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## **Livestock and poultry production in the age of artificial intelligence (AI): Transforming the livestock and poultry sector through modern innovation**

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### **Abstract**

This paper examines the revolutionary impact of Artificial Intelligence (AI) on livestock and poultry production in the world, especially in developed countries. Through description of AI technologies and their applications in the livestock and poultry production, I explore how these systems are reshaping traditional animal husbandry practices by improving animal welfare, efficiency, sustainability and decision-making on farms. I also discussed the policy and regulatory considerations, the challenges faced in using AI applications and the future prospects and implications of AI in livestock and poultry production. Clearly, the integration of AI in livestock and poultry production is a paradigm shift in the sector, which has a bright future and can contribute immensely in feeding a growing world population.

**Keywords:** Artificial intelligence, livestock production, poultry production

### **1. Introduction**

There are about 1.6 billion cattle globally as at 2022 and sheep and goats numbered 1.3 billion and 1.1 billion, respectively during the same year (Destatis, 2024) <sup>[2]</sup>. On the other hand, the population of chickens and pigs is estimated as 26.6 billion and 1 billion in 2022, respectively (Destatis, 2024; Livestock Data for Decisions (LDFD), 2025) <sup>[2]</sup>. According to FAO (2024) <sup>[4]</sup> about 361 million tonnes of meat were produced in 2022, which was about 129 million tonnes or 55 percent more than what was produced in 2000. About 90 percent of the total meat produced came from poultry, pigs and cattle. Globally, the United States is the largest producer of chicken and cattle, whilst China is the clear leader in pig production.

The livestock and poultry sector play an important role in many economies of the world by contributing to the attainment of food security, balanced nutrition, generation of foreign exchange and electricity, employment of millions of people, tilling the land for crop cultivation, hauling of goods on the farm and also to market centers, and fertilization of the soil. The livestock and poultry sector are one of the fastest-growing sectors in the Agriculture sector and this is driven by increasing incomes and urbanization. It has been established that as incomes grow, people change their diets to include livestock products and the same is true with urbanization. According to the Food and Agriculture Organization (2024) the livestock and poultry sector contributes billions of dollars to the global economy.

Technology has always played a crucial role in the livestock and poultry sectors and the current deployment of artificial intelligence globally is no exception. Indeed, artificial intelligence is currently transforming the livestock and poultry sector, by enhancing efficiency, productivity, sustainability and animal welfare. With the demand for livestock and poultry products rising continually, together with prevailing challenges such as climate change, population growth, disease management and resource constraints, AI offers innovative solutions to optimize livestock farming practices and help address these challenges. In this article, an attempt would be made to explore AI technologies, various applications of AI in livestock and poultry production, challenges in using AI applications, policy and regulatory considerations and future prospects and implications of AI in the livestock and poultry sectors. The article will be concluded with what needs to be done to enhance AI's impact in the livestock and poultry sectors.

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## 2. AI Technologies

Principe (2023) defined artificial intelligence as a branch of computer science that develops algorithms and programs to solve a problem or answer a question that enables various machines to operate like humans. Before machines can fulfil the above tasks, they must be “trained” on a large amount of data and information to recognize patterns via machine learning, which is a key component of AI systems. Deep learning is a part of machine learning and is used for tasks such as speech recognition, computer vision and self-driving tractors on the farm. Other key AI technologies used in livestock and poultry production include the Natural Language Processing (NLP), which enables computers to understand spoken words and written text. NLP in AI can be deployed to serve as virtual assistants or used in Chabot, which greatly enhances a company or farm’s interface and communication with its customers or clients. Computer vision helps machines to analyze images and videos and is that component of AI systems that helps to detect sick animals from the herd or flock. Robots are now being used on farms for repetitive and tedious tasks such as milking of dairy cows.

According to Marr (2023) artificial Intelligence started in the 1950s, with the Turing test conducted by Alan Turing to assess whether a machine could mimic human intelligence. However, the current explosion in Artificial Intelligence can be attributed to the landmark work of OpenAI. This company developed the deep learning techniques and the large-scale neural networks such as Generative Pre-trained learning techniques (GPT), which gave rise to the GPT-3 released in 2020. The most current version of GPT is ChatGPT- 4o.

AI market is now booming with the release of several AI tools, some of which are being used in the livestock and poultry industry. According to the Business Research Company (2025) the market size of AI in livestock farming is expected to grow from 470 million United States dollars in 2024 to about 1.55 billion United States dollars in 2029, at a compound annual growth rate of 26.8 percent. This growth is attributed to increasing adoption of precision agriculture, rising labor costs and increasing need for resource efficiency on the farm.

## 3. The applications of ai in livestock production

AI technologies are increasingly being adopted in livestock and poultry production to address various challenges faced by farmers.

### a) Enhancing Animal Health and Disease Management

Modern livestock operations increasingly rely on AI-powered systems for continuous health monitoring and assessments. Computer vision and machine learning algorithms can detect subtle changes in animal behavior, movement patterns and physical condition in real time that might indicate health issues before they become severe and spread among the herd or flock of animals. This capability saves livestock and poultry farmers money from animals that could be morbid; with reduced productivity and even die from such conditions eventually. For example, research workers at the University of California, Davis have developed AI systems capable of detecting lameness in dairy cattle with 95 percent accuracy, allowing for early intervention and treatment (Johnson *et al.*, 2023)<sup>[1]</sup>.

### b) Precision Feeding Systems

Feed costs account for a substantial portion of livestock production expenses. In poultry production in developing

countries, this cost is about 70 to 80 percent of the total cost of production (Ocran, 2020)<sup>[13]</sup>. Any technology and means that reduce this cost will be welcomed by farmers. The goal of precision feeding system is to optimize growth performance and feed utilization efficiency, while reducing feed waste and conserving resources. AI-driven precision feeding systems optimize nutrient delivery based on individual animal needs. These systems analyze multiple data points collected by sensors such as individual animal weight and growth rates, feed composition and quality, environmental conditions, milk production levels in dairy cattle and historical performance data. Machine learning algorithms then process this information and ensures that animals receive precise rations for optimal productivity and reduce waste and cost (Teye and Agyeman, 2020; Smith and Anderson, 2024)<sup>[17]</sup>.

### c) Reproductive Management and Breeding Programs

Artificial Intelligence has optimized reproductive management of animals through automated detection of estrus cycles and the prediction of optimal insemination timing, which leads to increased conception and pregnancy. AI also allows early pregnancy detection, which enables better reproductive management to be offered. Furthermore, AI can also monitor the birthing process and enable human assistance to be offered where necessary. Genetic algorithm and AI-driven analysis of genomic data enable the selection of animals with desirable traits to constitute the breeding stock. This approach accelerates genetic improvement, which enhances overall herd or flock productivity, disease resistance and adaptability to climate change (Goddard and Hayes, 2009)<sup>[6]</sup>.

### d) Environmental Sustainability

The environmental footprints of livestock production globally have been a source of concern to many people in recent times. AI models can assess the environmental impact of livestock operations, including greenhouse gas emissions and water usage. Ai therefore supports efforts to develop sustainable practices and meet environmental requirements (Herrero *et al.*, 2016)<sup>[8]</sup>. A research study conducted by the European Commission’s Joint Research Centre revealed that AI implementation in livestock operations can reduce greenhouse gases by up to 20 percent compared to traditional management systems (Brown, Martineez and Johnson, 2023)<sup>[11]</sup>.

### e) Automating Farm Operations

Labour costs on livestock and poultry farms are rising, paving the way for robotic and AI systems to be considered as possible alternatives. As the cost of robots and AI systems become cheaper, more of them would be deployed on farms. Automation driven by AI is currently revolutionizing farm operations, especially in developed countries (Singh, Jadoun, Brar and Kour, 2022)<sup>[15]</sup>. For example, robots equipped with AI capabilities are being used for tasks such as milking of cattle and goats, feeding and cleaning of barns and pens of livestock animals (Groher, Heitkamper and Umstatter, 2020; Dilaver and Dilaver, 2024)<sup>[7, 3]</sup>. These robotic systems improve efficiency, while reducing labour costs. Also, drones equipped with imaging technology can monitor pasture conditions and assess crop health from above, providing valuable insights for pasture management.

#### **f) Market Insights and Decision Support Systems**

Access to market insights generated by AI systems increase the profits made by livestock and poultry farms because they provide vital information on when the market is favorable to sell livestock animals and products. Similarly, market insights can also help in purchasing farm inputs for livestock and poultry production when the prices are low. AI can provide valuable insights into market trends that can positively influence livestock and poultry production. By analyzing market data and consumer preferences, artificial intelligence tools help livestock farmers to make informed decisions regarding which livestock products to prioritize based on demand. AI can also streamline supply chain operations by predicting demand fluctuations and optimizing logistics for transporting livestock products.

#### **4. Benefits of ai in livestock production**

AI applications on livestock provide many benefits in livestock production and marketing. Prioritizing animal welfare on farms is a current topical issue in livestock production. AI helps improve animal welfare on farms. Continuous monitoring of animals using sensors and AI systems ensures early intervention for sick animals and ensure that their overall well-being is kept. Consequently, animals do not suffer unduly from diseases and assistance is provided promptly to help them come back to health.

AI systems also help to increase efficiency on livestock farms. Automation and data-driven insights from AI systems streamline operations, reducing labor requirements and operational costs. AI systems excel at optimizing resource usage through predictive maintenance of equipment, smart water management, feed inventory management and energy consumption monitoring. Studies conducted across multiple countries indicate potential cost reductions of 15 to 30 percent in labour expenses and increased production efficiency of 10 to 25 percent (Wilson and Zhang, 2024) <sup>[20]</sup>.

AI systems on livestock and poultry farms enhance sustainability as it supports resource optimization and reduce environmental footprint of livestock production. Advanced AI algorithms help conserve natural resources by minimizing water usage through smart irrigation and cleaning system, reducing feed waste through precise portioning and optimizing transportation and logistics. AI can also help in managing grazing fields in pastoral systems. AI systems enable data-driven decision-making on livestock and poultry farms by providing real-time analytics that empowers farmers with actionable insights that enable them to enhance productivity and profitability of the farm.

#### **5. Policy and regulatory considerations**

Countries such as the United States, the United Kingdom, European Union countries have well-developed policy and regulatory laws governing the use of Artificial Intelligence. In most less developed countries, such policies and regulations are non-existent. The increasing reliance on AI systems raises important questions about data ownership. This is a complex issue due to cross-border data flows across organizations and sometimes countries with different policies and laws on the use of AI systems. Also, there are privacy concerns from individuals and organizations about how their datasets and information are being collected and used (Kamilaris *et al.*, 2019) <sup>[10]</sup>. Furthermore, cybersecurity measures need to be strengthened to curb cyber-threats. To

address these issues calls for national governments and industry bodies to develop appropriate AI system certifications, data protection standards and also industry standard pertaining to AI usage. Specifically, for the livestock and poultry industry, there should be a regulatory framework on animal welfare guidelines, environmental compliance and worker safety considerations. The European Union has one of the most stringent laws on animal welfare in the world. Africa, through the African Union Commission, has developed a policy framework on animal welfare and is assisting its member states to apply it in their individual countries.

#### **6. Challenges in using ai applications**

The use of AI systems comes with its unique challenges and problems. Successful AI implementation on a livestock and poultry farm requires a robust electricity availability and internet connectivity. A company using a chat-bot to help in interfacing with its customers requires around the clock electricity availability. There should also be adequate sensor networks on the farm to feed data to the AI system as well as a strong data storage and processing capabilities. In addition, the AI system needs to be integrated with existing farm management systems. In addition, there should also be regular maintenance and updates of AI systems. Many rural communities where farms are located still lack the necessary infrastructure to support these requirements effectively (Van der Burg *et al.*, 2019) <sup>[19]</sup>.

Initial investment costs for AI systems still remain prohibitive, as such many smaller livestock and poultry operators may not be able to afford them. Some of the expenses include hardware installation, software licensing, routine system maintenance and technical support. The transition to AI-powered systems requires new skill sets for farm managers, including basic data analysis, technology operation and maintenance, digital literacy, prompt engineering and cybersecurity awareness. Farm workers therefore need to be adequately trained to use AI systems and its associated technologies before they are introduced on the farm.

The use of Artificial Intelligence in livestock and poultry production raises ethical questions about animal rights and the implications of genetic manipulation (Fraser, 2012) <sup>[5]</sup>. Some farm animal welfare activists promoting animal welfare on our farms oppose the use of some AI systems.

#### **7. Future prospects and implications**

The future of AI in livestock production holds immense potential. I have already cited the future growth rate of AI in livestock production, as 26.8 percent per annum till 2029. Innovations such as autonomous robots for farm operations, advanced disease diagnostics, and AI-driven marketplaces for livestock trading are on the horizon. Other promising technologies are advanced genetic analysis tools, enhanced biosecurity measures, integrated blockchain and advanced environmental control systems.

The future of livestock production will likely see increased integration of AI with Internet of Things (IoT) devices, blockchain technology, drone systems, robotics, virtual and augmented reality. Ongoing research into machine learning algorithms will lead to even more sophisticated applications tailored specially for the livestock and poultry sector.

## 8. Conclusion

AI is transforming livestock production, especially in developed countries, offering unprecedented opportunities to meet the challenges of feeding a growing world population sustainably. While the journey towards widespread adoption of AI systems is not without obstacles, the benefits of AI in improving productivity, animal welfare, and environmental sustainability are undeniable. By addressing the associated challenges, stakeholders can unlock the full potential of AI in revolutionizing the livestock and poultry industry.

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