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Role of Artificial Intelligence in Modern Animal Husbandry

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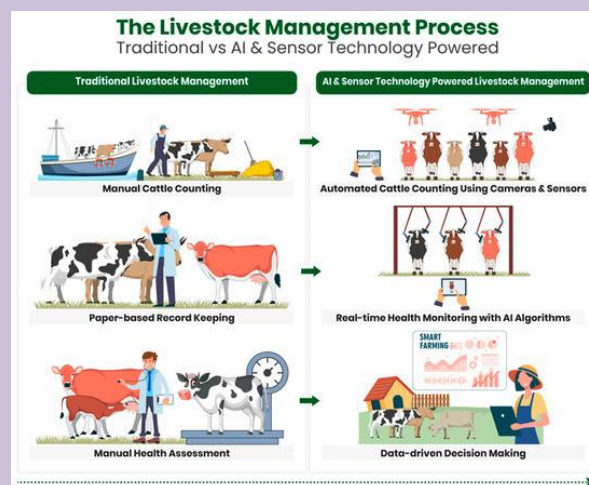
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INTRODUCTION

Artificial Intelligence (AI) is the intelligence demonstrated by machines rather than humans, which comprises components of human intelligence such as learning, reasoning, taking decisions, recognizing patterns, solving problems. In recent years, the application of AI technology in modern animal husbandry has involved many advanced technologies including machine learning, computer vision, robotics, unmanned aerial vehicles (UAVs), wearable sensors, and Internet of Things (IoT) for real-time monitoring of animals, early disease detection, the optimization of feeding and breeding, farm management, and productivity and animal welfare.



Traditional livestock farming is now being transformed by AI into precision livestock farming by facilitating data-driven automated decisions, which enhances the efficiency, sustainability, and profitability of animal production.

Why Ai is important in animal husbandry

AI plays a crucial role for the livestock industry as it detects early diseases, performs health monitoring, precision feeding, and better reproductive management. It assists farmers in heat detection and animal tracking, in nutrition optimization, and in milk, meat and egg production. AI further reduces labour needs, enhances farm management, and promotes animal welfare through timely attention and improved living conditions. Moreover, it promotes climate-smart livestock production through better use of resources and by lowering emissions, thereby making animal agriculture more sustainable and profitable.

Major applications of Ai in animal husbandry

1. Animal Health Monitoring

AI-enabled animal health monitoring relies on wearable devices, smart collars, cameras among others for real-time monitoring of animal health and behavior. It identifies fever, lameness, mastitis, respiratory, digestive, stress and reduced activity, among other conditions, in an early phase of the disease for early diagnosis and treatment. This results in decreased mortality, reduced costs of treatments, improved animal health and welfare, and more productive farms in general.

2. Precision Feeding

AI based precision feeding considers age, weight, breed, milk yield, growth rate and amount of feed consumed to estimate the nutritional requirements of individual animal. By suggesting the best quantity and quality of feed, AI minimizes the wastage of feed, increases feed conversion ration (FCR), productivity and reduces the cost of production.

3. Reproductive Management

The technology such as activity bucks, smart ear tags, computer vision, and thermal imaging of AI reproductive management is used to track and detect heat (estrus), ovulation, pregnancy and calving predictions with a high degree of accuracy. This allows for timely insemination, improving conception rates, reducing calving intervals, and enhancing overall reproductive efficiency and herd productivity.

4. Disease Prediction

The body temperature, rumination, heart rate, walking patterns, milk conductivity, and feed intake are monitored and analyzed using machine learning models in AI based disease prediction to detect body condition abnormalities prior to the onset of clinical symptoms. Prediction at an early stage facilitates intervention in time, which is instrumental in the prevention of disease outbreaks, reduction in the use of antibiotics, and veterinary care costs, and in the enhancement of herd health.

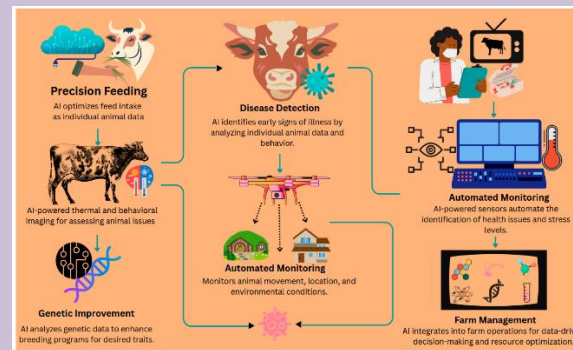
5. Milk Production Management

The management of milk production based on AI involves the real-time monitoring of milk yield, milk quality, fat content, solids-not-fat (SNF), milk conductivity, milking time, etc., and that of milking schedules and milking efficiency by robotics-based milking systems. This allows for early identification of problems related to udder health, increases the quality and quantity of milk, decreases labour, and increases total dairy farm productivity.

6. Livestock Behaviour Analysis

Livestock behaviour analysis based on AI is that the computer vision that can be used for eating, drinking, lying, competing, socialising and stress-related

activities of animals. This ensures early identification of health and welfare problems, better management decisions and increased productivity of dairy cows, buffalo, sheep, goats, pigs and poultrys.



7. Smart Poultry Farming

Feed and water consumption, egg production, bird movement, mortality, temperature, humidity, and ammonia levels are continuously monitored in AI-based smart poultry farming, which contributes to better flock management. With real-time analysis, diseases can be detected early, environmental control can be improved, egg production can be increased, mortality can be reduced, and the general health and productivity of poultry flocks can be enhanced.

8. Precision Pig Farming

Precision pig farming based on AI is empowered by computer vision, sensors, and machine learning that enables BW estimation, disease detection, growth monitoring, feed utilization optimization, pig counting, and animal welfare evaluation. The application of these technologies enhances the efficiency of production, reduces labor, improves health management, and even increase the economic returns to pig farmers.

9. Smart Dairy Farming

AI smart dairy farming incorporates robotic milking, automated feeding, smart collars, RFID tagging, computer vision and activity tracking to manage herd optimally. The above technologies have been proven to increase milk yield, decrease labour cost, enhance reproductive performance, and enable data-driven and efficient dairy farm management.

10. Genetic Improvement & Breeding

AI-driven genetic selection and breeding evaluates pedigree records, genomic data, production traits, and disease resistance to predict the best breeding animals. This leads to more informed selection decisions, faster genetic gain, enhanced productivity, and better health and performance of the livestock populations.

11. Farm Automation

Automation of livestock farming using AI such as Auto feeder, water supply, ventilation, lighting, cleaning, waste management and climate systems, adjusts the livestock houses and farming activities for best supply of feed and water for the particular stage of growth and type of livestock is easily feasible. These systems are now fairly widespread in diary, poultry and pig farming and contribute to making better use of resources, reducing labour, improving the well-being of animals and increasing overall-farm productivity.

12. Livestock Traceability

Livestock traceability enabled by AI technology, combined with RFID and blockchain, enables precise animal identification, management of health and vaccination records, tracking of movement, and monitoring of food safety. This improves traceability, disease surveillance, consumer confidence, and transparency along the livestock value chain.

13. Climate-Smart Livestock Farming

The climate via AI in livestock farming helps to optimize water and energy consumption, feed efficiency, heat stress management, and the reduction of greenhouse gases, mediated through data-driven decisions. These technologies enhance the efficiency of resource use, increase the animals' resilience to climate change, and contribute to sustainable and environmentally friendly livestock production.

Ai tools used in animal husbandry

Technology	Application
Machine Learning	Disease prediction, production forecasting
Computer Vision	Behaviour monitoring, body condition scoring
IoT Sensors	Temperature, rumination, activity monitoring
Smart Collars	Heat detection, movement analysis
RFID	Animal identification and traceability
Drones	Grazing and pasture monitoring
Robotics	Milking, feeding and cleaning
Thermal Cameras	Fever and inflammation detection
Cloud Computing	Data storage and decision support
Mobile Apps	Farm management and advisory services

Benefits of AI in animal husbandry

Advantages of AI in Animal Husbandry: By improving productivity and reducing the cost and time of labor and veterinary interventions and by enhancing profitability and efficient use of resources,

AI provides substantial economic, animal-welfare and environmental positive output. Among the aspects of animal welfare improved by early disease detection, reduced stress, better health care, comfortable housing and precision nutrition. Besides, reporting technology and AI improve the sustainability of livestock production by enhancing feed and water efficiencies; by lessening methane emissions and waste production and the environmental intensity of livestock farming.

Challenges of AI adoption

Barriers to Utilize AI in Livestock: The utilization of AI in livestock industry has some barriers as follows: high costs for initial investment, deskewing digital infrastructure, limited internet access at rural area, lack of know-how, issues on data privacy, small size of farm holding, maintenance and operation cost, and manpower with high know-how. Overcoming these constraints is critical in ensuring the possible diffusion of AI-based livestock farming.

Future Prospects of AI in Animal Husbandry

The animal husbandry of the future will be impacted by robotic livestock farms powered by AI, digital twins of individual animals, precision genomic breeding, drone-assisted grazing management, livestock traceability enabled by blockchain, AI-based veterinary telemedicine, predictive disease surveillance, fully automated smart dairy and poultry farms, and the coordination of AI with 5G, Internet of Things (IoT), and cloud computing. Such technologies will facilitate smart data-driven management of livestock for enhanced productivity, animal well-being, resource use efficiency and the sustainability of contemporary animal production systems.

CONCLUSION

The development of Animal Husbandry has been on process which in turn lead up to now into the intelligent, accurate and data-intensive exploitation of animals. By way of sensors, machine learning, computer vision, robotics, RFID, drones, and the IoT, AI facilitates health monitoring, disease recognition, precision feeding, breeding, production management, farm automation and traceability of livestock. It enhances productivity, animal welfare, resource use efficiency and farm profitability, while decreasing labour, feed wastage, veterinary costs and environmental impact. Nevertheless, for the time being the big challenge is the high cost of installation, the inadequate rural communications, the lack of technical knowledge and the potential for data privacy breaches. With the appropriate training, cost effective technologies and support from the government, AI can significantly empower contemporary livestock farming and enhance its prospects of being sustainable, profitable and climate-resilient.