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Application of Artificial Intelligence (AI) in Animal Husbandry

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Introduction:

The contribution of the livestock sector is 4.11% of GDP and 25.6% of total agriculture GDP in India. Approximately 80% of the economy of small and marginal farmers relies on the livestock sector. To enhance the contribution of the livestock sector towards GDP, ensure food safety and boost the economy, the productivity of the livestock sector needs to be augmented through the application of various cutting-edge and advanced technologies in farm management. Artificial Intelligence (AI), Machine Learning (ML), Robotics and Information and Communication Technology (ICT) are a few such recent technologies that are being implemented in livestock production and management. These technologies can accurately collect and analyze data on animal behaviour, production, reproduction, nutrition, health and other physiological parameters. With the help of AI, the need for extensive manpower and human intelligence can be replaced by machine intelligence and can be managed remotely.

Currently, some technologies are in operation worldwide, such as PIGUARD (developed by Serket) to keep track of the welfare of pigs before sacrifice, POULTRY SAFE by Octopus Robert, FLOX to keep track of poultry behaviour during night hours, KEYMAKR provides perfect image and radio annotation in poultry houses.

Artificial Intelligence in the Livestock Sector:

The main applications of artificial intelligence and machine learning focus on assessing physiological and behavioural changes, and early prediction of diseases (Neethirajan *et al.*, 2017; Neethirajan and Kemp, 2021). Besides these, sensor technology and networks can be implemented to assess lameness, mastitis, and oestrous detection in cattle (Taneja *et al.*, 2020; Wu *et al.*, 2020). Due to developments in sensor technology, Internet of Things (IoT) connectivity, remote sensing, computer vision, automation, and integration of animal science and animal welfare assessment approaches can be possible with involvement of minimal human intelligence (Morota *et al.*, 2018; Singh *et al.*, 2020).

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN LIVESTOCK FARMS

- **During animal birth or purchase:** Using AI, the data from previous reproduction cycles can be analyzed to predict the number of animals that will be born. For animal purchases, artificial intelligence can calculate the number of animals under given farming conditions and their costs.
- **Smart animal housing:** Artificial intelligence helps farmers to establish the best conditions for animals based on various conditions such as humidity, temperature and number of animals.
- **Grooming and cleaning of animals:** Using automation and livestock sensors, personalized and scheduled grooming plans can be done according to the breed, age, production level and lactation stage.
- **Maintenance of hygiene and cleaning of the cow shed:** By the use of autonomous robotic systems and drones, cleaning and proper maintenance of the hygiene of the cow shed can be done. Manual labour can be reduced by the use of AI for the removal of manure and disinfection of the shed.
- **Feeding of animals:** Best feed ingredients for different types of livestock, managing pastures, feed formulations, and least cost rations can be easily found with the help of AI.
- **Artificial Intelligence in automated milking:** Smart sensors and automated milking units are used to allow the cows to milk voluntarily, clean teats, attach milking cups, dispense milk and analyze the milk quality. Cows can be milked throughout the day by this method.
- **Artificial Intelligence for health monitoring:** Animals' vitals, body weight, metabolism, and other physiological parameters can be monitored by the sensors, cameras and wearables to detect any early signs of diseases. Physiological parameters, such as heart rate, body temperature and respiration rate, can be obtained from individual animals with involvement of minimal human intelligence (Fuentes *et al*., 2020).
- **Animal Behaviour:** Behavioural changes of animals can be understood by analyzing large datasets of movements, facial expressions, sounds, and rumination patterns by the use of sensors, cameras and wearables.
- **Artificial intelligence and breeding:** With the help of Artificial intelligence and machine learning, a huge amount of genetic data can be processed to identify the desirable traits. The possible breeding outcomes can also be predicted by the breeders. For example, to achieve superior milk quality, the data on milk parameters and reproductive qualities of the new variety of cows can be analyzed to suggest a 'smart breeding recipe'.
- **Improving animal health using facial recognition systems:** Facial features such as, the ear and eye movements of an animal can be studied to understand behaviour and excitement level, and pain, stress or discomfort in animals can be detected.
- **Improvement of the feed quality and milk production:** Through precision livestock farming using artificial intelligence, the feed quality and milk production can be improved. Utilizing different AI tools,

feed formulations can be optimized to increase the quantity and quality of milk of milk production.

- **Artificial Intelligence for Detection of Oestrus:** Artificial Intelligence tools such as cameras, accelerometers, pedometers, wearables, and monitors are used as components of the dairy automation system to collect data from the behavioural changes. The collected data are analyzed to provide insights for the detection of oestrus.
- **Monitoring the health of farm animals**: Health of the farm animals can easily be monitored by the use of AI powered sensors, drones, cameras, wearables and smart monitoring systems to identify the behavioural changes and illness in the farm that could directly impact the production level of the animals.
- **Robotics to deliver feed, medicines and vaccines:** By incorporating the robotic system, individual animal feed requirements can be determined for personalized feeding, enabling the delivery of drugs and vaccines to the animals.
- **Environmental Control:** By analyzing the data obtained by the sensors and satellite imagery, weather prediction, and detection of any early signs of pest infestation, diseases, and deficiencies can be possible. This can help to adopt modified management systems.
- **Precision Livestock Farming:** In a precision livestock farming (PLF) system, the feeding of individual animals is based on their individual requirements. AI can automate livestock farming, and large populations of animals can be monitored for behavioural changes, health status and welfare.
- **Animal Welfare:** By advanced monitoring and analysis of real-time data provided by the cameras, sensors and wearables, the behavioural analysis, early disease detection, precision farming and more personalized care for individual animals can be done easily.

Requirements:

There are some basic requirements to implement artificial intelligence in the livestock farms.

- Hardware such as sensors, cameras, wearables, and automated machinery to collect real-time data on animal activity, behaviour, physiological parameters, and environmental conditions.
- Software such as AI algorithms, machine learning models, is required to analyze and interpret the vast data.
- Infrastructure, such as internet connectivity, is the most important requirement for data transfer.
- Skilled computer professionals with expertise in animal science and data science are needed for successful implementations, maintenance and interpretation.
- High initial financial investment is required.

Benefits:

- **Improved animal health:** Real-time monitoring, behavioural study, improved diagnosis, and early disease prediction and detection with the help of artificial intelligence and machine learning, improve

animal health.

- **Increased efficiency:** Sensors, cameras and wearables can give large amount of data on animal behaviour, facial expressions, movements, feeding patterns, rumination patterns, walking and other physiological parameters. These data are analyzed by machine learning for precision farming, genetic selection, optimized feeding, delivering of drugs and vaccines, and early detection of diseases, ultimately improving efficiency.
- **Early disease detection:** By monitoring behavioural changes, physiological data, early signs of illness can be detected.
- **Optimized feeding:** AI can modify the individual feeding schedules based on the individual requirements, body weight, and health status**.**
- **Optimized breeding:** Breeding strategies can be optimized by the analysis of data by AI algorithms and machine learning.
- **Reduced Labour Cost:** Automation processes drastically reduce the labour cost.
- **Animal welfare:** Early disease detection, precision farming, smart breeding and personalized care can be taken from the analysis and interpretation of the data obtained from the camera, sensors and wearables, increasing animal welfare.

Challenges:

Though AI has numerous advantages, its adoption in the livestock farming system bears certain challenges. Technological infrastructures, data security and privacy are the major concerns. Integrating AI with the existing farm management systems is expensive, time-consuming and hence, can be a challenge. Correct interpretation of the data collected is important. For this, there is a need for adequate support, training to adopt the new technologies and specialised skilled personnel.

Conclusion:

Different industries have adopted artificial intelligence and machine learning technology. In agriculture and livestock farming, AI tools such as drones, robots, and intelligent monitoring systems are now set to revolutionize the future. The use of artificial intelligence can help increase the yield of farm animals, monitor their health status, increase production efficiency, and take precise care of them.

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