International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Using AI and Machine Learning for Early Detection and Management of Cattle Diseases to Improve Livestock Health and Productivity

P. Swapna[1], M. Geetha[2], Bellamkonda Nuthana[3], Remalli Rohan[4]

[1]*M. Sc -Data Science -PG Student,* Department of Computer Science

[2,3]*Degree Lecturer, Department of Computer Science,*

Telangana Social Welfare Residential Degree Collage for women, Jagathagirigutta, Hyderabad, India.

[4]*Researcher, Computer Science Educator, Hyderabad, Telangana, India.*

---***---

Abstract *- Livestock productivity and health depend on the accurate identification and treatment of diseases, but conventional approaches frequently fail in the heat of the moment. As a result, there is now more interest in cattle disease prediction frameworks that use cutting-edge data science methods to increase accuracy. Programming languages like Python and R, which have large libraries for processing training data and creating prediction models, are used in many investigations. Real-world datasets from data sources like Kaggle and Data World support these machine learning applications. Strong algorithms such as Naive Bayes, K-Nearest Neighbors (KNN), Support Vector Machines (SVM), Decision Trees, and Random Forest classifiers are commonly used by researchers to achieve remarkable illness prediction outcomes. Incorporating machine learning into veterinary health research improves illness detection and helps farmers make well-informed decisions about herd management, which eventually improves agricultural productivity and animal welfare.*

Keywords: Cattle health, Disease prediction, Machine learning, Livestock management, AI in agriculture, early detection.

1. INTRODUCTION

Public health, economic stability, and food security all depend on animal health. Maintaining livestock health is essential for the agricultural sector to prevent monetary losses, disease outbreaks, and problems with animal welfare. The World Health Organization (WHO) stresses the significance of early identification of animal health issues and related risk factors in order to improve food safety and prevent zoonotic illnesses, which can be transmitted from animals to people (WHO, 2020).

Artificial Intelligence (AI) and Machine Learning (ML) have emerged as useful techniques for the early detection and management of animal health problems in recent years. These tools use information from a variety of sources, including genetics, environmental factors, medical records, and animal behavior, to forecast health hazards in animals. Convolutional Neural Networks (CNNs), Random Forests (RF), and Support Vector Machines (SVM) are a few examples of machine learning techniques that are frequently used to examine massive datasets and offer insights about possible epidemics and health hazards. The WHO divides risk factors that impact animal health into three categories: socioeconomic, environmental, and biological. Climate, temperature, and air quality are examples of environmental variables that might affect the spread of disease. The biological characteristics of an animal, including its age, breed, and genetic composition, render it more susceptible to specific illnesses. Disease transmission is also influenced by socioeconomic variables, such as agricultural methods and the availability of veterinary treatment. The prediction and management of outbreaks depend on the early identification of these risk variables.

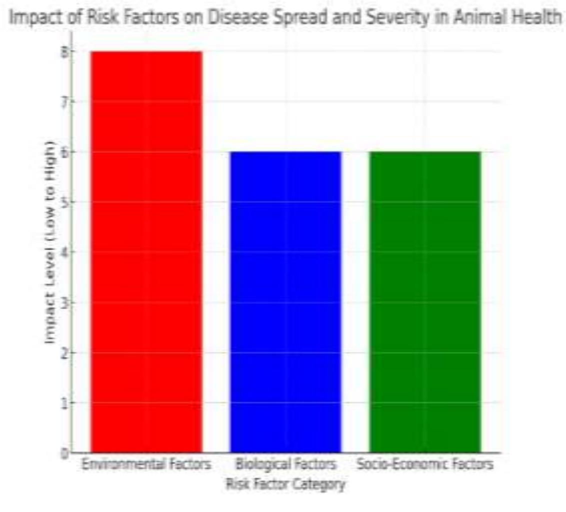

Fig.1: Impact of Risk Factors on Disease Spread and Severity in Animal Health

As demonstrated by illnesses like as avian influenza, foot-and-mouth disease (FMD), and lumpy skin disease (LSD), early identification and treatment can stop large-scale epidemics and guarantee successful veterinary care. However, since many diseases have little to no symptoms in their early stages, it is still difficult to spot early warning indications of illness. Tracking changes in animal behavior, like as feeding habits or body temperature, as well as environmental parameters like temperature and humidity, can be used to identify possible illnesses early on.

To increase the accuracy of disease prediction, data from multiple sources can be integrated, including satellite images, sensor data, and real-time health monitoring via wearable technology. The prediction, reaction times, and general management of animal health will all be improved by AI, ML, and big data analytics. To sum up, there is a lot of promise for improving animal health management with predictive analytics and machine learning models. These technologies can protect human and animal health and welfare by facilitating early diagnosis, predicting disease outbreaks, and evaluating risks based on WHO-identified variables.

2. LITERATURE SURVEY

The significance of machine learning in enhancing animal health management is examined in this literature review, with an emphasis on early disease identification and prediction. In order to investigate risk factors such biological, environmental, and socioeconomic influences on animal health, it looks at a variety of machine learning techniques. As summed up in Table 1, the survey emphasizes how these technologies can advance veterinary procedures and improve disease control.

The expanding role of technology, especially machine learning (ML), in enhancing livestock management and illness detection is highlighted by research in animal health and disease management. Studies by Juan M. Rodriguez et al. [4] and Azhari et al. [1] concentrate on improving animal husbandry through the use of regional resources, farmer education, and the automation of health assessments, such as Body Condition Scores in dairy cows. Studies conducted in urban areas and in labs, such as those by Claudio Manuel Rodrigues et al. [2] and chiara Romano et al. [3], tackle issues including population growth and the significance of health surveillance for public safety.

Through the use of machine learning and image processing techniques, Federica Borgonovo et al. [6] have been able to recognize skin abnormalities in animals like chickens and diagnose diseases early on. According Yingqi Peng et al. [15], deep learning technologies offer novel approaches to tracking cattle behavior and detecting vector-borne illnesses.

Nidiyare Hevia-Montiel et al. [14] draw attention to zoonotic illnesses including dengue and Chagas, stressing the importance of early detection and management. Even though machine learning has a lot of potential, issues with interpretable models, small datasets, and resource limitations still exist. Thermal imaging and Internet of Things sensors may improve disease prediction, according to research by Enrico Casella et al. [22] and Anitha Rao et al. [21]. To enhance data quality, system integration, and real-time monitoring, more research is required. Kim et al (23) used sensor data from 30 dogs gathered over a nine-month period to create an AI-based system for evaluating canine health. The study's "Health Score," which was developed using behaviours including scratching, licking, swallowing, and resting, demonstrated 87.5% concordance with veterinary assessments, demonstrating its potential for early disease diagnosis in pets.

Table-1: Summary and Methodology

Author	Dataset	Feature extraction	Algorithm	Result

International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Azhari, et al [1]	Local data collected from farmer groups on animal health and management practices.	Identification of common health practices and farmers' knowledge related to livestock management.	Workshops and educational sessions aimed at improving understanding	Farmers are now more knowledgeable and skilled in managing their cattle, and contemporary technology are encouraged for sustainable farming.
Claudio Manuel Rodrigues, et al [2]	Local data from surveillance and health organizations regarding animal overpopulation and public health.	Analysis of the impact of animal overpopulation on human and animal health, focusing on health promotion initiatives.	Health promotion initiatives and strategies for effective management.	Underlined the necessity of policies that support public health and reduce the dangers posed by an overabundance of animals.
Chiara Romano, et al [3]	Samples collected from lab mice to analyze exposure to various viruses impacting animal health.	Measurement of antibody levels and detection of viral infections in lab mice.	PCR and ELISA techniques for diagnosis.	Numerous mice were found to have been exposed to particular viruses, underscoring the significance of regular health checks in lab settings for both animal welfare and research integrity.
Juan M. Rodriguez et al [4]	Depth images of dairy cows used for estimating the Body Condition Score (BCS).	Estimation of BCS using depth images to automate assessment and overcome subjectivity and time constraints.	Transfer learning.	Automated BCS calculations were found to have a higher accuracy, highlighting their importance in monitoring cow productivity and health. Future research on larger datasets and more advanced methods is recommended.
Reshma S. et al [5]	UCI CKD dataset	Utilized fewer features for predicting CKD, focused on demographic information	Support Vector Machine (SVM)	An accuracy of roughly 96% Improvements that have been proposed using bigger datasets and more demographics Problems include missing information and unaccounted-for factors.
Federica Borgonovo et al [6]	Data on air quality from chicken farms	Focused on environmental parameters for early detection of coccidiosis	Machine learning algorithm	Effective in spotting coccidia infections early feasibility of an automated detection system; recommendations for future enhancements: include time-based data and more environmental factors

ISSN 2581-7795

				Data accessibility could lead to a decrease in accuracy.
Manoj et al [7]	Animal health data from UCI and Kaggle	Considered animal movement, medication, and medical history	Machine learning system	Supports livestock management by measuring and monitoring health; shows effectiveness in predicting illnesses; and has challenges due to hardware limitations and dataset dependency. Suggestions: Monitoring in real-time on mobile platforms
Luca Candeloro et al. [8]	Data on West Nile Virus (WNV) detection from horses, birds, and mosquitoes; environmental variables	Focus on environmental variables impacting WNV risk areas	Extreme Gradient Boosting (XGBoost) model	Predicting WNV circulation two weeks ahead of time with 84% accuracy has the potential to become an early warning system. However, accuracy of environmental data may limit reliability.
Noone Vijay Kishan et al. [9]	Health monitoring data including heartbeat and temperature	Health monitoring parameters	Decision Tree	When it came to predicting cattle disease, Naive Bayes had the best accuracy. According to the report, future investigations could look into automating health monitoring and extending data collection methods for improved illness control.
Daksh Ashar, et al [10]	Dataset with symptoms related to diseases in cows, sheep, and goats	Symptoms of livestock diseases	Support Vector Classifier (SVC)	The technique aims to reduce human error and expedite reaction times in rural regions by accurately forecasting livestock ailments and suggesting preventive actions. In order to improve illness prediction, future advancements may include additional data kinds and expand species coverage.
H.B. Chethan Kumar et al. [11]	National Animal Disease Reporting System (NADRS) data	Disease events, risk factors, spatial and temporal data	Geographic Information Systems (GIS)	Faster preventive measures are possible when tracking and reporting animal illnesses are centralized into a single system. Integrating zoonotic disease data through a One Health

International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

				approach—which encourages cooperation between the human and animal health sectors—is a crucial next step. Underreporting and disregarding regional sickness trends are obstacles, though.
Stephen J. Goodswen et al. [12]	Various datasets on microbial data	Techniques for drug resistance classification, disease diagnosis, and target prediction	Machine learning models for supervised and unsupervised learning (e.g., K-means clustering)	Emphasized the potential uses of machine learning in microbiology, such as the identification of diseases and the classification of drug resistance, and promoted the adoption of these methods in microbiology research.
Yeni Kustiyahningsih et al. [13]	350 cow disease records from Madura	21 health-related features reduced to 18	K-Nearest Neighbor (KNN)	A 94.29% classification accuracy for cow diseases was achieved using KNN with F-Score feature selection, underscoring the need of large datasets for improving diagnostic accuracy. The results of this study provide a valuable tool for early disease diagnosis for cow breeders.
Nidiyare Hevia-Montiel. et al [14]	Multimodal data including electrocardiography, echocardiography, Doppler signals, and ELISA antibody titers	Key features extracted from cardiac measures and antibody levels	Support Vector Machine	Achieved 93.3% accuracy in classifying control vs. acute infection; 100% accuracy for control vs. chronic infection.
Yingqi Peng, et al [15]	Time-series data from twelve cows using wearable collars	Movement and physiological data captured by inertial measurement units (IMUs)	Deep Residual Bidirectional LSTM (Bidir-LSTM)	94.9% accuracy in classifying cattle behavior; Best performance with a window size of 128 (12.8 seconds).
A.V. Brahmane et al. [16]	Symptoms input from dairy cattle	Symptoms reported by farmers	Decision Tree algorithm	Uses signs to identify possible diseases; it seeks to save farmers time and money.

International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Hevia-Montiel et al. [17]	ELISA antibody levels, Doppler imaging, ECG signals	Multiple data sources (serological, imaging, and cardiac data)	Random Forest, SVM, Decision Trees	High precision in differentiating infected animals from controls; possibility for Chagas disease early detection.
Shraddha Patil et al. [18]	A dataset containing various symptoms associated with specific illnesses in animals (goats, sheep, cows).	Extraction of relevant symptoms related to animal diseases to aid in early detection.	Decision Tree.	High prediction accuracy achieved, highlighting the importance of early intervention to control disease spread.
Kristina Dineva, et al [19]	IoT data from 120 cows in Bulgaria, including ambient conditions and health records.	Integration of data from environmental variables and health diaries using IoT devices.	Random Forest	Achieved a maximum accuracy of 95.9% with Random Forest, indicating strong predictive performance.
Hritika Kamble, et al [20]	Thermal images of animals used for analysis of temperature variations and health indicators.	Techniques to extract relevant features from thermal images, such as heat maps and temperature data.	Machine learning algorithms	Achieved high performance metrics, including accuracy, sensitivity, and specificity, surpassing existing methods.
Anitha Rao, et al [21]	Datasets obtained from sources like Kaggle, containing symptoms of cow illnesses and related therapies.	Analyzing symptoms and associating them with specific diseases and treatment options.	Decision Tree, and Random Forest.	Achieved high accuracy in predictions, aiding in easier diagnoses and helping veterinarians in decision-making.
Enrico Casella, et al [22]	Data collected from 159 calves over a two-year period, including health exams and ultrasonography.	Utilized precision IoT sensors to gather behavioral data, focusing on changes in health indicators.	Cost Optimization Worth (COW) paired with a heuristic approach called Cost-Aware Learning Feature (CALF).	Achieved an accuracy of 88% in predicting symptoms up to four days in advance, enhancing BRD management on farms.
Seon-Chil Kim, et al [23]	Data from 30 dogs, collected over 9 months (May 2022–Feb 2023)	Behaviors: scratching, licking, swallowing, sleeping. Data collected via activity sensors and analyzed using	AI algorithm with fuzzy associative memory	Health Score system with 87.5% agreement with veterinarians' diagnoses, facilitating early disease detection

		specific thresholds		

3. CONCLUSIONS AND FUTURESCOPE

By making precise disease identification, risk assessment, and decision-making possible, machine learning (ML) and deep learning (DL) are revolutionising health management in both the human and animal domains. Animal diseases like coccidiosis and lumpy skin disease as well as chronic human ailments like chronic kidney disease (CKD) can be accurately predicted by algorithms like Naive Bayes, Random Forest, and sophisticated deep learning models. By promoting early disease diagnosis, increasing diagnostic accuracy, and facilitating data-informed decision-making, these technologies greatly enhance overall health management. Using machine learning (ML) to forecast zoonotic diseases like West Nile Virus is in line with the One Health approach, which connects human, animal, and environmental health. Because interpretable machine learning models increase transparency, veterinarians and other medical practitioners may trust and act upon forecasts.

This results in proactive, promising solutions for disease prevention, animal welfare, and public health. To improve accuracy and personalisation, future research should concentrate on growing databases, adding real-time health data, and combining various data types (e.g., behavioural, demographic, genetic). Enhancing interpretability will increase the model's dependability for healthcare professionals. Real-time predictive algorithms will also help with quick outbreak response, especially in rural or low-resource locations, with a focus on ethical and scalable data methods. Thus, ML and DL have a great deal of promise to promote sustainable, data-driven health management across species and advance disease prevention.

REFERENCES

1. *Azhari, S. P., et.al. Animal Health Counseling and Animal Husbandry Management towards Smart, Creative, and Independent Farming (2019).*
2. *Claudio Manuel Rodrigues, et.al Animal Accumulation in Health Surveillance (2019).*
3. *Chiara Romano, et.al. Health-Monitoring Program for Laboratory Animals at IZSLER Facility (2019).*
4. *Juan Rodríguez Alvarez et al. "Estimating Body Condition Score in Dairy Cows from Depth Images Using Convolutional Neural Networks, Transfer Learning and Model Ensembling Techniques." Animals, Vol. 9, (2019).*
5. *Reshma S., et.al "Chronic Kidney Disease Prediction using Machine Learning." International Journal of Engineering Research & Technology (IJERT), Vol. 9, (2020).*
6. *Federica Borgonovo, et.al "A Data-Driven Prediction Method for an Early Warning of Coccidiosis in Intensive Livestock Systems." (2020).*
7. *Mittapalli, M. K. R. et.al "Assessing Livestock Disease in Animals Using Machine Learning (2020).*
8. *Luca Candeloro, Carla Ippoliti, Federica Iapaolo, Federica Monaco, Daniela Morelli, Roberto Cuccu, Pietro Fronte, Simone Calderara, Stefano Vincenzi, Angelo Porrello, Nicola D'Alterio, Paolo Calistri, Annamaria Conte. Predicting WNV, (2020).*
9. *Noone Vijay Kishan, et.al Cattle Disease Identification using Prediction Techniques. Published in Dayananda Sagar Academy of Technology and Management, Bangalore, Karnataka, India, Vol.7, (2021).*
10. *Daksh Ashar, et.al. Livestock Disease Prediction System. Published by VIVA Institute of Technology. (2021).*
11. *H.B. Chethan Kumar et al. Animal Disease Surveillance in India. Describes the National Animal Disease Reporting System for monitoring livestock diseases and responding to disease emergencies. (2021).*

12. *Stephen J. Goodswen et al. Machine Learning and Applications in Microbiology. FEMS Microbiology Reviews, fuab015, (2021).*
13. *Yeni Kustiyahningsih,et.al. Feature Selection and K-nearest Neighbor for Diagnosis Cow Disease. International Journal of Science, Engineering, and Information Technology, Vol.5, (2021).*
14. *Nidiyare Hevia-Montiel, et.al. Machine learning models for diagnosis and treatment of Chagas disease. Veterinary Sciences, Vol.9(1), pg.no1,12. (2022)*
15. *Yingqi Peng, et al. Recognising Cattle Behaviour with Deep Residual Bidirectional LSTM Model Using a Wearable Movement Monitoring Collar. Computers and Electronics in Agriculture, pg.no198, 107001(2022).*
16. *Brahmane, A.V., et.al. Survey on Dairy Livestock Disease Prediction System. Proceedings of the 2022 International Conference on Innovations in Engineering and Technology (ICIET), India, (2022).*
17. *Hevia-Montiel, et.al. Machine Learning-Based Feature Selection and Classification for the Experimental Diagnosis of Trypanosoma cruzi. Electronics, VOl.11 (5), pg.no785, (2022).*
18. *Shraddha Patil, et.al. Livestock Disease Prediction Using Machine Learning (2023).*
19. *Kristina Dineva, etal. Health Status Classification for Cows Using Machine Learning and Data Management on AWS Cloud.*
20. *Hritika Kamble, et.al. Thermal Image Processing for Disease Detection in Animals. (2023).*
21. *Anitha Rao, et.al. Cattle Disease Prediction Using Artificial Intelligence. International Journal for Research in Applied Science & Engineering Technology (IJRASET), VOL.11 (IV), (2023).*
22. *Enrico Casella, et.al. A Machine Learning and Optimization Framework for the Early Diagnosis of Bovine Respiratory Disease. IEEE Access, pg.no11, 3291348, (2023).*
23. *Seon-Chil Kim, et al. Development of a Dog Health Score Using an Artificial Intelligence Disease Prediction Algorithm Based on Multifaceted Data. Animals.VOL.14 (256), (2024).*