-pregnant animals by preventing inappropriate nutritional choices and behaviors. This not only improves the general welfare of the cattle but also promotes the development of an environmentally friendly and knowledgeable approach to animal care (8).

The efficiency of breeding approaches has a clear connection with the success of farm breeding. Proper pregnancy identification is crucial for assessing the efficacy of breeding activities and enables farmers to make suitable adjustments to their plans depending on reproductive outcomes. Through the identification and maintenance of animals possessing favorable reproductive characteristics, farmers can actively select specific attributes, enhancing the overall excellence of the cattle (9).

The validity and speed of a commercially available visual pregnancy test device intended towards the identification of "pregnancy-associated glycoprotein (PAG)" in "blood serum" for the recognition of early gestation in goats were examined in research (10). There was a strong correlation found between the progesterone concentration and the ultrasound results. Additionally, there was a notable concurrence between the ultrasound results and the “visual PAG-ELISA” data.

Study (11) investigated a strategy to predict early pregnancy in cows and identified the limits for diagnosing pregnancy based on levels of peripheral blood leucocytes (PBL) gene activity. The methods employed for early forecasting of gestation will decrease the duration of bovine pregnancy that help in the advancement of more effective systems for reproduction and technology.

Study (12) examined the accuracy of PAG detection ELISA and “transrectal ultrasound (TRUS)” in dairy cattle. It was done employing a Bayesian latent class methodology to predict the specificity as well as the sensitivity of the two methods. The approach was more reactive than TRUS performed by veterinarians, making it a cost-effective complement to a reproductive management strategy.

Study (13) investigated the diagnostic efficacy of the milk “PAG-based ELISA and TUS” examination in identifying the pregnant condition of specific milk cows. The approach used was suitable for validating the tests without the presence of a gold standard. The PAG evaluation's efficiency exhibited slight variations based on the parity value.

Research (14) examined the effectiveness of color Doppler ultrasonography (US) in diagnosing early pregnancy by evaluating the vascularization of the luteal region. The use of colour Doppler ultra-sonography to measure luteal vascularization and differentiate between pregnant and non-pregnant animals was regarded as an appropriate and very effective method starting from 17 days in breeding.

Research (15) analyzed the reproductive and survival characteristics of two distinct genetic groups (GG) of Holstein-Friesian cattle, which had been selected based on the Irish Economic Breeding Index (EBI). Their research was designed to determine the factors that could lead to higher reproductive efficiency among the groups. The findings clearly indicated the possibilities of targeted genetic selection for combating the adverse reproductive trends that have developed as an outcome of generations focusing on milk production.

Study (16) examined the effectiveness of pregnancy notifications (PregN) produced by an in-line milk analysis system (IMAS) using P4c profiles following artificial insemination (AI) in identifying the pregnancy and non-pregnancy condition of dairy cattle. Nevertheless, to achieve higher accuracy, it was recommended that the

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declaration of pregnancy should not take place until after the occurrence of artificial insemination, depending on IMAS reports.

Research (17) investigated the characteristics that are linked to the reproductive outcomes of cattle on rural small-scale farms. Their purpose was to determine the primary reasons for reproductive failure and develop successful strategies for development. Identifying significant variables and measures has resulted in suggestions for decisions that have the potential to enhance the efficiency of reproduction, manage the decreasing cow population and increase the ability of small-scale farmers to meet the growing local demand for meat.

Research (18) investigated the correlation between "pregnancy loss (PL)" and earlier experiences with "subclinical or clinical mastitis" before breeding or through pregnancy in first-time pregnant "Holstein cows." Their research indicated that "clinical mastitis" occurring during pregnancy could cause PL in first-time calving dairy cows, resulting in financial losses.

The process of pregnancy development in cattle is intricate and involves fertilization, ovulation, the emergence and expansion of the blastocyst into an elongated conceptus, communication for pregnancy identification and the maturation of the placenta and embryo. The effect of breeders on the maintenance of pregnancy in cattle was investigated in the study (19). Their research showed the significance of understanding whether the male parent's genes affect a pregnancy's development to improve milk cow reproductive efficiency.

Study (20) investigated the effect of several Interferon-Stimulated Genes on the "blood neutrophils" of gestating dairy cows undergoing fertilization. Their findings indicated that the ISGs produced by blood neutrophils played a critical role in the initiation of pregnancy and can serve as potential markers for the detection of pregnancy in cattle.

Finding the rate of CR and PD-PR on managed farms is the aim of the study.

METHODS

The Assam region served as the study's location. An examination was performed on the one-year data (January-December 2022) about artificial insemination (AI) and pregnancy diagnosis (PD) in an overall total of 1325 dairy animals, including 1027 cows and 298 buffaloes. The region experiences a subtropical climate with four distinct seasons: autumn (September-October), rainy (July-September), summer (April-June) and winter (October-March). The daily weather data was utilized to calculate the monthly mean values of T_{db} (°C) and RH (%). Subsequently, these values were utilized to calculate the average monthly dew point temperature (Tdp) and temperature humidity index (THI) using the established methodology.

The PD-PR and CR values were obtained using Equations (1 & 2).

$$Pregnancy\ diagnosis - Positive\ Rate = \frac{Number\ of\ cows\ diagnosed\ as\ positive\ pregnant}{Total\ number\ of\ cows\ presented\ for\ pregnancy\ diagnosis\ on\ a\ particular\ day\ after\ AI} \times 100 \quad (1)$$

$$Conception\ Rate = \frac{Number\ of\ animals\ conceived}{Total\ number\ of\ insemination\ done} \times 100 \quad (2)$$

STATISTICAL ANALYSIS

The data regarding PD and AI was gathered and organized. It was categorized by month and season to determine frequency. The data was transformed into percentages to make predictions. The chi-square test was employed to evaluate the overall disparity in PD-PR and CR across two species, as well as among various months and seasons in a specific species. The analysis was regarded as significant if the $P \leq 0.05$, while a trend was shown if the $P > 0.05$ and ≤ 0.1. The statistical evaluation was conducted employing the freely available SPSS 16 version.

RESULT

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Duration of pregnancy detection following AI

The current study provides the specific days on which dairy buffaloes and cattle were examined in Figure (1) for recognition of pregnancy using a rectal method. Additionally, it gives the PDPR and CR numbers based on the total number of animals that were verified pregnant during the assessment. The average number of days after AI that animals were examined for per recta PD was 74.89 (ranging from 38 to 119 days) for dairy cattle and 73.85 (ranging from 46 to 128 days) for buffaloes is displayed in Fig. 1. Early identification of pregnancy following fertilization can identify nonpregnant animals and potentially decrease the expenses associated with their management. Per rectal evaluation for pregnancy diagnosis is regarded as the most reliable method in field conditions and it is recommended to be performed ≥ 2 months after fertilization to ensure higher accuracy and minimize the risk of embryonic losses.

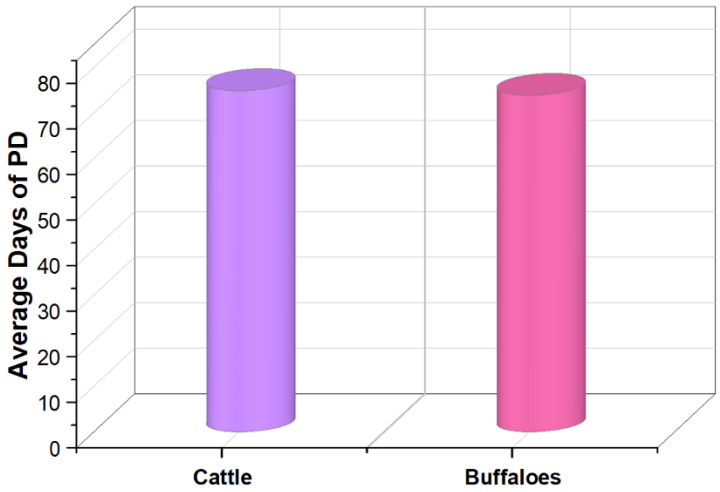

Figure (1). The average number of days between A.I. and pregnancy diagnosis in buffaloes and cattle (Source: Author)

The average number of days for PD was greater than the usual 65 days recommended for every rectal assessment, indicating that it was 20 days longer than recommended. This could be due to a delay in timely notification of animal pregnancy diagnosis. Early pregnancy identification upon fertilization is significant and helps in reducing the duration of the service period by detecting non-pregnant animals in the initial stages. An increase in the number of days that dairy cattle remain exposed results in significant financial losses for farmers. Therefore, it is necessary to introduce administrative intervention, such as a decision support system, to ensure accurate reporting and minimize the number of days wasted due to PD in dairy animals.

Pregnancy diagnosis-positive rate and conception rate

Cattle and buffaloes' monthly conception rates (CR) and pregnancy diagnosis-positive rates (PD-PR) are shown in Table (1) and Table (2), respectively. There was no substantial monthly variance in the PD-PR and CR values in cattle and buffaloes. However, we recognized a greater value for PD-PR and CR in January and a lower number in June. The overall PD-DR of buffaloes and cattle was 71.92% and 62.95%, correspondingly, which showed a significant difference ($\chi^2 = 10.43, df = 1, p < 0.001$). Nevertheless, the overall CR for buffaloes and cattle, which was 42.65% and 50.29%, respectively, did not show a significant difference. However, there was a pattern for buffaloes to have a higher CR compared to cattle ($\chi^2 = 2.91, df = 1, p = 0.092$). Cattle exhibit a greater CR than buffaloes in field conditions. The greater CR value of buffaloes, in comparison to cattle, is possibly due to the strategic fertilization of buffaloes at the optimal moment, utilizing a teaser bull for heat identification.

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Table (1). PD-PR and CR in cattle (Source: Author)

Months	No. of A.I	No. of cows presented	Pregnant	PD-PR (%)	CR (%)
January	91	53	46	86.79	50.54
February	78	50	39	77.08	48.68
March	89	54	42	77.78	47.19
April	90	55	38	69.09	42.22
May	94	53	37	69.81	39.36
June	93	52	34	65.38	36.56
July	79	44	30	68.18	37.97
August	89	51	34	66.67	38.20
September	67	38	26	68.42	38.81
October	60	35	24	68.57	40.00
November	96	56	39	69.64	40.63
December	101	68	49	72.06	48.51
Overall	1027	609	438	71.92	42.65

Table (2). PD-PR and CR in buffaloes (Source: Author)

Months	No. of A.I	No. of buffaloes presented	Pregnant	PD-PR (%)	CR (%)
January	18	16	13	81.25	72.22
February	31	27	19	70.37	61.29
March	13	12	8	66.67	61.54
April	31	21	13	61.90	41.94
May	29	22	12	54.55	41.38
June	18	14	7	50.39	31.25

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July	57	43	23	53.49	40.35
August	34	31	17	54.84	46.88
September	26	22	13	59.09	45.83
October	31	19	14	73.68	45.16
November	24	20	14	70.59	54.55
December	36	31	22	70.97	61.11
Overall	348	278	175	62.95	50.29

When a pregnancy is diagnosed after 43 days, the PD-PR value should be greater than 85% for optimal reproductive health. In cattle and buffaloes, the PD-PR values varied by 14.31% and 25.60%, respectively, in comparison to this PD-PR standard. Enhancing the oestrus detection rate and conception rate can decrease this gap since both of them have an impact on the PD-PR value. Moreover, the substantial difference in the overall PD-PR value between buffaloes and cattle can be related to a higher rate of submission in cattle following artificial fertilization (animals discovered in heat after fertilization and provided for fertilization). In cattle, the identification of oestrus is simple since the oestrus indicators are more apparent compared to buffaloes (silent oestrus). As a result, farm personnel can identify an increased number of open cows before they are provided for PD. Therefore, a higher quantity of pregnant cattle was brought in for PD, resulting in an enhanced PD-PR value in these species as compared to buffaloes.

Table (3) displays the seasonal changes of PD-PR and CR in cattle and buffaloes. While there was no significant variation in PD-PR values across seasons, the findings indicated that cattle exhibited a higher pattern of PD-PR during the winter season (61.50%) and a lower pattern during the rainy season (70.34%) in cattle ($\chi^2 = 7.49, df = 3, p < 0.059$). Nevertheless, the CR in cattle exhibited a notable increase during the winter season (38.08%) and a decrease during the rainy season (23.44%) ($\chi^2 = 9.90, df = 3, p < 0.02$). However, buffaloes showed a decreased trend of PD-PR throughout the summer (60.25%) and a greater trend during the winter (59.55%) is shown in Table 3. Buffaloes had a larger CR during winter (60.91%) compared to cattle. However, during summer, buffaloes had a decreased CR (61.84%). This difference was statistically significant ($\chi^2 = 7.79, df = 3, p < 0.015$).

Table (3). Seasonal differences in PD-PR and CR in buffaloes and cattle (Source: Author)

	Season	No. of AI	No. of animals presented	Pregnant	PD-PR (%)	CR % for PD after 45
Cattle	Winter	344	213	131	61.50	38.08
	Summer	214	171	109	63.76	50.93
	Rainy	435	145	102	70.34	23.44
	Autumn	36	79	96	121.51	266.66

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	χ^2	-	-	-	7.49	9.90*
Buffaloes	Winter	87	89	53	59.55	60.91
	Summer	76	78	47	60.25	61.84
	Rainy	69	67	41	61.19	59.42
	Autumn	66	44	34	77.27	51.51
	χ^2	-	-	-	7.79#	10.51*

The changes in PD-PR and CR values over seasons could be attributed to variations in stress levels, as demonstrated by THI or food factors. THI < 72 is regarded as an animal comfort zone, indicating that during the winter, our animals did not experience heat stress, as shown by the THI score. While heat stress was reduced throughout autumn, animals, however, experienced nutritional stress due to the lean periods in the agroclimatic region where the dairy farm was located. The two species exhibited distinct responses to heat stress, with cattle experiencing greater stress throughout the rainy season (hot and humid) and buffaloes experiencing greater stress throughout the summer (hot and dry). This difference is represented in the PD-PR and CR values. Cows have a highly efficient physiological mechanism for evaporative cooling, which helps them tolerate the dry and hot conditions of summer with minimal distress. However, during the rainy season, when atmospheric moisture is high, the process of evaporation is restricted, causing cows to experience increased stress. Buffaloes have a black body coat and less effective evaporative cooling due to their limited sweating abilities caused by a lower number of sweat glands. This could result in a higher heat load during summertime. However, buffaloes have a natural inherent tendency to indulge, which means that the wet season can be easier for them. Our results are consistent with a decrease in the rate of conception in Murrah buffaloes throughout instances of heat stress. The impact of climate on CR in cows and buffaloes are under natural conditions. It was discovered that CR was greater in animals fertilized throughout the winter season contrasted with various seasons. There is a decrease in CR in crossbred cattle that are fertilized during periods of heat stress (> 72 THI) relative to those fertilized under stress-free conditions. Furthermore, a decrease in CR was reported in Taurus cattle of temperate breeds. The reduction in PD-PR and CR during the heat stress stage can be impacted either through direct or indirect means. Heat stress has a direct impact on fertility by diminishing the quality of oocytes. Additionally, it indirectly affects fertility by decreasing the consumption of food, leading to an imbalance of energy in animals. This negative energy balance affects reproductive success by lowering the quality of both oocytes and embryos.

CONCLUSION

The total PD-PR of cattle was more significant than that of buffaloes. However, the CR in buffaloes exhibited a greater tendency in comparison with cattle. The prevalence of PD-PR and CR was most significant throughout the winter season in dairy cows and buffaloes, primarily due to favorable climatic conditions. However, lower rates of conception were seen in cattle and buffaloes during the summer and rainy seasons, respectively. Proper identification of oestrus, diagnosis of pregnancy and management strategies to reduce environmental stress can enhance the PD-PR and CR values. Animals could get stressed out through specific diagnostic techniques, such as ultrasonography. Stress can affect the animal's ability to reproduce as well as its overall welfare. Future diagnostic procedures should focus on minimizing stress on animals by utilizing modern technologies that ensure accurate identification while maintaining reproductive performance and overall well-being.

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