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Milk Yield Predictor with Nutritional Analysis for Dairy Farmers

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Abstract: - For dairy producers, milk production is their main source of income and it is greatly impacted by the diet that cows and buffaloes consume. Even though sophisticated dairy management systems frequently employ hardware and sensors to track the productivity and health of the animals, small and medium-sized farmers cannot afford these expensive technologies. In place of sensor-based monitoring, this study suggests a software-based milk yield forecast method that uses nutritional analysis. Depending on the kind and amount of feed given, the system assesses vital nutrients such energy, protein, calcium, phosphorus, fat, fiber, vitamins, and water. The computed values are contrasted with established standard nutritional needs for various dairy species to evaluate nutritional sufficiency. Through this evaluation, the system forecasts the anticipated range of milk production and pinpoints nutrient shortages. Furthermore, the software offers distinct and practical feeding recommendations to assist farmers in enhancing nutritional balance and increasing milk yield. To guarantee accessibility and practical usability, the system accommodates both English and Marathi languages, enabling farmers to select their desired language and comprehend recommendations effortlessly. The suggested method highlights cost-effectiveness, ease of use, and a farmer-focused design, rendering it appropriate for rural implementation. This study

shows that optimal nutrition, along with smart software analysis and suggestions, can act as an effective and feasible approach for predicting milk production without requiring costly sensor systems

Keywords: - Milk Yield Prediction, Nutritional Analysis, Dairy Farming, Feed Management, Decision Support System, Farmer-Centric Technology, Bilingual Application

INTRODUCTION

In the heart of India's countryside, dairy farming is more than just an agricultural activity—it's a lifeline. For countless families, raising cows and buffaloes is a primary source of income or a vital supplement to their earnings, forming the cornerstone of the rural economy. Today, India stands tall as one of the world's leading milk producers, an achievement made possible by the dedication of small and medium-scale farmers. These individuals tend to their animals under varied conditions, navigating daily challenges with resilience. Yet, behind this success lies a persistent struggle. Maintaining a steady flow of milk is no simple task, and one of the biggest hurdles farmers face is feeding their animals correctly. The quantity and quality of milk are deeply connected to what the animals eat. Just like humans, dairy cattle need a balanced diet rich in energy, protein, minerals, and water to stay healthy and productive. When their feed lacks essential nutrients, milk output drops, animals become prone to illness, and household incomes suffer. Many farmers rely on time-tested, traditional feeding methods passed down through generations. While this wisdom is valuable, it often doesn't align with modern scientific understanding of animal nutrition. Without clear guidance on crafting a balanced diet, it becomes difficult to spot deficiencies or know how to correct them. In response to these challenges, new technologies have entered the scene. Advanced systems using sensors and data analytics can now monitor an animal's health, activity, and milk yield with impressive precision. However, for the average small-scale farmer, these solutions remain out of reach. They often come with high costs, require reliable internet, and need technical know-how—barriers too steep for many in rural and semi-rural areas.

Other efforts have tried to predict milk yield using historical data or details like an animal's breed and age. While helpful, these methods frequently miss a crucial piece of the puzzle: the daily diet. What the animal eats is fundamental, and overlooking it means farmers receive incomplete advice on how to truly improve production.

This is where our work steps in. We envisioned a practical, farmer-centric solution—a system rooted in the power of nutrition. By simply inputting details about what they feed their animals, farmers can compare their practices with science-backed standards from trusted bodies like the ICAR and NRC. The system then highlights nutritional gaps, forecasts potential milk yield, and suggests affordable, tailored adjustments to their feeding routine. Designed with simplicity and accessibility at its core, this approach requires

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no expensive hardware or constant connectivity. By offering support in both Marathi and English, it speaks directly to farmers in their own context. Our goal is to bridge the gap between textbook nutrition and field reality, empowering farmers with knowledge that is both understandable and immediately useful. In doing so, we hope to support the unsung heroes of India's dairy sector, helping them nurture healthier herds and secure more prosperous futures.

1.1 Objectives of the Study

The main objective of this study is to design a simple software-based system that predicts milk yield by analyzing the nutritional content of feed given to dairy animals, helping farmers understand how nutrition affects milk production.

The specific objectives of the study are:

- To analyze the nutritional value of commonly used feed for cows and buffaloes.
- To compare farmer-provided feed data with standard nutritional requirements of dairy animals.
- To estimate milk yield based on the nutritional balance of the feed.
- To provide easy and practical feeding recommendations in both Marathi and English for farmers.

2. RELATED WORK (LITRERATURE WORK)

This project builds on a foundation of existing research from around the world that connects animal nutrition with dairy productivity. The following studies have been particularly influential:

1. **Moran, J. (2005) – Tropical Dairy Farming: Feeding Management for Smallholder Dairy Farmers**
   Moran's work focuses on the realities of small-scale dairy farming in developing regions. He clearly establishes the direct link between a balanced diet and both milk output and animal well-being, highlighting energy and protein as critical pillars for successful farmers.

2. **National Research Council (NRC), 2001 – Nutrient Requirements of Dairy Cattle**
   This comprehensive publication by the NRC is a cornerstone reference in animal science. It provides the essential, science-backed standards for nutrients like protein, energy, and minerals that dairy cattle need, serving as a universal benchmark for nutritional analysis.

3. **Indian Council of Agricultural Research (ICAR), 2013** – Nutrient Requirements of Cattle and Buffalo
   Recognizing that local conditions matter, the ICAR's guidelines tailor nutritional standards specifically for cattle and buffalo in India. This makes it an indispensable reference for accurately evaluating feed and planning diets within the Indian context.

4. **Rathod et al. (2016) – Adoption of Dairy Farm Technologies and Its Impact on Milk Production**
   This study examines the on-ground practices of rural farmers. Its key finding resonates deeply: that a lack of awareness about scientific nutrition, more than any other factor, is a primary reason for lower-than-possible milk yields on small farms, underscoring the need for better knowledge sharing.

5. **Kamal et al. (2018) – Milk Yield Prediction Using Machine Learning Techniques**
   Exploring modern methods, this research uses machine learning to predict milk yield based on factors like an animal's breed and lactation stage. However, it acknowledges a significant gap: it does not deeply incorporate the details of daily feed and nutrition, which are fundamental to production.

3. MATERIALS AND METHODS

3.1. Working Diagram and Explanation

Step 1: Welcome & Language Selection: You'll start by choosing your preferred language—English or **Marathi** —so you can use the system comfortably and understand every detail.

Step 2: Enter Your Farm's Details
Here, you'll tell us about your animal. We'll need to know:

- **Animal Species:** Is it a cow or a buffalo?
- **Weight:** What is the animal's current body weight?
- **Lactation Stage:** Is it early, mid, or late in its milking cycle?
- **Feed Type:** What are you currently feeding it (e.g., green fodder, dry straw, concentrates)?

Step 3: Behind the Scenes – The Science Library
Once you provide the details, our system quietly gets to work. It compares your feed information against trusted scientific standards set by organizations like **ICAR** and **NRC**, which are like reference books for animal nutrition.

Step 4: The Core Calculation
The system's engine then calculates the total nutrition your animal is receiving from its diet. It looks at key components:

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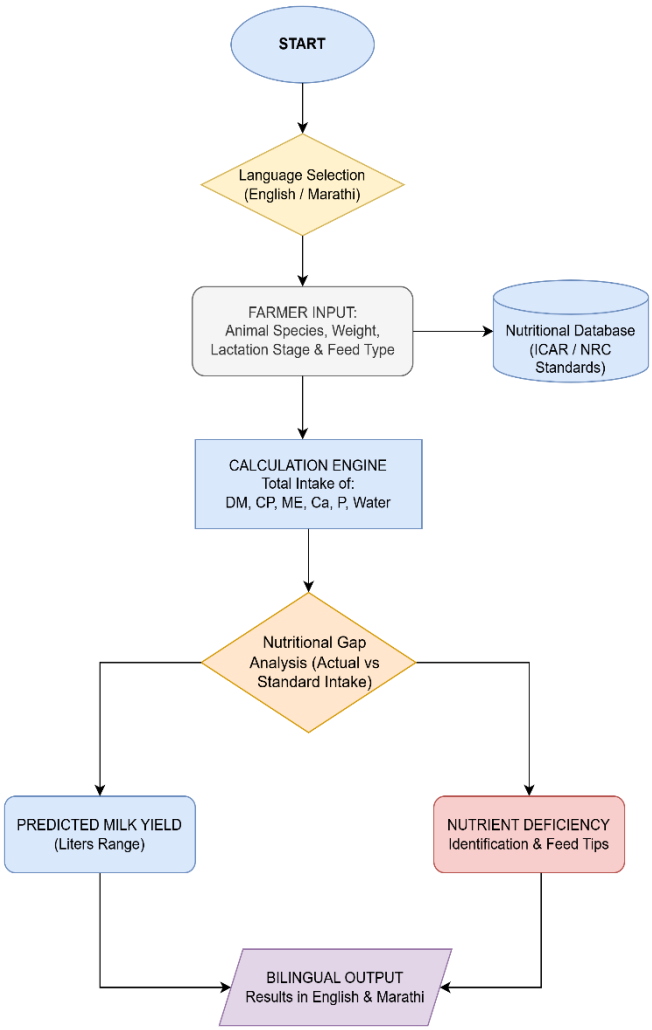
- **Dry Matter (DM)**
- **Crude Protein (CP)**
- **Metabolizable Energy (ME)**
- **Minerals like Calcium(Ca) and Phosphors (P)**
- **Water Intake**

Step 5: Finding the Gaps
Next, it performs a "Nutritional Gap Analysis." This simply means it compares what your animal is eating (from Step 4) with what it should be eating (from Step 3) to identify any shortages or excesses.

Step 6: Your Milk Yield Forecast
Based on this nutritional balance, the system provides a **Predicted Milk Yield** in a realistic range (e.g., 10-12 liters per day). This forecast shows you the potential milk production supported by the current diet.

Step 7: Personalized Feed Advice
If any gaps are found, the system won't just point out the problem—it will offer a solution. It clearly identifies any **Nutrient Deficiencies** and provides practical, actionable **Feed Tips** to help you correct them.

Step 8: Receive Your Bilingual Report
Finally, you receive a complete, easy-to-understand summary of all the results—the yield prediction, nutrient gaps, and recommendations—in both **English and Marathi**. This ensures the insights are accessible and useful for making decisions on your farm.



3.2. Nutritional Standard values of Dairy animals

Nutrient	Unit	Cow (Lactating)	Buffalo (Lactating)
Dry Matter (DM)	kg/ day	10 – 12	12 – 14
Crude Protein (CP)	kg/ day	1.2 – 1.6	1.4 – 1.8
Metabolizable Energy (ME)	MJ/day	90 – 110	100 – 120
Calcium (Ca)	g/day	50 – 70	60 – 80
Phosphorus (P)	g/day	30 – 45	35 – 50
Water Intake	Liters/ day	50-70	60-80

Table 1.1. standard values of Nutrients

3.3. Performance Matrix

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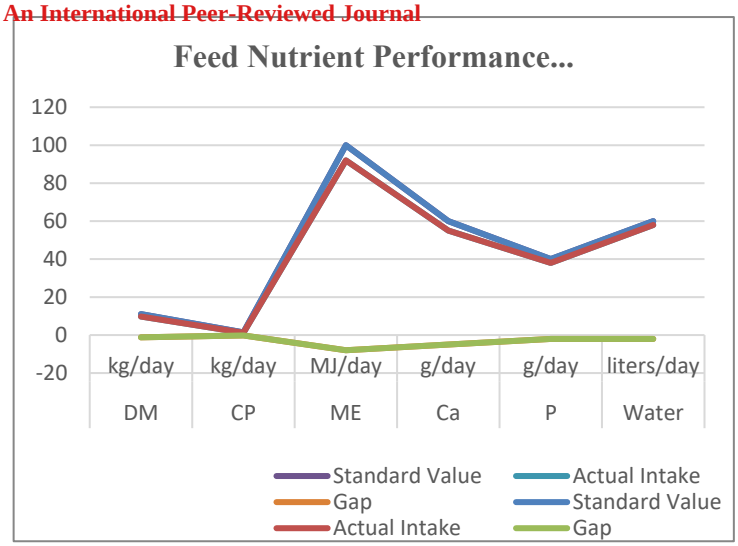

The system calculates daily nutrient intake using feed quantity entered by the farmer along with standard nutrient composition values. The major nutrients considered in the performance analysis are Dry Matter (DM), Crude Protein (CP), Metabolizable Energy (ME), Calcium (Ca), Phosphorus (P), and Water.

The intake calculations are performed using the following general formulas:

- **Dry Matter Intake (DM)**
  DM = Feed Quantity × Dry Matter Percentage
  This calculation estimates the actual solid feed consumed by the animal.

- **Crude Protein Intake (CP)**
  CP = DM × Protein Percentage
  Protein intake is calculated to assess its role in milk synthesis.

- **Metabolizable Energy (ME)**
  ME = DM × Energy Value
  Energy intake is used to evaluate whether the feed meets milk production energy needs.

- **Calcium Intake (Ca)**
  Ca = DM × Calcium Content
  Calcium is essential for milk formation and bone health.

- **Phosphorus Intake (P)**
  P = DM × Phosphorus Content
  Phosphorus supports metabolic functions and milk yield.
- **Water Intake:**
  Water intake is considered either through direct farmer input or by using a standard estimated value, as adequate water availability is essential for milk secretion.

The calculated nutrient intake values are compared with standard nutritional requirements to identify deficiencies or excesses. Based on this comparison, the system estimates the expected milk yield. The predicted milk yield is then compared with approximate milk production values reported by farmers to evaluate prediction effectiveness. The system also demonstrates good performance in terms of response time and usability. It processes input data quickly and presents clear results in both English and Marathi. Overall, the performance matrix shows that the proposed system is effective, efficient, easy to use, and suitable for small scale dairy farming applications

3.4. Experimental setup

Parameter	Unit	Standard Value	Actual Intake	Gap	Interpretation
Dry Matter (DM)	kg/ day	11.0	9.8	-1.2	Low intake
Crude Protein (CP)	kg/ day	1.4	1.2	-0.2	Protein deficient
Metabolizable Energy (ME)	MJ /day	100	92	-8	Energy deficit
Calcium (Ca)	g/ day	60	55	-5	Slight deficiency
Phosphorus (P)	g /day	40	38	-2	Near adequate
Water	liters/day	60	58	-2	Adequate

Table.1.2. Nutrient Intake and milk Yield

- **Software Tools:**

  Software tools were used only during the research, testing, and validation stages of the proposed system. Spreadsheet software such as MS Excel was used to enter sample feed data, calculate nutrient intake values like Dry Matter, Crude Protein, Energy, Minerals, and Water, and perform nutritional gap analysis. It was also used to prepare tables and summarize results in a structured format.

- **Graphical Analysis Tools:**

  Graphs such as line graphs were generated to visually compare standard nutrient requirements with actual nutrient intake. These graphs helped in explaining the analysis and interpreting results in the research work. The graphs are not part of the final

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software interface and are used only for academic representation.

- **Development and Documentation Environment:** A simple text editor or integrated development environment (IDE) was used to design and document the logic of the milk yield prediction system. This included writing the steps for nutrient comparison, gap identification, and milk yield estimation.

- **Data Sources:**

  Standard nutritional requirement values were collected from reliable sources such as the Indian Council of Agricultural Research (ICAR) and the National Research Council (NRC). These values were used as reference benchmarks for evaluating the nutritional adequacy of feed. Sample farmer feed data were assumed based on commonly followed feeding practices for experimental evaluation.

- **Calculation Environment:**

  Nutrient intake calculations were performed using basic mathematical formulas based on feed quantity and nutrient composition. Gap analysis was done by comparing calculated intake values with standard nutritional requirements to identify deficiencies or excesses.

- **Hardware Environment:**

  All experimental work and analysis were carried out on a standard computer system with basic hardware configuration. No specialized equipment, sensors, or additional devices were required.

- **Proposed System Environment:**

  The proposed system is designed as a simple, cost-effective, and software-based solution. It requires only basic inputs from farmers and provides results in a clear, text-based format. The system supports both English and Marathi languages, making it accessible to rural and small-scale dairy farmers

3.6 Performance Comparison

The performance of the proposed milk yield prediction system is compared with traditional feeding practices and existing technology-based dairy management approaches. This comparison is mainly qualitative, as the proposed system is software-based and does not rely on physical sensors or automated data collection devices.

In traditional dairy farming practices, milk yield estimation is largely based on farmer experience and past observations. While this method is simple, it does not provide clear insight into nutritional deficiencies or guidance for improving feed balance. As a result, farmers may continue feeding practices that limit milk production. Advanced dairy management systems that use sensors, IoT, and machine learning can offer accurate monitoring and prediction. However, these systems are expensive, require continuous internet connectivity, and need technical expertise, making them unsuitable for small-scale and rural farmers.

In comparison, the proposed system provides a balanced alternative. It uses simple farmer-provided inputs and standard nutritional values to analyze feed quality and predict milk yield. Unlike sensor-based systems, it is low-cost, easy to use, and does not require specialized hardware. The inclusion of nutritional gap analysis also helps farmers understand *why* milk yield may be low and *how* it can be improved. Overall, when compared to traditional methods and advanced technological solutions, the proposed system offers better accessibility, affordability, and practical usefulness for small and medium dairy farmers, while still delivering meaningful insights into milk yield and nutrition management.

4. RESULTS

The results of this study highlight the effectiveness of the proposed nutrition-based milk yield prediction system when compared with approaches discussed in existing literature. The literature review shows that earlier research mainly followed three directions: traditional feeding practices, technology-driven systems using sensors and IoT, and prediction models based on historical milk yield and animal characteristics such as breed, age, and lactation stage. While these methods provided useful observations, many of them either ignored detailed nutritional analysis or depended on expensive hardware and technical infrastructure, making them unsuitable for small-scale dairy farmers.

In the present study, standard nutritional requirement values recommended by ICAR and NRC were used as reference benchmarks. Unlike earlier models that focused largely on past production data or advanced sensing devices, the proposed system directly analyzes the nutritional content of the feed currently given by farmers. This approach enables clear identification of nutrient gaps, particularly in Dry Matter, Crude Protein, Metabolizable Energy, and essential minerals, which play a direct role in milk production. Experimental analysis revealed noticeable differences between standard nutrient requirements and actual feed intake. For instance, protein and energy deficiencies were

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observed in the sample data, which explained the lower predicted milk yield. These findings are consistent with conclusions reported in earlier studies that link poor nutrition with reduced milk output. However, the proposed system improves upon previous work by clearly quantifying these nutritional gaps and directly relating them to milk yield estimation.

Another important outcome of this research is the practical nature of the proposed system. Unlike many existing studies that only provide prediction results, this system also offers simple feeding recommendations to help farmers correct nutritional deficiencies. In addition, the system avoids the use of costly sensors and complex algorithms, making it affordable and easier to adopt in rural settings. The availability of results in both English and Marathi further enhances usability, which is rarely addressed in earlier research. Overall, the results confirm that combining established nutritional standards with farmer-provided feed data leads to a simple, cost-effective, and reliable milk yield prediction approach. The proposed system successfully bridges the gap between scientific nutritional guidelines and real-world dairy farming practices, making it especially suitable for small and medium-scale dairy farmers.

5. CONCLUSION AND FUTURE SCOPE

5.1. Conclusion

This study presented a simple and nutrition-focused milk yield prediction system designed especially for small and medium-scale dairy farmers. The system analyzes the nutritional content of feed provided to dairy animals and compares it with standard nutritional requirements recommended by ICAR and NRC. Based on this analysis, it predicts milk yield and provides practical feeding recommendations.

The results of the study show that nutritional imbalance, particularly deficiencies in protein, energy, and minerals, has a direct impact on milk production. Unlike many existing approaches that depend on expensive sensors, complex technology, or historical data, the proposed system relies only on farmer-provided feed details and standard nutritional values. This makes the system affordable, easy to use, and suitable for rural environments.

The bilingual interface supporting English and Marathi further improves accessibility and understanding among farmers. Overall, the proposed system successfully bridges the gap between scientific nutritional guidelines and real-world dairy farming practices. It can serve as a useful decision-support tool to help farmers improve feeding practices and achieve better milk yield in a practical and cost-effective manner.

5.2. Future Scope

1. **Real-Time Data Integration**
   In the future, the system can be connected with real-time data such as daily milk yield or animal weight to improve prediction accuracy without making the system complex or costly.

2. **Mobile Application Development**
   The software can be converted into a mobile app so that farmers can easily use it on their smartphones while working on the farm.

3. **Expanded Nutrient Coverage**
   More nutrients such as vitamins, trace minerals, and fiber content can be added to provide more detailed nutritional analysis and better feeding recommendations.

4. **Region-Specific Feed Recommendations**
   The system can be enhanced to suggest locally available feed options based on region and season, making it more practical and affordable for farmers.

6. Author Contribution

1). Prabha

Prabha conceptualized and finalized the research topic and clearly defined the problem statement. She designed the complete system architecture and methodology, prepared and analyzed the dataset, and performed all calculations related to nutritional analysis and milk yield prediction. Prabha developed the tables, graphs, and result interpretation, compared the proposed work with existing literature, and drafted the major sections of the research paper including methodology, results, conclusion, and future scope

2) Shreya

Shreya assisted in reviewing the research content and supported basic editing tasks such as proofreading, content organization, and formatting of the manuscript. She contributed to referencing, checking grammar and clarity, and helped in improving the presentation of the paper for submission.

Both authors jointly reviewed the complete manuscript to ensure clarity, consistency, and proper organization of the content. They discussed the overall structure of the paper, verified formatting and references, and suggested minor

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improvements where required. After incorporating the necessary revisions, both authors approved the final version of the manuscript for submission.

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