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Enhancing Dairy Production through Virtual Reality: A Comparative Study of Milk Quality and Quantity in Open and Closed Environments

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Abstract*: *In dairy production, understanding the factors influencing the milk production is crucial for enhancing productivity and ensuring quality. The research revolves around the concept of usage of Virtual Reality (VR) Technology for stimulating milk extraction by contrasting the result of Open and Close cow farming in India. A comparative analysis was conducted on milk quality and quantity between Open and Close cows, with a focus on the impact of pre and post production VR exposure on Close cow farms. This study comprises a summation of (no of cows) samples gathered from diverse geographical areas engulfing both (Open and Closed) settings. The study exhibits the effectiveness of VR bridging the gap between Close and Open environments. Findings suggest that VR has the potential to harmonize the milk production environment and enhance overall production.The dairy milk production is based on changing environment and geographical area.

Keywords: VR, Virtual Reality, Milk Production, VR in dairy farming, AI in dairy farming.

I. INTRODUCTION

Dairy sector acts as a cornerstone of agricultural systems worldwide providing a vital source of nutrition and sustenance globally. [3]At the core of this sector lies the production of milk, it is a complex mixture of proteins, carbohydrates, vitamins, minerals and other elements dispersed in water. In the diverse domain of dairy farming, the production of milk by cows and their health is greatly affected by their genes, the environment they live in and the technology advancements we use.

To delve deeper into this study, our research focuses on four distinct breeds of cows specifically adapted to controlled and confined environments: Sahiwal and Deoni representing the closed environment, and Kankrej and Kathwadi Gir representing the open environment. This research focuses on comparative dynamics of milk production, average weight and the factors shaping productivity across enclosed and closed parameters that are crucial for progressing dairy farming practices.

[12]Virtual Reality headsets were utilized on the cows in a close environment to replicate the open environment resulting in reduced stressed and anxiety amongst the cows and indirectly contributing to improved milk production yields.Cows are categorized into groups labeled with distinct colors, such as red, green, and yellow, for research classification purposes.

Serial no	Product Name	Price
1	PROCUS ONEX VR (42 MM for IOS and Android,360 degree with 3.5 MM jack inbuilt)	Rs 2499
2	BLACKPOOL Virtual Reality Headset Glasses Anti-Radiation Adjustable Screen Headband Latest VR Headset Virtual Reality Box for All Android Phones	Rs 799
3	REKHAS Virtual Reality Headset Glasses Anti-Radiation Adjustable Screen Headband Headset Box | VR Set Box | Gift for Kids and Adults for 3D Gaming and VR Videos	Rs 549
4	VR Headset, Azonee 3D VR Headset with Remote Controller,Virtual Reality VR 3D Glasses VR Set 3D Virtual Reality Goggles, Controller, Adjustable VR Glasses Support 4.7-6.0 Inches Smartphones	Rs 11,353

TABLE 1.1-Specification & Pricing of VR Headsets

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Our research (comparative analysis) is based on following geographical area:
At post : Khamni(Village name)21.2126° N, 76.2653° E,Dist- Burhanpur M.P
At post: Khardev Nagar,19.0551° N, 72.9139° E,Dist-Kurla Mumbai

Breed of cow	Average age	Average weight	Milk yield (per day)	Data Samples
Sahiwal	7-12 years	450 kg	7-11 liters	87
Deoni	10-12 years	458.5 kg	5-7 liters	37
Kankrej	10-15 years	431 kg	5-7 liters	52
Kathwadi Gir	12-15 years	400 kg	10-12 liters	130
Desi Cow	10-15 years	500 kg	2-3 liters	29

Table 1.2-Description of Categories of Cows

II. LITERATURE REVIEW

[3] As the authors have conveyed in this research paper: "Livestock farming' in Rajasthan is integral to the rural economy and particularly in milk production. The state is the second largest milk producer in India and primarily from local buffalo and cow breeds. Past research has explored milk production economics across regions and but variations persist. Understanding' production costs' is crucial for economic viability and' policy making'. This study aims to analyze the cost an' returns of milk production in Rajasthan to inform effective pricing strategies and' support dairy farmers'.

[10] The research suggests that a Turkish farmer enhances milk yield by equipping cows with VR goggles displaying green pastures, following a concept from Russia. This experiment resulted in increased daily milk output from 22 to 27 liters, leading to reduced stress and improved emotional well-being among the cattle. Plans to extend this approach to the entire herd are considered, alongside existing tech-savvy practices like embedded leg chips for monitoring. Despite the growing global VR market, the extent of cows' involvement remains uncertain.

[12] The use of VR headsets on dairy cows near Moscow aims to reduce anxiety and potentially increase milk production by simulating a calming summer environment.

Initial results show decreased anxiety and improved emotional mood among the herd. However, this application raises concerns about VR's potential to distract from real-world problems, suggesting a future where people might use VR as an escape from pressing social and environmental issues rather than addressing them directly. This underscores the importance of ethical consideration and mindful use of VR technology as it becomes more prevalent in society.

III. TECHNIQUES

1) Problem Statement 1: Decline in Milk Yield in Closed Environments

The productivity of dairy cows in closed environments has demonstrated a concern in the trend of decreasing milk yield over the past few years. This decline raises questions about the effectiveness of closed environments in maintaining or enhancing dairy production compared to traditional open environments. Identifying the factors contributing to this decline is crucial for devising strategies to improve and optimize dairy production systems.

2) Problem Statement 2: Impact of Artificial Interventions on Cow's Health.

In quest of higher milk yield, dairy farmers are adapting to Artificial Interventions such as injections to stimulate lactation in cows. The implications of these interventions on overall milk quality as well as long term health and wellbeing of cows is not adequately recognised.

IV. OBJECTIVES

1) Utilize VR technology to formulate the system that Address and Narrow the Milk Yield Disparity Between Closed and Open Environments in Dairy Farming.
2) Analyzing the impact of VR technology and how it enhances cow's emotional well-being compared to close environments, offering stress relief and an open atmosphere, positively impacting psychological assessment.
3) Develop a Mechanism Utilizing VR Technology to Enhance Immune Function, Reproductive Health, Lactation Cycle, Lifespan, and Growth in Cows, as Part of Prioritized Modern Dairy Farming Practices.
4)

V. RESEARCH METHODOLOGY

According to the methods employed in this study the data on milk yield , cow breeds, Average age and Average weight were gathered directly from sheds in Khamni village, Burhanpur District in Madhya Pradesh and Deonar village, Kurla District ,Mumbai Maharashtra encompassing open and closed cow farming settings respectively

1) Statistical methods were utilized such as hypothesis testing which included Pearson's correlation test and chi-square test, to analyze associations between milk quality and various variables such as fat content and breed categories
2) Additionally, to calculate the total solids percentage in milk, a formula was employed. The total solids percentage (TS) is determined by the following formula:

   Total Solid (in %) = (0.22 x Fat%) + (0.36 x SNF%) + 0.32

   Fat% represents the percentage of fat content in the milk sample

   SNF% represents the percentage of solids-not-fat (SNF) in the milk sample
3) In the preliminary phase of our research,the calculation of fat percentage was derived through the application of the provided formula:

   Fat %=(Total Fat Yield(in gm)/Total Milk Yield(liters))*100
4) For the context of this study, the VR technique was employed to introduce cows in closed farming environments to replicate open landscapes,ultimately leading to potential milk production yields.

VI. FACT FINDINGS

1) According to our dataset, the morning milk production density is greater than evening milk production density by 0.13 kg/m^3 .From this we can draw a conclusion that cows naturally produce more milk in the morning due to their increased level of prolactin , prompt milk synthesis, cow's quality of sleep , digestion , overall activeness during these early hours.
2) Average milk production per day by Kathwadi Gir (9.8L) is more than Sahiwal(8.02L) by 1.6 liters .Deoni(5.9L) and Kankrej(6L) is more production of milk than Desi cow (3.1L) by 2.9 liters.
3) With respect to data distribution the total solid percentage of milk in considered categories varies between 11.3 to 15 which indicates the milk quality.
4) Through our visualization, we observe that maintaining cows in an open environment, as indicated by 249 instances, is correlated with more stable health conditions compared to closed environments, which are represented by 122 instances, highlighting a difference of 127 as indicated by a count of 249 instances, is associated with more stable health conditions
5) VR goggles were employed during evening milking, and it was observed that milk density increased. Despite typically higher morning yields, this suggests a potential positive influence on milk quality during evening sessions.
6) In the post-virtual reality (VR) graph analysis,it was revealed that Sahiwal breed exhibited an average milk production of 12 liters, contrasting sharply with Deoni breed's average yield of 8 liters. A notable difference is noted in milk productivity between the two breeds.
7) Based on the analysis of milk quality, Sahiwal breed demonstrates a wider range of milk quality, with a maximum of 14.30 of total solids , compared to Deoni breed's maximum of 14.38 of total solids. However, Deoni breed exhibits a higher median milk quality of 13.79 compared to Sahiwal's median of 13.41.
8) The data is distributed among five breeds, each contributing to the total count as follows: Sahiwal cows make up 26%, Kathwadi Gir represents 38%, Desi cow accounts for 8.7%, Deoni comprises 11%, and Kankrej contributes 15.5%.
9) Hypothesis Testing

Null Hypothesis : There is no association between milk quality and other variables (e.g., fat content, solids not fat).

Alternative Hypothesis: There is a significant association between milk quality and other variables.

Test carried out:

- Pearson's Correlation Test
- Chi-Square Test

Hypothesis Test 2 -

- Pearson's correlation p-value: 1.1257650281497657e-08

The p-value for Pearson's correlation test between milk production and fat content is approximately 1.13e-08, which is a very small value. This indicates strong evidence against the null hypothesis of no correlation. In other words, there is a significant correlation between milk production and fat content in the data.

Hypothesis Test 3 -

- Chi-square test p-value: 3.3972046791151153e-51

The p-value for the chi-square test comparing milk quality between categories of cows is approximately 3.40e-51, which is extremely small. This indicates strong evidence against the null hypothesis of no association between categories of cows and milk quality. In other words, there is a significant association between categories of cows and milk quality in the data.

- PRE VR VISUALISATION

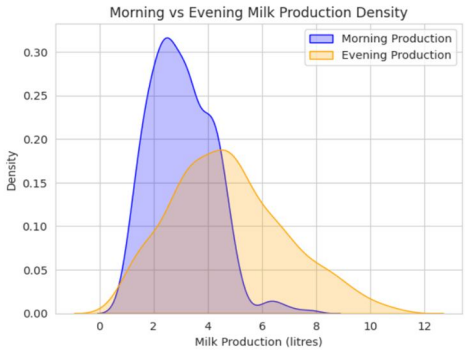


FIG 6.1 -Morning vs Evening milk production density

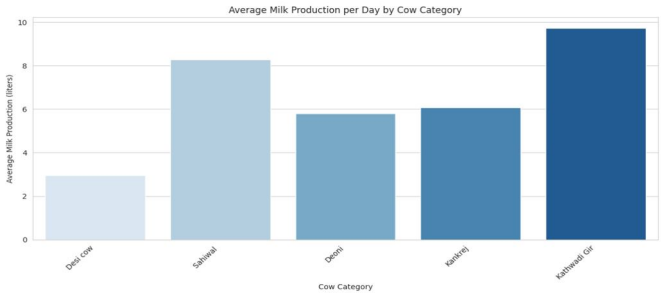


FIG 6.2 -Average milk production per day by cow category

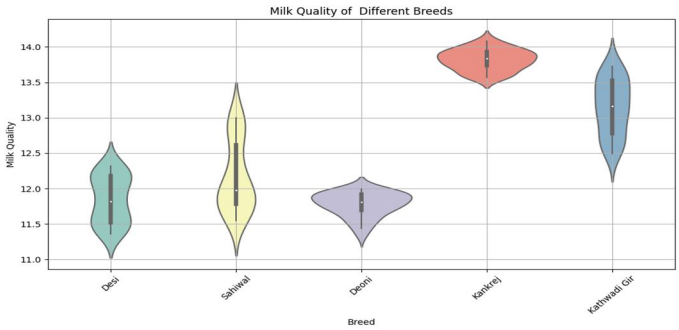


FIG 6.3 - Milk quality of different breeds

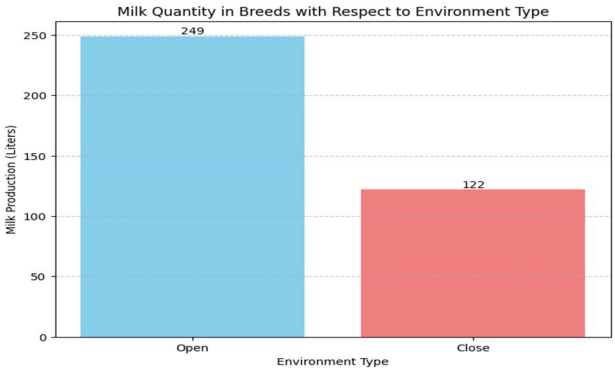


FIG 6.4 - Milk quality with respect to environment type

- Post VR Visualization

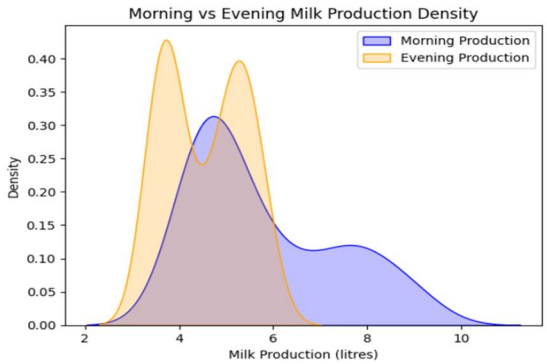


FIG 6.5 Morning vs Evening milk production density

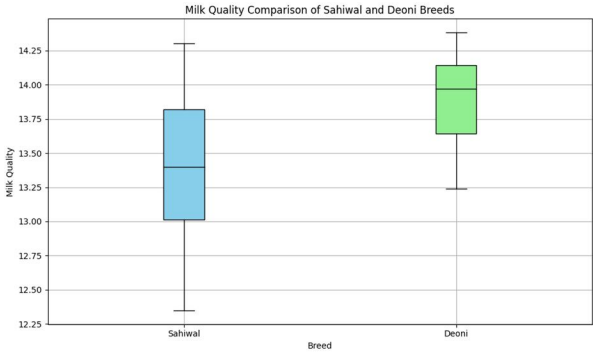


FIG 6.6 - Milk quality comparison of sahiwal and deoni breeds

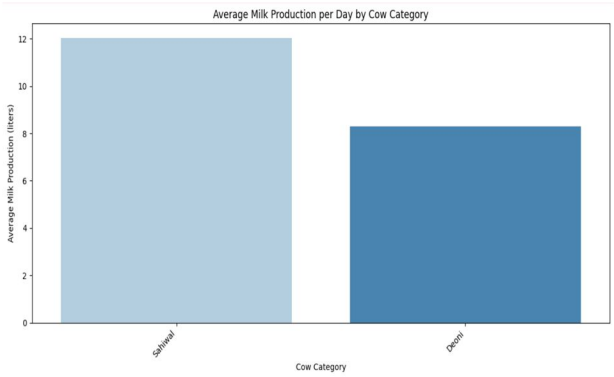


FIG 6.7-Average Milk production per day by cow category

VII. CONCLUSION

1) After conducting our study, we found that VR simulations in closed environments led to significant increases in milk yield for Sahiwal and Deoni cows, from 8.4 to 11.8 liters and 5.9 to 7.7 liters respectively. This finding underscores the potential benefits of utilizing virtual reality technology to enhance the well-being and productivity of cows within confined settings.

2) In summary, a pivotal move in the direction of increment in animal welfare promotions and sustainable development of dairy farming practices on a larger scale. The artificial methods ,including administration of an injection has been rejected which favors VR technology, helped in a commitment to safeguard the healthiness of cows and considering the inadequacy of methods along with their harmful consequences.

3) Upon assessment of milk quality parameters , it becomes clear that VR simulation in closed environments led to marked advancements in somatic cell count, protein content and microbial composition. Notably, the total average solid showcased a noteworthy increase in post-experimentation ranging from (11.6% to 13.00%) to (12.25% to 14.26%) of Sahiwal and (11.48% to 12%) to (13.20% to 14.25%) for Deoni, highlighting the significance of virtual reality technology in positively impacting nutritional value thereby enhancing the milk quality.

4) In conclusion , our study featured the implementation of Virtual Reality headsets that can potentially contribute to the emotional and mental stability of cows. By engendering an open environment within closed settings ,cows may experience a sense of familiarity,homeliness and comfort , nurturing a positive emotional state.

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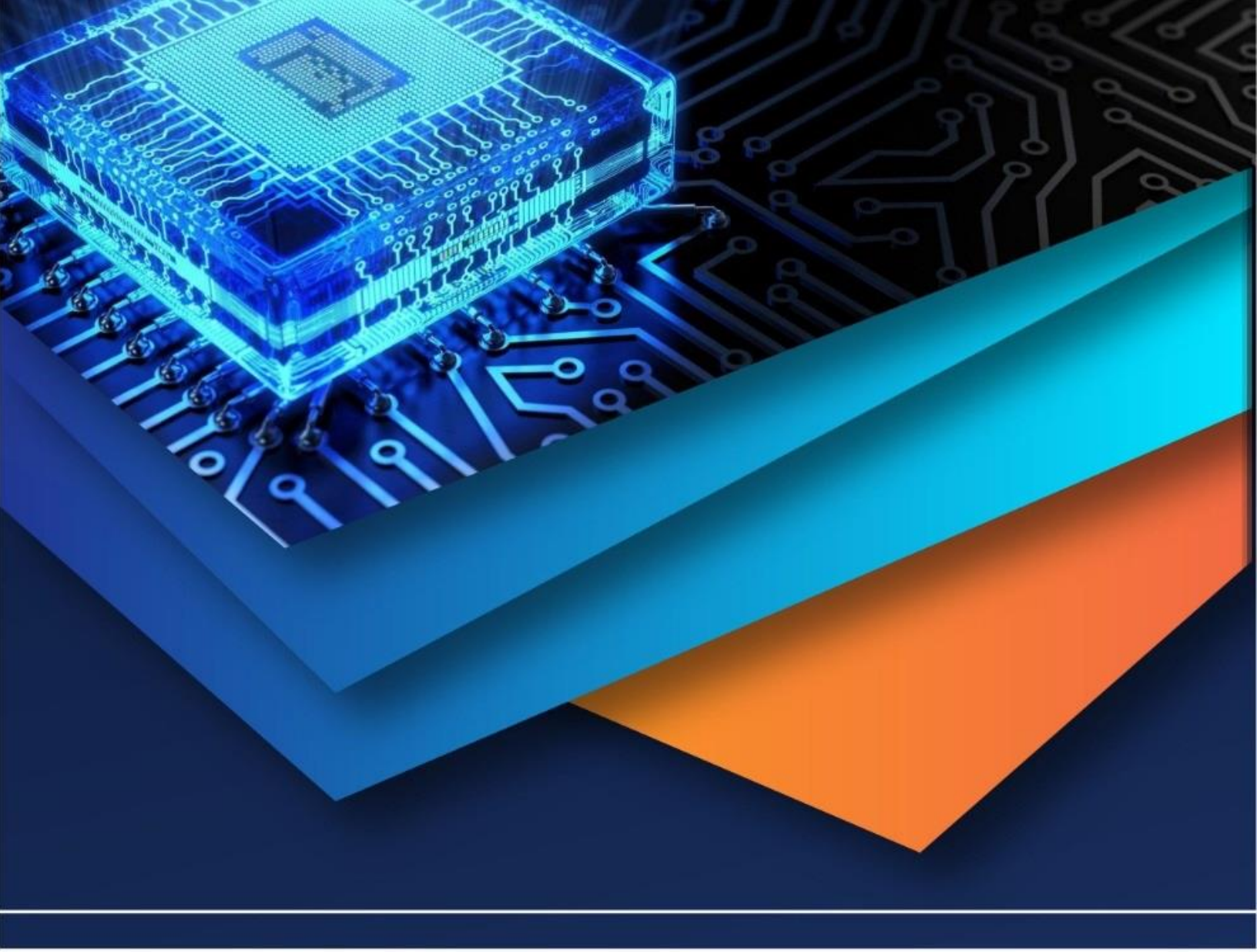
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