Pharaonic Journal of Science
https://pjscience.org/
PJS
SPBH

Review Article

The role of artificial intelligence in improving poultry production performance and reducing operating costs in modern farms

Raghad Alnuaimy[1*], Ghadeer Abd Al-Moneim Mohammed Rahawi[1]

[1]Department of Animal Production, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq.

Corresponding Author: Raghad Alnuaimy: raghad.alnuaimy@uomosul.edu.iq

DOI: https://doi.org/10.71428/PJS.2026.0414

Abstract

In recent decades, the poultry production sector has witnessed an accelerated digital transformation due to rapid developments in artificial intelligence technologies, and it has become one of the important pillars in the development of precision animal production systems. This review aims to provide a comprehensive scientific overview of the latest applications of artificial intelligence in modern poultry farms, with a focus on computer vision, machine learning, deep learning, infrared thermography, the Internet of Things, environmental and acoustic sensors, robotics, big data analysis, and digital twins. The article discusses the role of these technologies in real-time monitoring of bird behavior and feed and water consumption, early detection of diseases and heat stress, and controlling environmental conditions inside breeding halls, including temperature, humidity, ventilation, and ammonia and carbon dioxide concentrations, in addition to improving bird welfare, health, productivity, and feed conversion efficiency, and reducing losses, resource consumption, and operating costs. It also addresses the challenges related to economic feasibility, integration between systems, data quality, and applicability to commercial farms, and reviews future prospects for adopting these technologies within the shift towards smart and sustainable farms. The review concludes that AI represents a promising tool for improving poultry production performance, reducing operational costs, and supporting sustainability, provided application, integration, and cost challenges are overcome.

Keywords: artificial intelligence; poultry production; computer vision; deep learning; thermal imaging; precision agriculture.

Introduction

The poultry production sector has witnessed a major digital transformation in recent decades, driven by rapid developments in artificial intelligence. It has become a key pillar in the development of precision animal production systems. The poultry sector is one of the fastest-growing agricultural sectors globally, contributing significantly to food security by providing an economical source of high-quality animal protein, in addition to contributing billions of dollars to the global economy. However, the increasing demand for poultry products, coinciding with population growth, climate change, and rising production costs, coupled with labor shortages and increased disease incidence, has necessitated the adoption of smart technologies capable of increasing and improving production and supporting sustainability in the poultry sector (1). Rapid technological advancements in artificial intelligence have contributed to a significant shift in poultry farm management, as computer vision systems have become (Computer Vision), and machine learning (Machine LearningAnd deep learning (Deep LearningInternet of Things (IoT) technologyInternet

Received: August 20, 2026. Accepted: October 10, 2026. Published: November 12, 2026

of Things IoTBig data analysisBig Data AnalyticsIn addition to key tools for monitoring birds and farms in real time, all these systems rely on smart cameras and acoustic and environmental sensors to collect and analyze data. This allows monitoring of bird behavior and feed and water consumption, as well as early disease detection. It also allows monitoring environmental conditions inside breeding halls by controlling temperature, humidity, ammonia and carbon dioxide concentrations, and ventilation levels. All of this contributes to improving the birds' productive performance and reducing resource loss (2). The poultry industry faces numerous challenges that directly affect the economic returns of breeding farms and the quality and efficiency of production. Among the most important of these are labor shortages, outbreaks of infectious diseases, heat stress, changes in environmental conditions, rising feed prices, and other poultry-related issues that can negatively impact production. Various studies have shown that traditional management systems are no longer sufficient to meet these challenges, prompting researchers to find solutions. They have relied on artificial intelligence to make flock monitoring and management more efficient while maintaining accurate tracking of the flock's health and productivity (3). Poultry care and welfare are among the most important determinants affecting poultry farming, production, and sustainability, as they are directly linked to growth rates, feed conversion ratio, egg and meat production and quality, and mortality rates. In this regard, artificial intelligence applications have provided non-internal means of monitoring birds through conventional and thermal cameras and night vision technologies, allowing for continuous monitoring of behavioral and physiological changes and the observation of disease signs before the appearance of clinical symptoms, thus enabling early and appropriate intervention (4). Recent studies have shown that combining deep learning algorithms and computer vision techniques supports the automated analysis of images and videos for diseases, relying on changes in bird behavior, movement, body temperature, and morphological characteristics, and analyzing the phenotypic characteristics of bird droppings with greater accuracy than traditional examination methods in most cases. These applications have also contributed to the development of early warning systems that help contain the spread of diseases, reduce the use of antibiotics, and improve biosecurity within breeding facilities (5). With regard to automation, artificial intelligence has become a key element in the discovery and operation of agricultural robots within poultry farms for use in feeding, cleaning rearing halls, and continuous data collection. This has enabled farmers to reduce labor costs and dependence on them and improve the efficiency of production and field operations. Intelligent algorithms also help to improve feed formulation, provide predictions of growth rates, and manage resource consumption, which positively impacts increasing production, improving its quality, and reducing economic losses (6,7). Furthermore, recent reports indicate that adopting artificial intelligence technologies in poultry farm management contributes to achieving environmental sustainable development goals by enhancing the efficiency of feed, water, and energy use. It also reduces gas emissions, especially greenhouse gases, by up to 20% compared to traditional management systems, making these technologies an important tool in the pursuit of sustainable smart agriculture (8). Despite the significant progress made in this technology, most studies have addressed artificial intelligence applications in isolation, such as early disease detection, bird behavior monitoring, environmental management, or robotic automation, without providing an integrated vision of how to combine these technologies into a single system to simultaneously improve bird productivity and welfare, enhance resource utilization, and reduce operating costs. Furthermore, recent studies lack a comprehensive scientific review that systematically compares different algorithms and technologies in terms of their efficiency, practical applicability,

economic feasibility, and expected environmental impact, especially in light of the global shift towards smart farms and sustainable production. Accordingly, this article aims to provide a comprehensive scientific overview of the latest artificial intelligence applications in the poultry industry, focusing on the role of computer vision, machine learning, deep learning, and their impact on enhancing bird welfare, optimizing resource utilization, and reducing operating costs. The article also addresses the major challenges associated with implementing these technologies and explores their future potential for adoption in commercial farms, contributing to the development of more efficient and sustainable poultry production systems and enhancing their ability to meet global food security requirements.

Artificial intelligence in poultry production

Artificial intelligence represents one of the most prominent digital technologies that has fundamentally transformed smart agricultural systems, as it aims to develop computer systems capable of mimicking human cognitive abilities in learning, reasoning, decision-making, and problem-solving, relying on the automated analysis of massive amounts of data (9). In recent years, the poultry production sector has witnessed remarkable progress in the application of artificial intelligence technologies in response to the continuous increase in global demand for food products such as meat and eggs, rising production costs, labor shortages, and increasing environmental and health risks. This technology has become an integrated system combining deep learning, machine learning algorithms, computer vision, the Internet of Things, intelligent robots, and big data analytics to enable accurate and immediate monitoring of all information within the farm. This integration helps analyze data received from cameras, wearable devices, environmental sensors, and devices measuring the amount of feed and water consumed by birds, thus enabling the detection of early health problems, enhancing environmental management, and providing highly accurate predictions of production performance (10). Artificial intelligence differs from traditional management programs because it relies on continuous learning from data. Intelligent models adapt to new data and continuously improve their performance automatically, leading to enhanced prediction and decision-making accuracy over time. For example, deep learning algorithms can recognize bird behavior patterns by analyzing thousands of images or videos and detect changes associated with heat stress or disease, such as decreased bird activity before clinical symptoms appear. This allows for early intervention and reduces production and economic losses. Such models also enable us to predict growth rates, egg production, feed conversion ratio, and birds' nutritional needs based on historical or previously recorded data and real-time data from the farm (11,12). In the context of precision poultry farming, artificial intelligence is not limited to automating processes or procedures, but has become an integrated smart digital platform for farm management based on continuous monitoring, real-time analysis, and automated decision-making (13). High-resolution cameras, thermal cameras, sound sensors, ventilation quality sensors, humidity and temperature gauges, and gas concentration sensors are used to continuously collect data, which is then analyzed by artificial intelligence algorithms to generate data-based recommendations or implement automatic actions, such as adjusting cooling or ventilation systems and issuing early warnings upon detecting any abnormal changes within the halls. This contributes to improving flock health, increasing resource utilization efficiency, and reducing water and energy consumption (10). Recent studies indicate that artificial intelligence is a key component in the shift towards smart poultry farms. It contributes to the integration of data collected or received from multiple sensor systems and production records within a single platform capable of supporting accurate and rapid decision-making (14). Numerous

studies have also shown that artificial intelligence technology used in poultry farms has improved productivity indicators and feed conversion ratios, reduced mortality rates, and improved bird welfare, in addition to lowering operating costs and environmental emissions, making it one of the most important technologies supporting the poultry industry and its future sustainability (7,15).

Artificial intelligence components and technologies used in poultry farms

Smart poultry farms rely on an integrated system of digital technologies that work together to extract accurate operational decisions based on automated data, contributing to improved production performance and enhancing bird health and farm sustainability (16). The role of artificial intelligence is not limited to the use of machine learning algorithms only, but includes an integrated system that includes smart sensors, computer vision, cloud and edge computing, robotics, the Internet of Things, big data analytics, and finally digital twins that integrate with each other to provide real-time monitoring and autonomous decision-making in the various stages of production (10).

The role of computer vision and thermal imaging in monitoring the body temperature of birds

Body temperature is an important indicator reflecting the health and metabolism of poultry, as it is directly affected by infectious diseases, heat stress, inflammation, and surrounding environmental conditions (17). Clinical signs usually precede changes in the bird's body temperature, making it a vital indicator for early warning or detection of health disorders within the flock. Recent developments in artificial intelligence and computer vision using infrared thermal imaging have contributed to this. Infrared thermography (IRT) is described as a non-contact and non-invasive method by which body surface temperature is measured and changes in the body temperature of birds are continuously tracked and monitored without the need to touch or handle them, thus reducing stress and enhancing the accuracy of measurements (18). Recent studies have shown that integrating thermal imaging with artificial intelligence algorithms helps improve the accuracy of early detection of heat stress, some viral and bacterial diseases, and respiratory diseases by analyzing thermal indicators and integrating them with environmental behavior indicators (19). These systems also contribute to evaluating ventilation and cooling systems within breeding farms, monitoring birds and their distribution based on heat sources, and identifying abnormal thermal zones (identifying hotspots with thermal variations), i.e., those suffering from poor ventilation or temperature imbalances. This enhances flock health and welfare, reduces mortality rates, improves feed conversion ratios, and increases overall farm production (20,21). In addition, the integration of thermal imaging, environmental sensors, and deep learning technologies enables the development of early warning systems capable of predicting disease conditions before clinical symptoms appear. This supports biosecurity programs, reduces antibiotic use, and lowers economic losses resulting from disease outbreaks or spread. Therefore, AI-powered thermal imaging is considered one of the most promising technologies in smart poultry farms, given its ability to provide accurate and continuous monitoring of the flock and its health, improve production performance, and reduce operating costs (22-24).

Table (1) illustrates the impact of artificial intelligence in smart poultry farms

Description of the application ratio	Accuracy ratio	Source
A two-stage model identifies the chicken's head and then detects fowlpox infection based solely on images of healthy heads to learn about the abnormality.	92.71% (Accuracy)	(25)
ResNet-9 detects salmonella, Newcastle disease, and coccidiosis from images of chicken feces	98.83%	(26)
A deep learning model for early prediction of coccidiosis outbreaks in broiler chickens	90.4%	(27)
A machine learning algorithm that predicts bird flu outbreaks based on environmental data	92.2%	(27)
Herd sounds (sneezing/coughing) for early detection of avian influenza and Newcastle disease using CSCNN and BiLSTM	Up to 98.5%	(28)
Body position and movement speed are monitored to distinguish between sick and healthy chickens.	Up to 99.7% (mAP)	(29)
In-depth learning to detect spinal deformities in their early stages	Not numerically specified (qualitative results)	(29)

Effect of improved body temperature

We observe a difference in the body temperature of poultry depending on the disease they are suffering from, even under stressful conditions (30). Accurate diagnosis of body temperature can help in the early detection of diseases in sick birds and determine their health status (31). The body temperature of domestic birds can be measured using thermal imaging with infrared rays (32). A study mentioned that detecting avian influenza infection in the early stages of the disease using a specialized system gave good results. These technological developments have a significant impact on improving production in poultry farms (33).

The effect of humidity

Humidity is one of the most important environmental factors in poultry farming, and its impact is significant, as high humidity levels can contribute to the growth of harmful microorganisms such as bacteria and fungi, which may cause respiratory problems and other health problems in poultry (34). Also, low humidity levels cause dehydration and stress, and their effect is on egg production performance and reduced growth (35). In recent years, we have observed a growing interest in the use of artificial intelligence, including for humidity levels in poultry farms. Artificial intelligence has enabled the analysis of temperature and humidity data, as well as many other environmental factors, to identify patterns and make adjustments to ventilation systems and other tools (36). This has identified optimal humidity levels for improving bird health and productivity by using ventilation systems to maintain optimal humidity levels. One method of monitoring humidity in poultry farms is the use of sensors integrated with the litter. Excessive humidity increases bacterial growth and can lead to respiratory diseases and foot infections (37).

Benefits of artificial intelligence in poultry production

Artificial intelligence (AI) applications in poultry production offer numerous benefits in production and marketing (15). Prioritizing AI in poultry farm care is a key issue in the poultry industry, and AI has helped improve farm poultry management (38). Continuous monitoring of poultry using sensors and AI systems ensures early intervention in detecting sick animals and maintaining their health (39). This has helped AI systems increase poultry production efficiency and reduce labor requirements and operating costs. AI systems excel at optimizing resource utilization through predictive maintenance, intelligent management, and feed consumption (13). Several studies conducted in various countries have indicated a reduction in labor costs ranging from 15% to 25% (40).

Companionate care and a smart parenting environment

Artificial intelligence utilizes several technologies, including computer vision and acoustics, to analyze poultry behavior and environment in real time (13). Some technologies have even been able to analyze sounds and identify stress calls with 95% accuracy, enabling early intervention to improve bird welfare and treat illness as soon as it is detected (41).

Conclusion

Artificial Intelligence represents a transformative tool in the modern poultry sector, providing integrated solutions to improve production performance and reduce operational costs. By integrating computer vision, deep learning, thermal sensing, and the Internet of Things, these technologies enable real-time monitoring of bird behavior, early detection of disease and heat stress, and precise control of environmental conditions. These applications contribute to enhancing bird welfare and health, improving feed conversion efficiency, and reducing waste and resource consumption. Early warning systems also support biosecurity programs and reduce the need for antibiotics. Despite challenges related to economic feasibility, integration between systems, and data quality, artificial intelligence remains a promising tool for achieving sustainability in poultry production, provided that these challenges are overcome and its application is expanded on commercial farms.

Conflict of interest: NIL

Funding: NIL

Reference:

1- Melak, A., Aseged, T., & Shitaw, T. (2024). The influence of artificial intelligence technology on the management of livestock farms. International Journal of Distributed Sensor Networks, 2024(1), 8929748.

2- Natho, P., Boonying, S., Bonguleaum, P., Tantidontanet, N., & Chamuthai, L. (2025). An enhanced machine vision system for smart poultry farms using deep learning. *Smart Agricultural Technology*, *12*, 101083.

3- Caldwell, D. G. (Ed.). (2012). *Robotics and automation in the food industry: current and future technologies*. Elsevier.

4- Mitchell, M. A., & Kettlewell, P. J. (2009, May). Welfare of poultry during transport–a review. In *Poultry Welfare Symposium* (Vol. 1, No. 1, pp. 90-100). Cervia: Association Proceeding.

5- Goymann, W. (2005). Noninvasive monitoring of hormones in bird droppings: physiological validation, sampling, extraction, sex differences, and the influence of diet on hormone metabolite levels. *Annals of the New York Academy of Sciences*, *1046*(1), 35-53.

6- Vinueza-Naranjo, P. G., Nascimento-Silva, H. A., Rumipamba-Zambrano, R., Ruiz-Gomes, I., Rivas-Lalaleo, D., & Patil, N. J. (2021). IoT-Based smart agriculture and Poultry farms for environmental sustainability and development. In *Information and Knowledge in Internet of Things* (pp. 379-406). Cham: Springer International Publishing.

7- Taleb, H. M., Mahrose, K., Abdel-Halim, A. A., Kasem, H., Ramadan, G. S., Fouad, A. M., ... & Abd El-Hack, M. E. (2025). Using artificial

intelligence to improve poultry productivity–a review. *Annals of Animal Science*, *25*(1), 23-33.

8- Sindhu, S. (2024). AI-Driven Precision Livestock Farming: A Smart Framework for Sustainable Animal Health, Welfare, and Environmental Efficiency. *National Journal of Animal Health and Sustainable Livestock*, *2*(1), 26-32.

9- Fuentes-Peñailillo, F., Gutter, K., Vega, R., & Silva, G. C. (2024). Transformative technologies in digital agriculture: Leveraging Internet of Things, remote sensing, and artificial intelligence for smart crop management. *Journal of sensor and actuator networks*, *13*(4), 39.

10- Goyal, V., Yadav, A., & Mukherjee, R. (2024). A literature review on the role of internet of things, computer vision, and sound analysis in a smart poultry farm. *ACS Agricultural Science & Technology*, *4*(4), 368-388.

11- Shwetha, V., Maddodi, B. S., Laxmi, V., Kumar, A., & Shrivastava, S. (2024). Latest trend and challenges in machine learning–and deep learning–based computational techniques in poultry health and disease management: A review. *Journal of Computer Networks and Communications*, *2024*.

12- Rohan, A., Rafaq, M. S., Hasan, M. J., Asghar, F., Bashir, A. K., & Dottorini, T. (2024). Application of deep learning for livestock behaviour recognition: A systematic literature review. *Computers and Electronics in Agriculture*, *224*, 109115.

13- Natsir, M. H., Mahmudy, W. F., Tono, M., & Nuningtyas, Y. F. (2025). Advancements in artificial intelligence and machine learning for poultry farming: Applications, challenges, and future prospects. *Smart Agricultural Technology*, 101307.

14- Khanal, R., Choi, Y., & Lee, J. (2024). Transforming poultry farming: A pyramid vision transformer approach for accurate chicken counting in smart farm environments. *Sensors*, *24*(10), 2977.

15- Wu, Z., Willems, S., Liu, D., & Norton, T. (2025). How AI improves sustainable chicken farming: A literature review of welfare, economic, and environmental dimensions. *Agriculture*, *15*(19), 2028.

16- Astill, J., Dara, R. A., Fraser, E. D., Roberts, B., & Sharif, S. (2020). Smart poultry management: Smart sensors, big data, and the internet of things. *Computers and Electronics in Agriculture*, *170*, 105291.

17- Lara, L. J., & Rostagno, M. H. (2013). Impact of heat stress on poultry production. *Animals*, *3*(2), 356-369.

18- Paneru, B., Dhungana, A., Dahal, S., Ritz, C. W., Kim, W., Liu, T., & Chai, L. (2026). Computer vision models for precision poultry farming: A narrative review of behavioral and welfare monitoring studies. *Poultry Science*, 106887.

19- Pacheco, V. M., de Sousa, R. V., da Silva Rodrigues, A. V., de Souza Sardinha, E. J., & Martello, L. S. (2020). Thermal imaging combined with predictive machine learning based model for the development of thermal stress level classifiers. *Livestock science*, *241*, 104244.

20- Mangan, M., & Siwek, M. (2024). Strategies to combat heat stress in poultry production—A review. *Journal of Animal Physiology and Animal Nutrition*, *108*(3), 576-595.

21- Hernández-Sánchez, R. C., Martínez-Castañeda, F. E., Domínguez-Olvera, D. A., Trujillo-Ortega, M. E., Díaz-Sánchez, V. M., Sánchez-Ramírez, E., ... & Hernandez, E. (2024). Systematic review and meta-analysis of thermal stress assessment in poultry using infrared thermography in specific body areas. *Animals*, *14*(22), 3171.

22- Fan, W., Peng, H., & Yang, D. (2025). The application and challenges of advanced

detection technologies in poultry farming. *Poultry Science*, 105870.

23- Kalita, A. J., Subba, M., Adil, S., Wani, M. A., Beigh, Y. A., & Shafi, M. (2025). Application of artificial intelligence and machine learning in poultry disease detection and diagnosis: A review: AI and Machine learning in poultry disease diagnosis. *Letters In Animal Biology*, *5*(1), 01-06.

24- Brassó, L. D., Komlósi, I., & Várszegi, Z. (2025). Modern technologies for improving broiler production and welfare: a review. *Animals*, *15*(4), 493.

25- Zaman, M. R., Bappy, M. A. H., Hossain, M. M., & Hossain, M. S. (2025). Data-Efficient Deep Learning Framework for Real-Time Avian Pox Identification in Broiler Chickens Using Two-Stage Approach. *Smart Agricultural Technology*, 101246.

26- Kaviya, P., Sibi Siddharthan, S., Kishore, M., & Muthuram, M. (2023, December). A smartphone-based deep learning framework for detection and classification of poultry diseases from faecal images. In *International Conference on Cognitive Computing and Cyber Physical Systems* (pp. 229-240). Singapore: Springer Nature Singapore.

27- Babatunde, A. O., Oladipo, I. D., Ajagbe, S. A., Akanmu, M. A., Akinpelu, S. A., Bankale, M. I., ... & Mudali, P. (2025). Analysis of deep learning algorithm for predicting poultry diseases. *Discover Data*, *3*(1), 44.

28- Islam, A. K. M., Hassan, M. R., Uddin, M., & Rahman, M. S. (2025). Lightweight model for poultry disease detection from fecal images using multi-color space feature optimization and machine learning. *arXiv preprint arXiv:2507.10056*.

29- Bist, R. B., Wang, D., Chai, L., & Xiong, Y. (2026). Precision Farming Technologies for Monitoring Livestock and Poultry. *AgriEngineering*, *8*(2), 64.

30- Farag, M. R., & Alagawany, M. (2018). Physiological alterations of poultry to the high environmental temperature. *Journal of thermal biology*, *76*, 101-106.

31- He, P., Chen, Z., Yu, H., Hayat, K., He, Y., Pan, J., & Lin, H. (2022). Research progress in the early warning of chicken diseases by monitoring clinical symptoms. *Applied Sciences*, *12*(11), 5601.

32- Tattersall, G. J., & Cadena, V. (2010). Insights into animal temperature adaptations revealed through thermal imaging. *The Imaging Science Journal*, *58*(5), 261-268.

33- Jacob, F. G., Baracho, M. D. S., Nääs, I. D. A., Souza, R., & Salgado, D. D. A. (2016). The use of infrared thermography in the identification of pododermatitis in broilers. *Engenharia Agrícola*, *36*(2), 253-259.

34- Wang, K., Shen, D., Dai, P., & Li, C. (2023). Particulate matter in poultry house on poultry respiratory disease: a systematic review. *Poultry Science*, *102*(4), 102556.

35- Mavani, N. R., Ali, J. M., Othman, S., Hussain, M. A., Hashim, H., & Rahman, N. A. (2022). Application of artificial intelligence in food industry—a guideline. *Food Engineering Reviews*, *14*(1), 134-175.

36- Sohail, M., Sun, D. W., & Zhu, Z. (2018). Recent developments in intelligent packaging for enhancing food quality and safety. *Critical reviews in Food Science and Nutrition*, *58*(15), 2650-2662.

37- Rico-Contreras, J. O., Aguilar-Lasserre, A. A., Méndez-Contreras, J. M., López-Andrés, J. J., & Cid-Chama, G. (2017). Moisture content prediction in poultry litter using artificial intelligence techniques and Monte Carlo simulation to determine the economic yield from energy use. *Journal of Environmental Management*, *202*, 254-267.

38- Paneru, B., Dhungana, A., Dahal, S., & Chai, L. (2026). Artificial intelligence in precision

poultry farming: opportunities, challenges, and future features. *Animal Frontiers*, *16*(2), 41-50.

39- George, A. S., & George, A. H. (2023). Optimizing poultry production through advanced monitoring and control systems. *Partners Universal International Innovation Journal*, *1*(5), 77-97.

40- Neethirajan, S. (2023). Artificial intelligence and sensor technologies in dairy livestock export: charting a digital transformation. *Sensors*, *23*(16), 7045.

41- Manikandan, V., & Neethirajan, S. (2025). AI-driven bioacoustics in poultry farming: A critical systematic review on vocalization analysis for stress and disease detection. *Preprint*.