DLINE JOURNALS

Journal of Information Technology Review

Print ISSN: 0976-3511
Online ISSN: 0976-2922

JITR 2024; 15 (4)
https://doi.org/10.6025/jitr/2024/15/4/138-144

A Review of Smart Livestock Farming Using Artificial Intelligence

Pradeepa Palraj
Sambhram University, Jizzakh
Uzbekistan
drppradeepaa@gmail.com

Sevara
Master of Science in Information Technology
Sambhram University, Jizzakh
Uzbekistan

ABSTRACT

Livestock farming is an important factor in Uzbekistan's economy. The agricultural and livestock sectors have been the subject of a number of reforms because of their important role in the Uzbekistan economy, employing about 40% of the population and producing one-third of the country's gross domestic product. This paper aims to review the major technological developments in cattle farming and the role of imparting the trending technology in smart animal production and farming for improved efficiency at less investment for the sustainable development of agriculture. Modern technology, including artificial intelligence, blockchain, geofencing, smart and biosensors, the internet of things, etc, have tremendously changed agriculture and cattle farming by reducing the challenges in real-time animal breeding in large numbers. This paper summarizes the major technological trends and developments in each sector of livestock management.

Keywords: Smart Livestock Farming, Artificial Intelligence, Cattle Breeding, Geofencing, Blockchain Technology

1. Introduction

Modern livestock management aims to improve animal care, streamline processes, and increase productivity. This paper aims to review the different technologies involved in livestock management and the applications of smart biosensors in animal health management systems. The monitoring of livestock farming is revolutionized by adapting modern technologies, including blockchain, big data, and AI. The biometric sensors provide real-time health data, and they are integrated with AI-equipped smart systems to monitor livestock continuously. Geofencing technology has taken a new paradigm in animal husbandry. This paper aims to simplify the challenges in livestock management by summarizing the convergence of smart agriculture and animal management technologies. This will build a new arena that is grounded in ground breaking technological

Advancements in waste management, cattle milking, animal breeding, and feeding systems have been made in recent years. Although cattle farming is growing tremendously, meeting the upcoming animal protein requirements due to global population growth presents equal challenges. Another factor is the climatic challenges that have a great impact on livestock farming (U. Bernabucci, 2019). Sudden climatic variations result in disease outbreaks and easy spread that demand immediate action to avoid economic losses.

2. Revolutionizing Animal Farming

Activity trackers, GPS collars, remote monitoring systems, smart feeders, health wearables, pet-access doors, tank regulators, telemedicine services, livestock sensors, and health applications are just a few examples of the many instruments that fall under the category of smart technologies for animal health. When used in tandem, these tools ensure the security and welfare of animals. Smart feeding technology in animal husbandry includes custom mixers, RFID-tagged systems, automatic feeders, consumption sensors, nutritional analysers, and real-time monitoring. These technologies guarantee accurate nutrition and effective animal feed management by streamlining the feeding procedure.

Numerous devices are used in smart animal monitoring and control, such as wearables, remote cameras and sensors, automated feeding systems, livestock trackers, behaviour sensors, robotic herding, gates and fences for access, and cloud-based management. When combined, these technologies improve care efficiency and improve animal welfare.

AI equipment, genetic testing tools, embryo transfer devices, hormone monitors, smart identification systems, health monitors, automated feeding, data analytics platforms, and livestock management software all come together in intelligent animal breeding and management. This integration aims to enhance general animal care and optimize breeding procedures. Combined, these methods guarantee both the effective management of animal populations and the generation of healthier progeny.

Various technologies are integrated into the smart distribution of animal farm goods, including GPS management, supply chain software, RFID/barcodes, and smart packaging sensors for tracking and quality monitoring throughout transportation. IoT sensors monitor the quality of the products, while blockchain guarantees transparent tracking. Automated packing and cloud-based inventories allow for real-time tracking. Combined, these technologies provide consistent, superior distribution along the whole supply chain.

The socio-economic effects of smart animal farming are centred on critical technologies, such as remote monitoring and data analytics, for well-informed decision-making and animal welfare. This covers genetic testing, wearable health technology, management software, automated feeding, and the application of supply chain and blockchain technologies for transparent tracking and quality improvement. Overall, these technical innovations help the farming industry achieve favourable social and economic results by increasing output, improving animal welfare, and optimizing resource management, as shown in Figure 1.

3. Technology Alternatives in Smart Animal Production

Standard techniques, including visual evaluations, handwritten records, and creature-rearing methods, are workable alternatives to creativity in astute creature creation. Farmers can manage livestock without using novel observation techniques, such as physical support and tactile management techniques. Specific breeding and analog health monitoring demonstrate traditional proficiency. Even though they might not be as high-tech as others, these procedures highlight the integration of tried-and-true strategies with cutting-edge technologies for the overall administration of animals. Astute animal breeding ranches provide several advantages to their technological innovations. By the way, other ethical and biological ways exist to provide sustenance. Enhancing animal welfare, reducing environmental impact, and strengthening community relationships can be achieved by using genetic selection processes, expert management techniques, optional food research, local procurement as a top priority, and coordinated marketing.

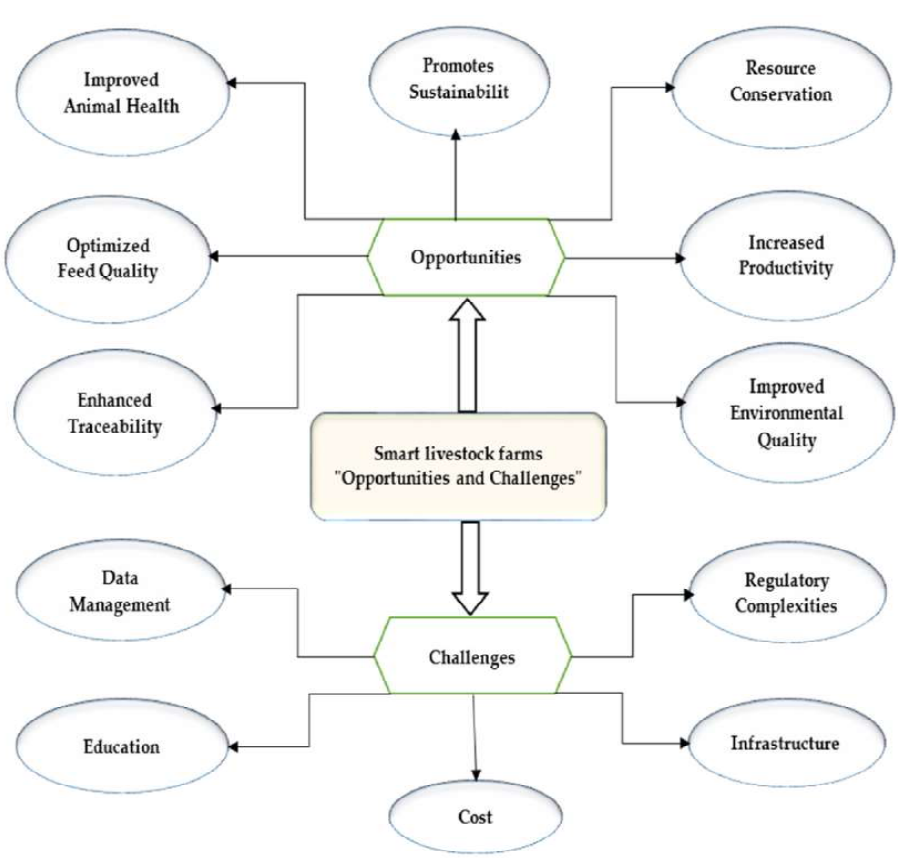

Figure 1. Smart Livestock management

Although astute ranches provide creative focal points, producing ethical and biological sustenance necessitates various approaches, including local sourcing, optional bolsters, management techniques, inherited traits, and reduced environmental effects (Phuphaniet al. et al., 2019). Smart apps use devices like smart collars and automated frameworks to provide precise care and data-driven insights, improving animal welfare in agriculture.

The field of clever advancements in animal healthcare and security is proliferating. It offers many advantages, such as increased efficiency, lower veterinary expenses, improved animal prosperity, and increased security. These advances have several applications: security checking, pharmaceutical accuracy, behavioural checking, and inaccessible observing. Shrewd bolstering frameworks (SFSs) use sensors, machine learning (ML), and artificial intelligence (AI) to automate and advance animal feeding techniques. These developments could improve the quality of drain and meat, increase production in the food industry, lower the cost of food, and advance animal welfare. Additionally, SFSs can advance traceability and provide support in lessening the organic impact of animal agriculture. Because SFSs are becoming more reasonable and modern, a wider application in the creature creation trade is expected (Baldi D et al., 2017).

Modern creature inspection and control uses sensors, actuators, and artificial intelligence (AI) to gather data about behavior, well-being, and surroundings. These tactics provide the most recent information on behavior, health, safety from predators, and position verification. The advantages include increased skill, reduced effort on the part of caregivers, and significantly higher animal prosperity. Some present obstacles are information protection, fetched, and partner worthiness. Notwithstanding these obstacles, these advancements have the potential to improve the lives of animals significantly. Supportability, efficiency, and well-being are

advanced by advanced innovation in creature care through AI, information analytics, and sensors. Accuracy reinforcement, welfare monitoring, and behavioral and regenerative management improve the well-being of animals (Helwatkar D et al, 2014). These factors also increase yields, take-a-hit reserve money, and natural neighborliness. Despite challenges with estimation and regulations, it can transform animal husbandry and pave the path for a more practical and moral food source in the future. Innovative animal-raising farms use creativity to enhance and automate their animal-generation processes. This could lead to creating creature items that are more nutrient-dense, helpful, and maintainable (Nasirahmadi J et al., 2020). Advertising and spreading smart creature products can be challenging. Still, producers can overcome these obstacles by highlighting the benefits of their products to customers and educating them about nearly shrewd cultivating developments. To display and distribute keen creature products, organizations, e-commerce, social media, substance promotion, traceability, real-time information checking, and social media can all be used to cultivate innovation in keen cultivation.

3.1. Artificial Intelligence in Animal Husbandary

Artificial Intelligence significantly helps in animal husbandry by solving issues related to the welfare of the cattle or tracking them and hence achieving better economic benefits. AI helps massively provide smart solutions for animal health issues, increasing efficiency (S. Neethirajan, 2017). The main focus of AI is to care for the quality of animal health and improve animal production efficiency. Moreover, AI also helps in achieving sustainable and optimal livestock farming. Literally, the goal of achieving animal welfare using traditional measures is not easy as livestock welfare includes metrics like health condition, behavioural expression and cattle safety. However, AI has fortunately aided in giving hope to livestock management and improving production performance (Alves et al., 2021). Recently lot of studies in the emerging areas of machine learning, deep learning algorithms and artificial neural networks have addressed enormous challenges in the field of livestock farming (Riaboff et al., 2022)

3.2. Geographical Information Systems

Livestock farming requires a lot of planning concerning the usage of land resources, infrastructure planning, optimal use of resources, etc. This requires the spatial patterns of the landscape and asset mapping. Geographical Information System (GIS) tremendously helps in spatial analysis and asset mapping that farmers can effectively use to increase the productivity and effective utilization of resources and hence improve animal welfare (Viscardi AV et al., 2017). GIS is a reliable source of information that precisely maps the infrastructure in livestock farming. The livestock assets include breeding centres, livestock markets, feed analysing labs, quality control and checking units, and veterinary hospitals for disease identification. Hence, GIS has effectively increased productivity and efficiency in livestock farming and has played a major role in the cattle breeding industry.

3.3. Smart Sensors

Animal health management is effectively improved by using smart biosensors. The animal disease is diagnosed quickly at earlier stages, reducing economic losses. Smart sensors are widely used by the poultry farms and the dairy farms. The cattle's health is continuously and remotely monitored accurately, unlike the predictive monitoring of experienced farmers (Neethirajan, 2017). The physiological and behavioural characteristics of the livestock are evaluated at regular intervals using these smart sensors. The smart sensors are available in two different categories, namely, invasive and non-invasive sensors. Examples of such sensors are pedometers, activity sensors using microelectromechanical systems (MEMS), and global positioning systems (GPS). These sensors are also used in measuring and monitoring internal physiological parameters, including temperature, rumen health pressure, etc. These measurements are also unbiased and accurate and can be easily used in large farming with fewer human resources to monitor and track cattle activity (Helwatkar et al. 2014). The data collected from the sensors are stored for future analysis, besides being processed by machine learning and other AI-based algorithms (Benjamin and Yik, 2019). Besides, these sensors are also effectively used in tracking animal activities with a pre-recorded threshold and send a notification to the farmers from a remote location when any abnormality is sensed. These smart sensor signals are combined with AI, big data analysis, genomics, etc, to identify the animals with desirable characteristics and select them for the breeding process (Ellen E.D.

et al. 2019). The usage of these smart sensors has reasonably increased in the last few years and is expected to increase in the next ten years tremendously. This is owing to the numerous advantages these sensors provide in terms of precision, efficient output, data storage, etc. Thermal infrared imaging is a widely used non-invasive method for monitoring body temperature and disease diagnosis four to six days earlier (Koltes J. E. et al., 2018). This also helps in quick treatment and reduces the contagious disease and control in the earlier stages. Other non-invasive sensors used are radio-frequency identification systems and thermometers, cameras, microphones, and RFID tags to enable the farmers to track the location and health of the livestock (Benjamin and Yik, 2019). Microphones are also installed in big herds of cattle to monitor them continuously and easily (Mahdavian et al., 2020). Similarly, smart cameras can also be installed at identified locations to monitor the animal's position and mobilization. This technique of analysing the camera images tracks the animal's height, walk, intake, etc (Norton et al. 2019). Machine learning algorithms are applied to detect facial traits and track the changes due to emotional states (Marsot et al. 2020).

3.4. Blockchain Technology

Blockchain is an emerging technology that uses the distributed database management system and improves the safety and security of the database management system. This has the power to completely transform the livestock industry by improving its sustainability, efficiency, and transparency while offering many advantages and opportunities to farmers, customers, and other stakeholders. However, it is imperative to recognize the drawbacks of this technology, such as high upfront expenditures, cybersecurity threats, labour scarcity, and regulatory obstacles (Chattu et al., 2019). Research and development expenditures are crucial to addressing these issues, and working together is crucial to creating an atmosphere that will encourage the broad use of Blockchain technology. These issues will probably be resolved as technology advances and matures, opening the door for Blockchain to revolutionize the livestock industry. The potential benefits of blockchain technology for the livestock industry greatly outweigh the drawbacks.

Blockchain technology majorly helps in detecting and tracking animal disease outbreaks (Dyda A., et al. 2020). One of the important features of blockchain is transparency, and this is mostly sought parameter regarding concerns about the sustainability and morality of livestock farming and the treatment of animals bred. According to the WHO, food safety concerns demand strict monitoring of food-related issues. Considering all the above factors, blockchain technology has proven to be a feasible solution in ensuring transparency and better ease in cattle farming.

3.5. Internet of Things

The Internet of Things (IoT) contributes to livestock farming by providing innovative solutions and hence revolutionising the farming sector by reducing costs and increasing productivity (Vijay Rana et al., 2023). The IOT technology eases the challenges in livestock farming by identifying interconnected devices, analysing the data from the smart sensors, and using machine learning techniques to automate the process and predict the challenges in advance. In addition, IOT is widely used in locating cattle, alarming when the cattle are crossing the boundaries, monitoring animal health, etc. (Parisa Niloofar et al. 2021). Traditional farmers widely shifted to modern tools like IOT because of the cost-effective solutions, reduction in crop waste and intelligent solutions for various real time challenges. Mention a few major developments in livestock farming, such as machine-assisted milking, automatic feeding, continuous animal health monitoring, etc. However, the increase in the demand for animal products and protein supplements has created a demand for the upscaling of this technology for an effective increase in meeting the rising demands of this sector (Dyda PY et al., 2020).

3.6. Geofencing

There are many advantages to using technology in cattle husbandry. Firstly, increasing growth rates and manufacturing efficiency help to raise productivity. Second, by increasing output levels and decreasing the demand for manpower, these technologies improve efficiency. By guaranteeing that animals receive the right nourishment and medical attention, technological equipment also significantly contributes to the improvement of animal care (Lin J et al., 2018). Geofencing is an emerging technology that uses GPS, RFID, and Wi-Fi to create a virtual boundary and to track any device or person within this boundary. This technology is widely applied for surveillance and live tracking systems using Artificial Intelligence (AI).

These technologies help to enhance livestock production in terms of productivity by improving feed quality and offering better health care. Additionally, technological instruments contribute to increased efficiency by minimizing human labour and optimizing resource utilization. Lastly, by improving the surroundings and facilitating better medical treatment, these technologies promote animal welfare and raise the standard of livestock.

There are several obstacles when it comes to using technology in animal production. First off, some breeders may find it very difficult to use these gadgets due to their expensive cost. Furthermore, the requirement for constant upkeep increases breeders' already heavy jobs. Reliance on energy is another problem, particularly in places with erratic electrical supplies. Furthermore, these devices' susceptibility to malfunctions or breakage raises questions about their dependability, which could impact the overall productivity of cattle farming operations (Mahdavian et al, 2020).

Technology has many benefits for livestock farmers, greatly outweighing any possible disadvantages because it increases animal care, productivity, and efficiency. Even though these gadgets have many advantages, it is crucial to carefully consider aspects like expenses, upkeep, and energy dependence.

4. Conclusion

It may be concluded that recent advancements in precision livestock farming (PLF) technologies have garnered significant attention due to their potential to enhance animal production efficiency while addressing crucial consumer concerns regarding animal welfare, environmental sustainability, and public health. Key components of these technologies include biometric and biological sensors, big data analytics, and blockchain technology. Biometric and biological sensors enable real-time animal health and welfare monitoring, facilitating proactive management strategies to ensure a sustainable and safe food supply. Big data analytics processes vast sensor data into actionable insights for farmers, optimizing decision-making processes. Blockchain technology makes livestock agriculture more transparent and traceable, increasing consumer trust and improving food safety.

References

[1] Baldi, D., Gottardo, A. (2017). Livestock production to feed the planet: Animal protein: A forecast of global demand over the next years. Rel: Beyond Anthropocentrism, 5, 65. https://doi.org/10.7358/rela-2017-001-bald

[2] Dyda, P. Y., Nguyen, A., Chughtai, C. R., MacIntyre, R. (2020). Changing epidemiology of Salmonella outbreaks associated with cucumbers and other fruits and vegetables. Global Biosecurity, 1(3). https://doi.org/10.31646/gbio.49

[3] Helwatkar, D., Riordan, J., Walsh, J. (2014). Sensor technology for animal health monitoring. In 8th International Conference on Sensing Technology (pp. 266-271). Liverpool.

[4] Khaliduzzaman, S., Fujitani, A., Kashimori, T., Suzuki, Y., Ogawa, N., Kondo, N. (2019). A non-invasive diagnosis technique of chick embryonic cardiac arrhythmia using near infrared light. Computers and Electronics in Agriculture, 158, 326-334. https://doi.org/10.1016/j.compag.2019.02.014

[5] Mahdavian, S., Minaei, C., Yang, F., Almasganj, S., Rahimi, S., Marchetto, P. M. (2020). Ability evaluation of a voice activity detection algorithm in bioacoustics: A case study on poultry calls. Computers and Electronics in Agriculture, 168, 105100. https://doi.org/10.1016/j.compag.2019.105100

[6] Nasirahmadi, J., Gonzalez, B., Sturm, O., Hensel, U., Knierim, U. (2020). Pecking activity detection in group-housed turkeys using acoustic data and a deep learning technique. Biosystems Engineering, 194, 40-48. https://doi.org/10.1016/j.biosystemseng.2020.03.015

[7] Phuphanin, L., Sampanporn, B., Sutapun, B. (2019). Smartphone-based device for non-invasive heart-rate measurement of chicken embryos. Sensors, 19(22), 4843. https://doi.org/10.3390/s19224843

[8] Viscardi, A. V., Hunniford, M., Lawlis, P., Leach, M., Turner, P. V. (2017). Development of a piglet grimace scale to evaluate piglet pain using facial expressions following castration and tail docking: A pilot study. *Frontiers in Veterinary Science*, 4, 51. https://doi.org/10.3389/fvets.2017.00051

[9] Alves, V. M., Auerbach, S. S., Kleinstreuer, N., Rooney, J. P., Muratov, E. N., Rusyn, I., et al. (2021). Curated data in—trustworthy in silico models out: The impact of data quality on the reliability of artificial intelligence models as alternatives to animal testing. *Alternatives to Laboratory Animals*, 49(3), 73-82.

[10] Müller, B. R., Soriano, V. S., Bellio, J. C. B., Molento, C. F. M. (2019). Facial expression of pain in Nellore and crossbred beef cattle. *Journal of Veterinary Behavior*, 34, 60-65. https://doi.org/10.1016/j.jveb.2019.07.007

[11] Piñeiro, J., Morales, M., Rodríguez, M., Aparicio, M., Manzanilla, E. G., & Koketsu, Y. (2019). Big (pig) data and the internet of the swine things: A new paradigm in the industry. *Animal Frontiers*, 9(2), 6-15. https://doi.org/10.1093/af/vfz002

[12] Corkery, G., Ward, S., Kenny, C., & Hemmingway, P. (2013). Incorporating smart sensing technologies into the poultry industry. *Journal of World's Poultry Research*, 3(4), 106-128.

[13] Ellen, E. D., Van Der Sluis, M., Siegford, J., Guzhva, O., Toscano, M. J., Bennewitz, J., et al. (2019). Review of sensor technologies in animal breeding: Phenotyping behaviors of laying hens to select against feather pecking. *Animals,* 9(3), 108. https://doi.org/10.3390/ani9030108

[14] Morota, G., Ventura, R. V., Silva, F. F., Koyama, M., Fernando, S. C. (2018). Big data analytics and precision animal agriculture symposium: Machine learning and data mining advance predictive big data analysis in precision animal agriculture. *Journal of Animal Science*, 96(4), 1540-1550. https://doi.org/10.1093/jas/sky014

[15] Buller, H., Blokhuis, P., Jensen, P., Keeling, L. (2018). Towards farm animal welfare and sustainability. Animals, 8(6), 81. https://doi.org/10.3390/ani8060081

[16] Lin, J., Shen, Z., Zhang, A., Chai, Y. (2018). Blockchain and IoT based food traceability for smart agriculture. *In Proceedings of the 3rd International Conference on Crowd Science and Engineering* (pp. 1-6).

[17] Niloofar, P., Francis, D. P., Lazarova-Molnar, S., Vulpe, A., Vochin, M. C., Suciu, G., et al. (2021). Data-driven decision support in livestock farming for improved animal health, welfare, and greenhouse gas emissions: Overview and challenges. Computers and Electronics in Agriculture, 190, 106406. https://doi.org/10.1016/j.compag.2021.106406

[18] Neethirajan, S., Ragavan, K. V., Weng, X. (2018). Agro-defense: Biosensors for food from healthy crops and animals. Trends in Food Science & Technology, 73, 25-44. https://doi.org/10.1016/j.tifs.2017.12.005

[19] 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

[20] Neethirajan, S. (2017). Recent advances in wearable sensors for animal health management. Sensors and Actuators B: Chemical, 12, 15-29. https://doi.org/10.1016/j.sbsr.2016.11.004