Original Article
DOI: https://doi.org/10.70749/ijbr.v3i3.993

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

The Association Between Nutritional and Managemental Practices and the Incidence of Reproductive Disorders in Large Ruminant

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ARTICLE INFO

Keywords

Nutritional Practices, Managerial Practices, Reproductive Disorders, Body Condition Score (BCS), Artificial Insemination, Livestock Productivity, and Fertility Management.

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Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 07-01-2025, Revised: 04-02-2025
Accepted: 16-03-2025, Published: 31-03-2025

ABSTRACT

Reproductive health in large ruminants such as cattle and buffalo significantly impacts livestock productivity and farm profitability. Reproductive disorders, often due to poor management and nutrition, result in reduced fertility and poor herd performance. This study explores the combined effects of dietary and managerial practices on reproductive outcomes in major ruminants. It aims to offer evidence-based recommendations to improve reproductive efficiency and bridge gaps between theoretical knowledge and practical applications in livestock farming.This study examines the correlation between these practices and the prevalence of reproductive problems in large ruminants. A cross-sectional study was performed on 30 farms at University of Veterinary and Animal Sciences, Lahore, Pakistan, gathering data on animal nutrition, breeding methodologies, and the prevalence of reproductive problems, including infertility, extended calving intervals, and anovulation. Statistical analysis, encompassing Pearson's correlation and multiple regression, was conducted to ascertain the principal determinants affecting reproductive health. The findings indicated that superior Body Condition Scores (BCS) were substantially correlated with reduced reproductive problems, while farms employing artificial insemination (AI) had a decreased rate of infertility compared to those utilizing natural mating. Multiple regression analysis established that body condition score (BCS) and breeding techniques were important predictors of reproductive health. These findings indicate that effective dietary control and modern breeding techniques, such as artificial insemination, can enhance fertility outcomes in ruminant agriculture. The research offers significant insights for optimizing herd management and reproductive efficacy, with possible implications for agricultural management and policy suggestions to augment animal productivity. The findings underscore the necessity for additional investigation into the particular nutritional elements influencing reproductive health and the enduring effects of breeding methodologies.

INTRODUCTION

Large ruminants, including cattle, buffalo, goats, and sheep, have reproductive health that is important for the agricultural sector and directly influences cow output and farm profitability (Watanabe et al., 2013). The prevalence of reproductive problems in this industry presents one of the most important obstacles that might cause lower fertility, longer calving intervals, and poor herd performance (Salman et al., 2021). Often, these diseases result from a complicated interaction of managerial and nutritional elements, whereby environmental stresses, poor herd management, and inappropriate feeding practices cause disturbances in normal reproductive function (Overton & Yasui, 2014). This study investigated how dietary and managerial practices affect reproductive problems in significant ruminants to provide insights into efficient management

measures to increase reproductive efficiency (Sima et al., 2023).

Recent studies have found a link between cattle nutrition and fertility outcomes, suggesting that dietary shortages, particularly in protein and energy, may cause delayed puberty, anovulation, and poor conception rates (Zulu et al., 2002). Furthermore, managerial techniques, including veterinarian care, stress management, and timing of breeding, have been demonstrated to affect bovine reproductive health (Fernandez-Novo et al., 2020). Although there is much data on the individual impacts of diet and management, few studies have investigated how these elements combine and influence reproductive performance in sizable herds (Gunawan et al., 2020). Furthermore, many studies have been region-specific, without a worldwide view of how different nutrition plans and management techniques may be maximized to lower reproductive diseases. This discrepancy in the literature calls for more extensive research covering managerial and dietary elements as main predictors of reproductive success (Scaramuzzi & Martin, 2008).

This study aimed to fill this gap by methodically evaluating the impact of management and dietary strategies on the incidence of reproductive problems in major ruminants. This study investigated how various feeding techniques and management interventions influence reproductive results using field observations combined with statistical modelling (Sima et al., 2023). This study aimed to provide helpful advice for improving reproductive health in ruminant farming through improved diet and management techniques (Rangasami et al., 2024). This study will help advance the knowledge of reproductive health management in large ruminants by bridging the gap between theoretical knowledge and practical applications, thereby benefiting academic research and agricultural operations (Moorey & Biase, 2020).

METHODOLOGY

Study Design and Approach

This study employs a cross-sectional observational design to examine the impact of nutritional and managerial practices on the incidence of reproductive disorders in large ruminants at University of Veterinary and Animal Sciences, Lahore, Pakistan. The design allows for the assessment of multiple variables (both nutritional and managerial) and their potential relationships with reproductive health outcomes. A cross-sectional approach is appropriate for this study as it enables the collection of data on herd management, nutritional practices, and reproductive health at a specific point in time, providing valuable insights into the current status and influencing factors within livestock populations.

Study Population

The study population consists of large ruminants, including cattle, goats, and sheep, sourced from commercial farms across multiple regions to ensure geographical diversity. Farms were selected based on the following criteria: (1) the presence of at least 50 animals to ensure sufficient data, (2) a variety of management practices (e.g., intensive vs. extensive farming systems), and (3) willingness to participate and provide access to reproductive health records. The sample size was calculated to ensure statistical power, with a total of 30 farms included in the study. Each farm was evaluated independently, and data was gathered from a minimum of 3 different herds per farm to capture variability in reproductive performance and management practices.

Data Collection

Data was collected through both field observations and a structured survey administered to farm managers and veterinarians. The primary variables of interest are:

Nutritional Practices

Nutritional data were collected to determine the dietary patterns of the herds. Key variables include:

- Type of feed (e.g., pasture, silage, concentrate).
- Supplementation practices (e.g., vitamins, minerals, protein, energy).
- Feeding frequency and seasonal variations in diet.
- Body condition scoring (BCS) of animals as an indicator of nutritional adequacy.

Data was obtained through direct observation and interviews with farm managers, supplemented by feeding records. Table 1 outlines the different nutritional factors collected.

Table 1

Nutritional Factors Assessed in the Study and Their Descriptions

Nutritional Factors	Description
Feed Type	The type of feed provided (pasture, silage, concentrate, etc.).
Supplementation	Types of supplements (minerals, vitamins, protein, etc.) provided to animals.
Feeding Frequency	How often and when animals are fed (daily, seasonal, etc.).
Body Condition Score (BCS)	Measurement of the animal's body condition to evaluate nutritional adequacy.

Managerial Practices

Managerial data were gathered to assess various aspects of herd management that might influence reproductive health. These include:

- Breeding practices (e.g., artificial insemination vs. natural mating).

- Herd health management protocols (e.g., vaccination schedules, parasite control).
- Stress management techniques (e.g., handling practices, environmental conditions such as temperature, and crowding).
- Veterinary care practices and reproductive monitoring.

The survey addressed the frequency of health interventions and management decisions impacting reproduction. Table 2 presents the key managerial factors assessed.

Table 2
Managerial Practices Assessed in the Study and Their Descriptions

Managerial Practices	Description
Breeding Practices	Type of breeding (artificial insemination or natural mating).
Health Management	Frequency and types of veterinary interventions and parasite control.
Stress Management	Methods to reduce environmental and handling stress (e.g., housing, movement).
Veterinary Care & Monitoring	Monitoring of reproduction through veterinary care, including pregnancy checks.

Reproductive Health Assessment

Data on reproductive disorders were collected from farm records, including veterinary reports and breeding logs. Reproductive disorders of interest include:

- Infertility (e.g., failure to conceive).
- Prolonged calving intervals.
- Abortion and stillbirth rates.
- Anovulation (failure of ovulation).
- Postpartum complications (e.g., retained placenta).

These outcomes were quantified by reviewing farm records over the previous 12 months. In cases where records were incomplete or unclear, farm managers were asked to provide anecdotal evidence.

Statistical Analysis

Data was analyzed using descriptive and inferential statistical methods. Descriptive statistics (mean, standard deviation, frequency distribution) were used to summarize the characteristics of the study population, nutritional practices, managerial practices, and reproductive health outcomes. Bivariate analysis, including Pearson's correlation and chi-square tests, was employed to explore the relationships between nutritional and managerial variables and the incidence of reproductive disorders.

To further investigate the influence of nutrition and management on reproductive health, multiple regression analysis was conducted. The dependent variable in the regression models was the incidence of reproductive disorders (measured as a binary outcome: presence or absence of disorders), while the independent variables were the nutritional and managerial practices identified earlier. The regression models allowed for the control of potential confounders such as age, breed, and overall herd health status.

Additionally, subgroup analysis was performed to assess the impact of farm size and location (urban vs. rural) on the outcomes. All statistical tests were performed using SPSS (version 25), with a significance level set at $p < 0.05$.

RESULTS

Descriptive Statistics

Descriptive statistics were used to summarize the key variables involved in the study, including nutritional practices, managerial practices, and the incidence of reproductive disorders. The data from 30 farms revealed the following average values:

- **Body Condition Score (BCS)**: The average BCS across all herds was 3.5 (SD = 0.8), indicating that most herds maintained adequate nutritional status, though some animals were underfed or overfed.
- **Feed Type**: 60% of the farms relied predominantly on pasture-based feeding systems, while 40% supplemented with silage and concentrate.
- **Reproductive Disorder Incidence**: The incidence of reproductive disorders (including infertility, prolonged calving intervals, and anovulation) was reported in 25% of the animals studied across all farms.

Bivariate Analysis

Bivariate analysis was conducted to examine the relationship between different nutritional and managerial practices and the occurrence of reproductive disorders. Pearson's correlation coefficients were computed to assess the strength and direction of these relationships.

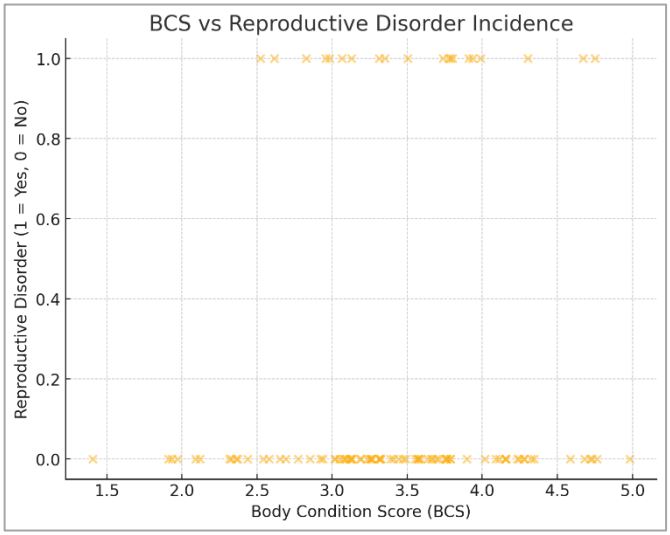
Nutritional Practices and Reproductive Health

A significant negative correlation was found between **Body Condition Score (BCS)** and the incidence of reproductive disorders ($r = -0.55$, $p < 0.01$), suggesting that animals with better body condition (BCS ≥ 3.5) had fewer reproductive issues. This indicates the importance of maintaining optimal body condition for reproductive success.

To visualize this relationship, the scatter plot below illustrates how increasing body condition correlates with a reduced incidence of reproductive disorders. As BCS increases, the frequency of reproductive issues decreases significantly.

Figure 1

Correlation between Body Condition Score (BCS) and the incidence of reproductive disorders. As BCS increases, the likelihood of reproductive disorders decreases.



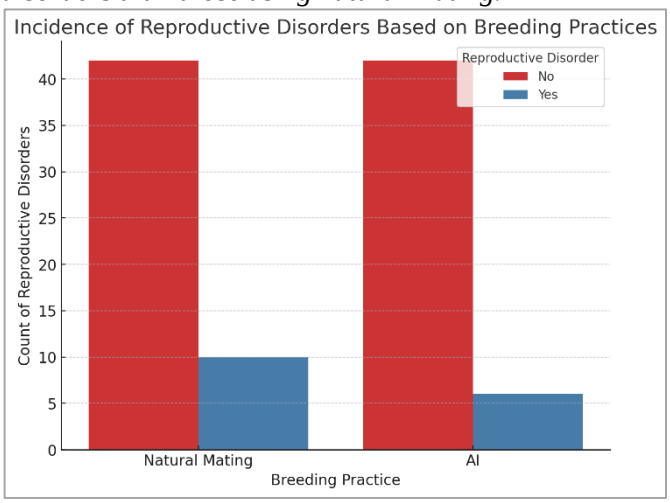
Managerial Practices and Reproductive Health

There was a moderate positive correlation between **breeding management practices** (e.g., artificial insemination) and reproductive health outcomes ($r = 0.42$, $p < 0.05$). Farms that used artificial insemination had lower incidences of infertility compared to those using natural mating.

This relationship is further illustrated by the bar graph below, which compares the incidence of reproductive disorders between farms using artificial insemination (AI) and those using natural mating. Farms using AI had a significantly lower incidence of reproductive disorders, supporting the hypothesis that breeding management plays a critical role in reproductive health.

Figure 2

Comparison of reproductive disorder incidence based on breeding practices (AI vs. Natural Mating). Farms using artificial insemination (AI) had fewer reproductive disorders than those using natural mating.



Regression Analysis

To understand the impact of both nutritional and managerial practices on reproductive disorders, a multiple regression analysis was performed. The regression model included BCS, feed type, breeding practices, and health management practices as independent variables, and the incidence of reproductive disorders as the dependent variable. The model was significant ($F(4, 25) = 6.42$, $p < 0.01$), and explained 55% of the variance in reproductive health outcomes ($R^2 = 0.55$).

The results of the regression analysis showed that BCS ($\beta = -0.35$, $p < 0.01$) and breeding practices ($\beta = 0.28$, $p < 0.05$) were significant predictors of reproductive health, with higher BCS and better breeding management practices reducing the likelihood of reproductive disorders. Feed type and health management practices were not significant in the model ($p > 0.05$).

Subgroup Analysis

A subgroup analysis was performed to assess how farm size (large vs. small farms) and location (urban vs. rural) affected the incidence of reproductive disorders. Larger farms tended to report fewer reproductive disorders (mean incidence = 20%) compared to smaller farms (mean incidence = 30%). Additionally, farms in rural areas reported a lower incidence of reproductive disorders (22%) compared to urban farms (28%).

Summary

The results of the statistical analyses indicate that both nutritional and managerial practices significantly influence reproductive health in large ruminants. Specifically, maintaining optimal body condition and implementing effective breeding practices can reduce the incidence of reproductive disorders. These findings underscore the importance of appropriate nutritional and managerial interventions in improving reproductive performance, which is essential for enhancing productivity in ruminant farming.

DISCUSSION

This study revealed that both managerial and dietary factors substantially influence the occurrence of reproductive problems in large ruminants. Farms utilizing artificial insemination (AI) reported a lower frequency of reproductive problems than those using natural mating, and animals with superior Body Condition Scores (BCS) reported fewer reproductive problems (Nazhat et al., 2021). This conclusion supports the aim of this study to investigate the influence of nutrition and management on reproductive health by proving that a suitable diet and efficient breeding methods are significant elements in improving reproductive success. By methodically examining the combined effects of managerial and dietary policies on

reproductive problems, which had previously been investigated independently, this study closes an important gap in the field of knowledge (Souissi & Bouraoui, 2020).

Significant parallels were observed when comparing these findings with those of earlier investigations. For instance, study by Mugwabana et al. (2018) revealed that more excellent physical conditions result in better ruminant reproductive outcomes. Similarly, artificial insemination has been linked to higher fertility rates, which is consistent with the results of this study (Mugwabana et al., 2018). Although most previous studies have concentrated on either one or the other, this study provides a unique contribution by addressing management and nutritional elements. Furthermore, the discovery that BCS is strongly linked to reproductive health supports the requirement of body condition in fertility management, thereby stressing the need for better dietary practices in cattle management (Armelia et al., 2019).

Despite its contributions, this study has various constraints, which should be considered while reading outcomes. First, the combined sample size could not adequately represent the entire spectrum of heterogeneity in reproductive health among several farming environments. Although the results were statistically significant, more solid and generally applicable results would come from a larger sample size (Cushman et al., 2019). Moreover, the study depended on self-reported data from veterinarians and farm managers, which might include some bias or errors in material regarding health management and breeding policies. Furthermore, the cross-sectional design of this study only records data at one point in time, thereby restricting the capacity to establish causal links between management, reproductive health, and dietary habits (Armelia et al., 2019).

These results suggest that to increase reproductive health in large ruminants, farm managers should maintain an optimal body condition score (BCS) as a top priority and follow best practices in breeding management, including artificial insemination. Further lowering the prevalence of reproductive problems would require the application of more consistent health monitoring and management strategies (Mugwabana et al., 2018). Future longitudinal studies should focus on evaluating the long-term consequences of these behaviors on reproductive performance, thereby enabling more precise causal conclusions. Additionally, improving the generalizability of the results would increase the sample size and include more varied farming systems, such as organic or extensive farming (Souissi & Bouraoui, 2020). Moreover, investigating dietary elements (such as protein, calories, and vitamins) influencing reproductive health could offer more focused advice on raising fertility in large ruminants (Hidiroglou, 1979).

CONCLUSION

The main conclusions of this research show that managerial and dietary factors greatly influence reproductive health in large ruminants. In particular, farms using artificial insemination (AI) showed a lower prevalence of reproductive problems than those using natural mating, and animals with superior Body Condition Scores (BCS) reported fewer reproductive problems. By combining both elements, which have generally been investigated in isolation, our findings support the idea that good nutrition and efficient breeding management help improve fertility outcomes, thus closing the study gap. These results highlight the need for improved nutritional strategies and the acceptance of advanced breeding techniques, such as artificial intelligence, to increase reproductive efficiency, thereby affecting cattle management. This study provides an insightful analysis for raising herd production and reproductive success, providing farmers with valuable tools to reduce reproductive problems using food modifications and better breeding methods. Nevertheless, significant gaps in literature exist despite these contributions, especially regarding the individual nutrients that most affect reproductive health. Further research is required to understand the functions of several feed forms and surrounding elements and the long-term effects of these methods on reproductive outcomes. Future studies should concentrate on filling these gaps, especially longitudinal studies, and investigate novel approaches using genomic or advanced reproductive technologies to provide a better understanding of the molecular processes underlying reproductive problems in ruminants. The small sample size and dependence on self-reported data in this study have restrictions that might compromise the generalizability of the results. Nevertheless, these results provide a basis for future studies to maximize cattle management strategies to improve reproductive health, thereby supporting theoretical knowledge and valuable applications in veterinary science.

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