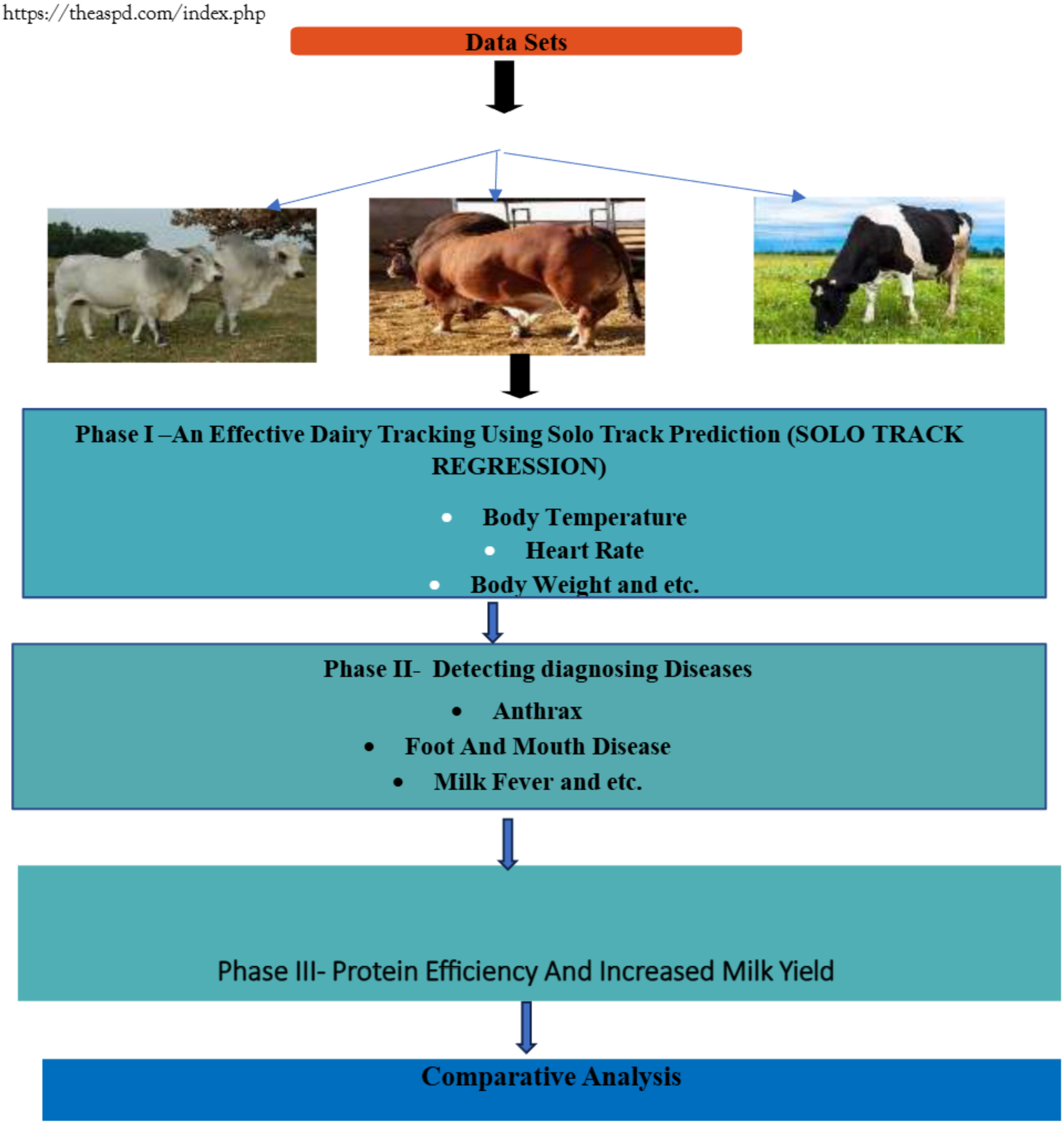
International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 18s,2025
https://theaspd.com/index.php

A Smart IoT-Based Semantic Model for Sustainable Dairy Farming Enhancement using Solo Track Algorithm

M.Santhosh[1],Dr S.Mangayarkarasi [2]
[1]Research Scholar, Department of Computer Science, VISTAS, Chennai
[2]Professor, Department of Advanced Computing and Analytics, VISTAS, Chennai.

Abstract
The dairy farming industry is at a crossroads, where traditional practices must evolve to meet the increasing demands for efficiency, sustainability, and animal welfare. The integration of Smart Internet of Things (IoT) technology offers transformative potential, but realizing this potential requires a structured approach to effectively manage and interpret the vast amount of data generated by IoT systems. This dissertation presents a novel semantic framework designed to enhance dairy farming techniques through the intelligent application of Smart IoT technology.
The proposed framework integrates semantic technologies with IoT to create a coherent and adaptive system that improves decision-making and operational efficiency in dairy farming. By leveraging semantic web technologies such as ontologies and knowledge graphs, the framework enables advanced data management, interoperability, and real-time analytics.
Keywords: *Smart Technology, Dairy Farming, Interoperability, real-time analytics.*

1.INTRODUCTION
The Internet of Things (IoT) refers to a network of interconnected physical objects equipped with sensors, processing capabilities, and communication technologies that enable data exchange across devices and systems over the Internet or other communication networks. IoT has vast applications in fields ranging from personal computing devices like smartphones and wearables to advanced domains such as healthcare, agriculture, and industrial automation.
In agriculture, particularly in smart dairy farming, IoT plays a transformative role. Smart wearables, medical implants, and
sensor-based systems contribute significantly to real-time data collection, enabling precise monitoring of livestock. By integrating information, physical, and functional technologies, IoT not only enhances operational efficiency but also reduces cost and time, thereby improving the overall quality of life and agricultural productivity.
As demand for high-quality dairy products continues to rise, smart dairy farming emerges as a critical approach to meeting this need. It involves health monitoring systems that track essential physiological parameters in cows, including body temperature (normal range: 38.6°C–39.7°C), humidity, heart rate, and respiration rate. These indicators help ensure animal health, which directly affects milk yield and quality.
Traditionally, dairy cattle are distinguished from beef cattle, but in many cases, the same livestock may be used for both milk and meat production. Current smart systems like MooCare support milk yield optimization by aligning with the cows' nutritional needs. Additionally, machine learning techniques are increasingly used to detect conditions such as lameness, allowing for early intervention through real-time warning systems.
Despite the availability of health monitoring tools, manual observation of large herds is time-consuming and ineffective. Therefore, smart sensors and wearables are being deployed to enable automated, continuous livestock monitoring. These technologies empower farmers to detect anomalies early and take preventive measures, enhancing both productivity and animal welfare.
In this research, we introduce a data-driven semantic framework to enhance dairy farm performance. A key component of this framework is the Solo Track regression algorithm, which is specifically designed to evaluate and predict complex interdependencies among various factors influencing dairy cattle health and productivity. These factors include feed composition, environmental conditions, and health metrics.



The algorithm is trained on extensive datasets to extract meaningful insights, allowing for targeted improvements in milk production and animal care.

The aim of this work is to support precision agriculture by leveraging the potential of IoT and machine learning for real-world applications. The implementation of the Solo Track algorithm will be tested in operational farm settings, where its predictive accuracy and practical value will be assessed.

As the dairy industry faces growing challenges related to sustainability, efficiency, and animal health, the integration of advanced data analytics and IoT presents a powerful solution. The insights gained through this research can help farmers make informed decisions, optimize operations, and meet the evolving demands of a growing global population.

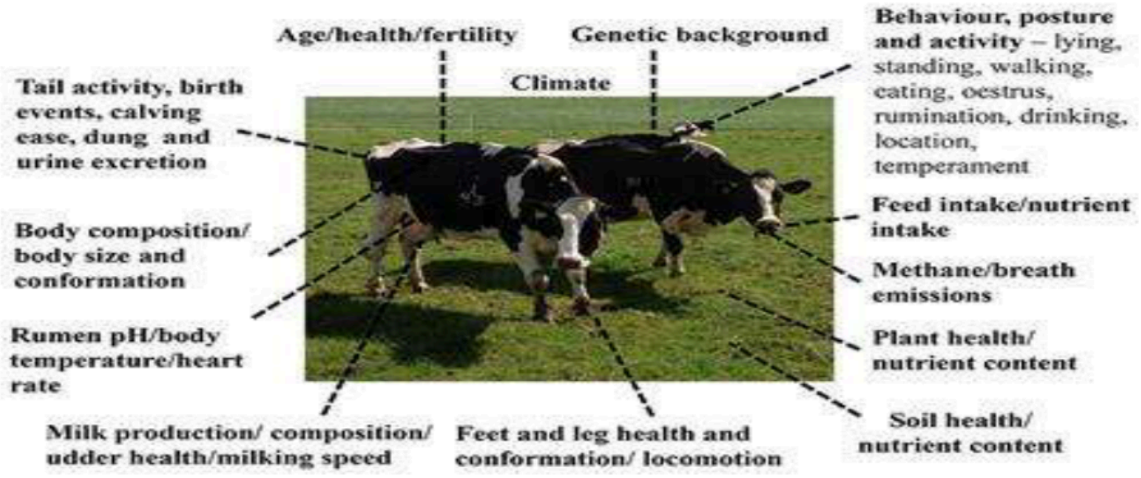
Ultimately, smart dairy farming, powered by semantic technologies and IoT, represents a major leap forward in agricultural innovation. It provides scalable, data-driven methods to enhance animal well-being, improve milk yield, and sustain the future of dairy production.

2.PROPOSED METHODOLOGY FOR ENHANCING DAIRY CATTLE PERFORMANCE USING IOT AND DATA-DRIVEN APPROACHES

This research proposes an integrated methodology that combines Internet of Things (IoT) technologies with data-driven analytical methods—specifically the Solo Track regression algorithm—to enhance the performance, productivity, and health of dairy cattle. Represented in the Figure 1.1 :The primary goal is

to enable intelligent monitoring, early disease detection, and optimization of milk production through real-time data processing and predictive analytics. The methodology is organized into the following key stages:
2.1. Data Collection
IoT-based smart sensors are deployed across the farm to collect real-time data related to:
Animal health parameters (e.g., body temperature, heart rate, activity level)
Figure 1: The Proposed Work of Solo Track Regression
Environmental conditions (e.g., humidity, ambient temperature)
Production metrics (e.g., daily milk yield, feeding patterns)
Wearable devices, RFID tags, automated milking machines, and environmental sensors form the core data acquisition layer.
2.2. Data Preprocessing and Cleaning
Raw data collected from multiple sensors may contain inconsistencies, missing values, or noise. This step involves:
Data normalization and transformation
Outlier detection and removal
Handling missing or incomplete records
Time synchronization for temporal consistency
2.3. Feature Selection
Critical features influencing dairy cattle performance are selected based on domain knowledge and statistical analysis. Key features may include:
Feed composition and intake
Physiological health metrics
Behavioural patterns
Weather and housing conditions
Dimensionality reduction techniques like PCA (Principal Component Analysis) may be applied to improve model efficiency.
2.4. Model Training and Regression Analysis
The Solo Track regression algorithm is trained on the cleaned and labeled dataset. This model is designed to:
Identify complex relationships among multiple input variables
Predict outcomes such as milk yield, disease likelihood, and reproductive efficiency
Adapt to temporal changes and dynamic farm environments
The model is evaluated using cross-validation and metrics like RMSE, MAE, and R^2.
2.5. Real-Time Prediction and Decision Support
Once trained, the regression model is integrated into a decision support system (DSS) to:
Provide real-time predictions on health status and productivity
Alert farmers about anomalies or potential health issues
Recommend optimal feeding or breeding schedules
This enables proactive farm management and early intervention strategies.
2.6. Actuation and Automated Systems
Based on prediction results and alerts, the system can:
Automatically adjust feeding systems
Activate cooling or ventilation units in barns
Trigger automatic health check routines or isolate sick animals
Such actuation ensures timely responses with minimal human intervention.
2.7. Data Visualization and Reporting
An intuitive dashboard is developed for farm owners and veterinarians, offering:
Visual summaries of herd health and milk yield trends
Interactive charts and graphs for parameter tracking
Daily, weekly, and monthly performance reports
This improves transparency and supports evidence-based decision-making.
2.8. Continuous Improvement and Model Fine-Tuning
The system is designed to learn and evolve over time. This includes:

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 18s,2025
https://theaspd.com/index.php
Regular updates to the regression model using new data



Retraining based on seasonal patterns or herd behavior changes
Incorporation of farmer feedback for model refinement
The iterative feedback loop ensures sustained performance and adaptability to real-world variations.

3. IMPLEMENTATION

3.1 PHASE I –AN EFFECTIVE DAIRY TRACKING USING SOLO TRACK PREDICTION (SOLO TRACK REGRESSION)

The phase I proposed with the following data sets:
Body temperature,
Body weight of cows,
Milk Production (Natural Nutrition)

BODY TEMPERATURE:
Normal body temperature of cows
Maximum temperature of cows
Minimum temperature of cows
The temperature of the cattle when they are outdoors in the morning, afternoon, evening and night in the cattle farm.
The temperature inside of the cattle when they are in the morning, afternoon, evening and night in the cattle farm.

HEART RATE MONITORING

The typical heart rate of a cow is between 48 and 84 beats per minute. Heart rate monitoring is an essential part to evaluate the health and well-being of cows. Significant departures from this range could be a sign of serious health issues that require attention. Represented in Figure 2, While 48 to 84 beats per minute are thought to be the common range, cows may have a different or irregular pulse rate. Regularly elevated or lowered heart rate can be a sign of several health issues, such as infections, dehydration, stress, or cardiovascular disease.

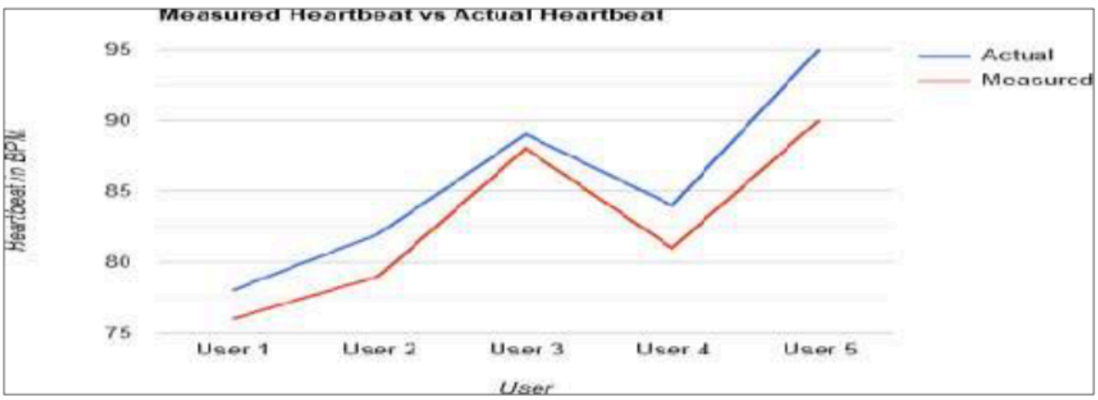


Figure 2: Comparative Analysis

COW BODY WEIGHT:

Healthy body weight of cows

Minimum body weight of cows

Maximum body weight of cows

Figure 3: The Proposed Work of Solo Track Regression with various Parameters

MILK PRODUCTION (NATURAL NUTRITION)

To understand the food needs of the animals and to provide food patterns accordingly.

A sensor installed in a specific area of the cow farm to monitor the cows in the cow farm so created represented in the Figure 4.

The sensors installed in the cow farm have pre-entered the full physical data of the cows.

Earlier sensors were arranged around the neck of cows.

Since the sensor in the neck area of

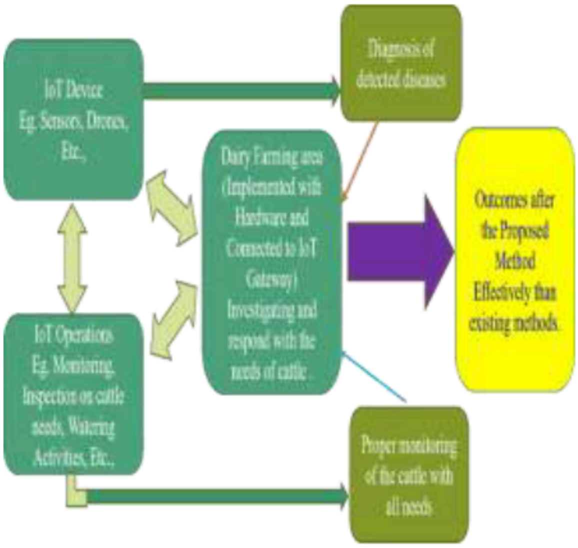


Figure 4: The proposed work completed the below activities

The cows used to disturb the cows, now the sensor has been installed in the ears to remove the disturbances.

A sensor will be fitted in each cow's ears to monitor all activities in the cows.

This sensor is now mounted in the ear area compared to the previous cow neck area sensor which is lighter in weight and placed without any disturbance to the cows, and also cows Functions accurately are set to calculate.

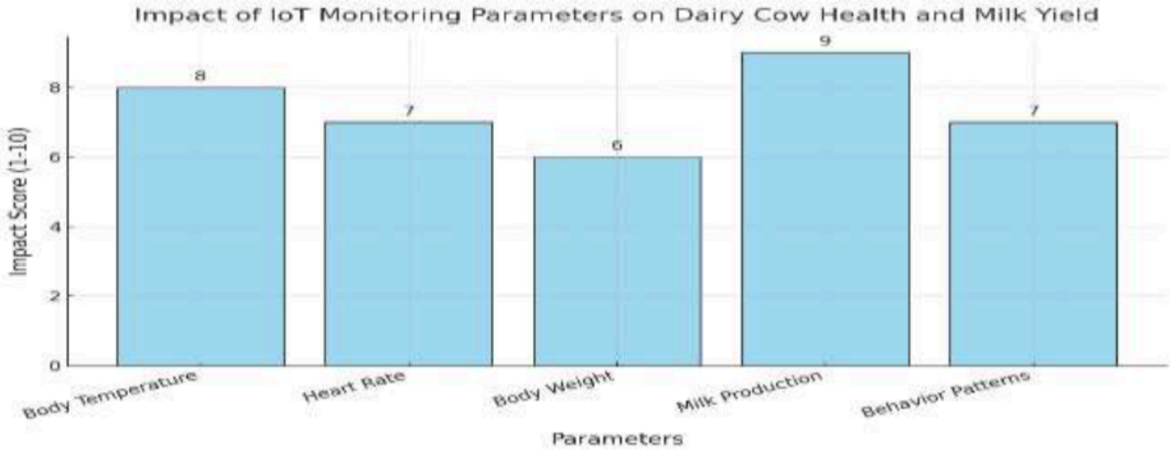
The sensor in the cow farm and the sensor in the non-cattle area exchange information from one sensor to another through a signal called zippy.

The data of each cow thus stored is set up to be compared with the data of the sensors installed in the cow farm.

An alarm has been designed to notify immediately if there are any variations in this.

Through this, cows are protected by identifying and solving physical problems of cows.

This system is very helpful to the farmers by protecting the cows



Here is a bar graph depicting the impact of different IoT monitoring parameters on dairy cow health and milk yield. Each parameter is scored on a scale from 1 to 10, reflecting its significance in optimizing farming efficiency.

3.2.PHASE II- DETECTING DIAGNOSING DISEASES

Anthrax, foot and mouth disease, foot rot, milk fever and etc.

Below are the method proposed for the detection and diagnosing:

Anthrax

The normal Body temperature of the cow is 101.5 F to 102.5 F (38.6 C to 39.2 C). The symptom difficult breathing resembles the disease affected. And the Fever ranges beyond the normal levels (i.e 106 to 108) will require diagnosing. The disease will make the cow not able take proper feeds.

Preventive measure

The preventive measures lead to the proper diagnose methods such as Vaccination. Vaccination recommended by the monitoring of the cow in the method I proposed.

Black quatre (Black leg)

The below are symptoms detected and ready for diagnosing

Fever up to 106 to 108

Rapid pulse and heart rates

Difficult breathing

Lameness affected to the leg

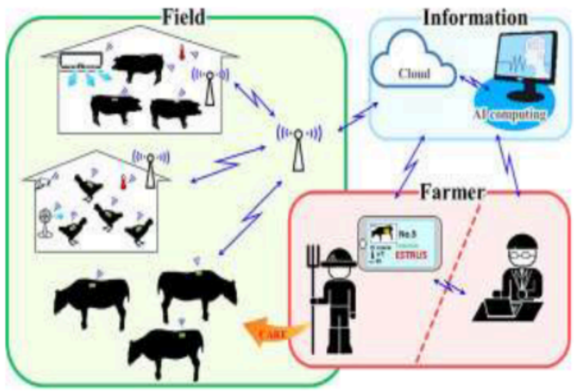


Figure 5: Process of Detecting Diseases

Food and mouth diseases

These diseases will be affected into the cow legs in between fingers

Diseases that can spread to the mouth, lap, milk-producing area and the area between the toes.

It is a disease that can be spread through water, hues, straw and grazing land.

Symptoms

Fever up to 104 to 105

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 18s,2025
https://theaspd.com/index.php
Preventive measure
Steps to cure sores
Prevention of fly attack
six months once to put injections.
Isolation of infected cows
consult the doctor
Bovine ephemeral fever:
A known kind of disease that can be caused by insects
Hunger pangs
If you breathe
Heartbeat
Sudden drop in milk yield

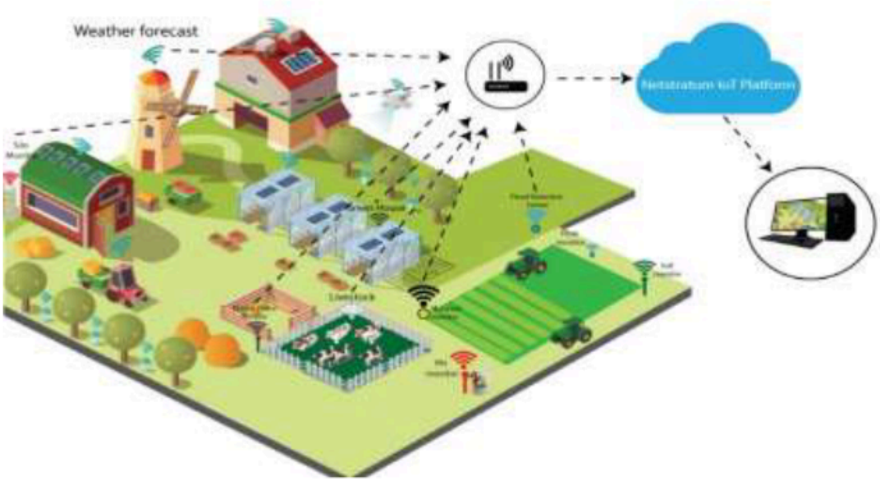


Figure 6: DETECTING DIAGNOSING DISEASES

Mastitis
Sudden swelling of the mammary glands
Stress
Sudden fever
Bacteria and fungus cause disease in the mammary gland
Foot rot
It refers to diseases in the feet of cows.
The infection increases by treating the cows in the mud.
Milk fever
A drop in calcium levels is what causes the condition.
Today occurs as a result of the calf's decreased calcium levels. Between the ages of 5 and 10 years, the disease most frequently affects cows.
When the calcium level falls throughout the course of the first 48 hours in calf calves, this illness develops.

DATASET / DISEASE	FEVER	ULCERAT	DECREASED MILK PRODU	SHIVERING	HIGH/ LOW TEMPE	FATIGUE
ANTHRAX	YES			YES		
FOOT & MOUTH DISEASE		YES	YES	YES	YES	

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 18s,2025
https://theaspd.com/index.php

MILK FEVER					YES	YES
DIARRHEA	YES	YES				YES
SMALLPOX	YES	YES	YES			YES

Table : Comparison of Symptoms Across Different Cow Diseases

Fever is a common symptom across most diseases.

Decreased milk production is notably present in Foot & Mouth Disease, Smallpox, and Diarrhea.

Shivering is mostly observed in Milk Fever and Anthrax.

Ulceration is linked to Foot & Mouth Disease and Smallpox.

Fatigue is common in Foot & Mouth Disease, Smallpox, and Diarrhea.

By monitoring these symptoms and following preventive measures, the risk of these diseases can be minimized, and cows can receive timely treatment.

3.3.PHASE III- PROTEIN EFFICIENCY AND INCREASED MILK YIELD

Understanding the Protein efficiency

Applying the knowledge on farm management.

Provide a balanced and nutritious diet for the cows: A balanced diet with adequate levels of protein, energy, vitamins, and minerals is essential for maintaining cow protein efficiency and increasing milk yield. The diet should consist of high-quality forages, grains, and supplements such as protein concentrates, vitamins, minerals, and probiotics.

2. Regular health check-ups: Regular check-ups ensure the cows are healthy and free from any diseases or infections. This helps them to maintain their protein efficiency and milk yields for an extended period.

3. Proper sanitation: A clean and hygienic environment reduces the chances of infections and diseases, and it also helps to improve milk yields.

4. Regular milking: Regular milking of cows helps to maintain appropriate milk production and also helps to reduce the risk of infections and diseases.

5. Proper breeding: Proper breeding practices such as selecting the right bulls and cows with good genetics can help to improve cow protein efficiency and milk yield.

6. Regular exercise: Providing cows with regular opportunities to exercise can help to improve their musculoskeletal health, which can lead to better milk production.

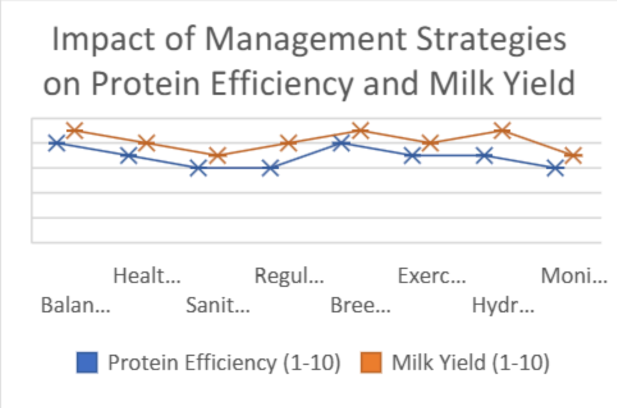
7. Proper hydration: Proper hydration is essential for maintaining cow protein efficiency and milk yield. Cows should have access to clean drinking water at all times.

8. Monitor heat cycles: Monitoring heat cycles can help to identify the optimal time for insemination, which can lead to increased milk yield.

Strategy	Protein Efficiency (1-10)	Milk Yield (1-10)
Balanced Diet	8	9
Health Check-ups	7	8
Sanitation	6	7
Regular Milking	6	8
Breeding	8	9
Exercise	7	8
Hydration	7	9
Monitor Heat Cycles	6	7

Table : Impact of Management Strategies on

Protein Efficiency and Milk Yield



CONCLUSION

This methodology leverages the synergy between IoT-enabled real-time sensing and advanced regression modeling to transform traditional dairy farming into a smart, data-driven process. The Solo Track regression model provides deep insights into productivity drivers, enabling dairy farmers to make informed, timely decisions. Ultimately, this approach aims to improve milk yield, animal welfare, and operational efficiency—contributing to sustainable and scalable dairy production. The integration of IoT technologies with data-driven predictive analytics represents a transformative advancement in the field of dairy farming. The proposed methodology, centered around the Solo Track regression model, provides a comprehensive framework for improving dairy cattle performance through real-time monitoring, intelligent prediction, and automated decision-making. By collecting and analyzing health, environmental, and production data, this approach enables early detection of health issues, optimizes milk yield, and enhances overall herd management.

The use of smart sensors, automated systems, and visual reporting dashboards ensures that farmers receive timely, actionable insights, thereby reducing manual labor and increasing operational efficiency. Furthermore, the continuous feedback and model fine-tuning process supports long-term adaptability and sustainability of the farming system.

Ultimately, this methodology not only contributes to increased productivity and animal welfare but also supports the broader goals of precision agriculture, enabling dairy farmers to meet the growing global demand for high-quality dairy products in an efficient, cost-effective, and environmentally responsible manner.

REFERENCES

1. Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). *Big Data in Smart Farming – A review*. Agricultural Systems, 153, 69–80. https://doi.org/10.1016/j.agsy.2017.01.023
2. Kamilaris, A., Kartakoullis, A., & Prenafeta-Boldú, F. X. (2017). *A review on the practice of big data analysis in agriculture*. Computers and Electronics in Agriculture, 143, 23–37. https://doi.org/10.1016/j.compag.2017.09.037
3. Rutten, C. J., Velthuis, A. G., Steeneveld, W., & Hogeveen, H. (2013). *Invited review: Sensors to support health management on dairy farms*. Journal of Dairy Science, 96(4), 1928–1952. https://doi.org/10.3168/jds.2012-6107
4. Banerjee, S., & Nath, A. (2016). *Use of Internet of Things in Agriculture – A case study on Smart Dairy Farming*. International Journal of Computer Applications, 152(9), 25–29.
5. Salam, A., & Shah, A. (2020). *Internet of Things in Smart Agriculture: Enabling Technologies and Open Challenges*. IEEE Access, 8, 52910–52924. https://doi.org/10.1109/ACCESS.2020.2973675
6. Lee, J., Park, J., & Hwang, D. (2021). *Application of machine learning in livestock monitoring: A review*. Computers and Electronics in Agriculture, 187, 106291. https://doi.org/10.1016/j.compag.2021.106291
7. Taneja, M., & Davy, A. (2017). *Resource efficient IoT data collection using smart contracts*. In Proceedings of the IEEE World Forum on Internet of Things (WF-IoT), 442–447. https://doi.org/10.1109/WF-IoT.2017.7461398
8. Kumar, R., & Patel, D. R. (2014). *A survey on Internet of Things: Security and privacy issues*. International Journal of Computer Applications, 90(11), 20–26.
9. Jadhav, A., & Pati, B. (2021). *Smart dairy farming using IoT and data analytics*. International Research Journal of Engineering and Technology (IRJET), 8(5), 3675–3678.
10. FAO. (2018). *Dairy production and products: Cattle dairying*. Food and Agriculture Organization of the United Nations. http://www.fao.org/dairy-production-products/production/en/

11. Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). Big Data in Smart Farming – A review. *Agricultural Systems*, 153, 69–80. https://doi.org/10.1016/j.agsy.2017.01.023
12. Rutten, C. J., Velthuis, A. G. J., Steeneveld, W., & Hogeveen, H. (2013). Sensors to support health management on dairy farms. *Journal of Dairy Science*, 96(4), 1928–1952. https://doi.org/10.3168/jds.2012-6107
13. Kamilaris, A., Kartakoullis, A., & Prenafeta-Boldú, F. X. (2017). A review on the practice of big data analysis in agriculture. *Computers and Electronics in Agriculture*, 143, 23–37. https://doi.org/10.1016/j.compag.2017.09.037
14. Banerjee, S., & Nath, A. (2016). Use of Internet of Things in Agriculture – A case study on Smart Dairy Farming. *International Journal of Computer Applications*, 152(9), 25–29.
15. Lee, J., Park, J., & Hwang, D. (2021). Application of machine learning in livestock monitoring: A review. *Computers and Electronics in Agriculture*, 187, 106291. https://doi.org/10.1016/j.compag.2021.106291
16. Salam, A., & Shah, A. (2020).Internet of Things in Smart Agriculture: Enabling Technologies and Open Challenges. *IEEE Access*, 8, 52910–52924. https://doi.org/10.1109/ACCESS.2020.2973675
17. Kumar, R., & Patel, D. R. (2014). A survey on Internet of Things: Security and privacy issues. *International Journal of Computer Applications*, 90(11), 20–26.
18. Zhou, K., Fu, C., & Yang, S. (2016).Big Data Driven Smart Energy Management: From Big Data to Big Insights. *Renewable and Sustainable Energy Reviews*, 56, 215–225. https://doi.org/10.1016/j.rser.2015.11.050
19. Li, B., & Wang, J. (2020). IoT-enabled smart livestock farming systems: A review of the architecture, enabling technologies, and future challenges. *Computers and Electronics in Agriculture*, 170, 105251. https://doi.org/10.1016/j.compag.2020.105251
20. FAO.(2021). Dairy production and products. *Food and Agriculture Organization of the United Nations.* http://www.fao.org/dairy-production-products/production/en/