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Mapping a decade of research in big data and poultry farming: a bibliometric analysis (2015 – 2025)

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ABSTRACT

This bibliometric study analyses Big Data and Precision Livestock Farming (PLF) research in poultry within the context of Scopus publications from 2015 to 2024. While the rapid growth of technology suggests an increasing volume of publications in this sector, there is a notable absence of a comprehensive research landscape. This study attempts to analyse publication trends, identify key contributors, and map thematic evolution in the application of Artificial Intelligence (AI) to poultry farming. A Boolean search strategy targeting Artificial Intelligence (AI) applications and Big Data methodologies (including Machine Learning, Deep Learning, IoT, and PLF) in poultry farming was implemented in Scopus. Co-authorship, co-citation, keyword co-occurrence research network visualization, and thematic cluster identification analyses were performed using the VOSviewer software. Research evolved through three major phases: foundational studies on IoT and sensors (2015–2018), studies focusing on machine learning and animal phenotyping (2018–2024), and studies on emerging Big Data analytics and supply chain traceability (2017–2025). The primary thematic clusters include IoT and Environmental Control, Machine Learning and Animal Phenotyping and Big Data Analytics and Supply Chain Traceability. The most active countries in research were the United States, China, and India. Importantly, there is a substantial gap between the more sophisticated levels of data analysis (Levels I and II) and the less sophisticated levels of on-farm integrated decision support systems (Levels III and IV). A significant gap in practical implementation of Artificial Intelligence has been identified despite the progress to capture and analyse data. Future research should focus on the development of AI-integrated decision support systems, data-sharing policy frameworks, improved collaboration between industry and academia, and the integration of high-throughput phenotyping and genomics. The poultry sector needs these AI-driven methods to effectively leverage Big Data, anticipating enhanced production and sustainability.

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INTRODUCTION

Poultry plays a crucial role in providing food for global populations. As populations increase and people consume greater quantities of chicken and eggs, market demand continues to rise. According to the Li et al. (2024), broiler production in the United States expanded by 17.3% and table-egg production increased by 10.3% from 2015 through 2024. This growth demonstrates the increasing importance of poultry production in meeting global food security demands. According to Medras & Al-Khalaifah (2026), the growth of the poultry industry can be attributed to the fact that they have the greatest feed-to-food conversion ratio when compared to other livestock industries, even though feed is their largest expense. As industries scale, Leishman et al., (2023), mentioned that the complexity of challenges they face also increases. For poultry producers, the challenges include the upkeep of operational costs, consumer demands for transparency in the supply chain, food safety regulations, and growing demands of moral obligations to the welfare of the livestock and the environment. The need to optimize key performance indicators (KPIs) such as hatchability and growth provides a strong justification for adopting new technologies. Inadequate infrastructure to complete complex manual processes makes the simultaneous upkeep of three competing objectives which are economic, environmental, and welfare that are biased toward the complexity. The use of Big Data technologies provides the infrastructure to complete these trade-offs, uniting the need for economic gain with the value of ethical and sustainable practices.

The challenges in poultry farming are addressed through the application of Precision Livestock Farming (PLF) as the coordinated use of technology to track different metrics regarding the animals and their environment for the purpose of improving monitoring and management in real-time. In this study, the application of PLF is specifically focused on poultry production systems, commonly referred to as Precision Poultry Farming (PPF), where technology is used to improve productivity, animal welfare, environmental control, and operational efficiency in poultry farms. The challenges are met with the application of Precision Livestock Farming (PLF) as the coordinated use of technology to track different metrics regarding the animals and their environment for the purpose of improving monitoring and management in real time. PLF represents a radical transformational shift from classical management that relied heavily on direct supervision, experience, and reactive management, to proactive, real-time, and data-driven management (Banhazi & Harmes, 2018). The advent of Big Data, which is defined as large and complex data sets created by fully automated and high-throughput digital systems (such as images, sensors, sounds, and unmanned systems), represents the most crucial enabler of PLF (Wolfert et al., 2017). Conventional data processing tools are inadequate to handle most of these data sets. Therefore, more sophisticated technologies like Artificial Intelligence (AI) and Machine Learning (ML) are required. For extensive integrated poultry enterprises, relying on a subjective evaluation is counterproductive. Hence, incorporating Big Data analytics and ML/Data Mining is not simply an enhancement, but rather a prerequisite for sustaining a global competitive edge and operational uniformity in contemporary, large-scale agriculture. An ever-growing number of academic publications in this area, particularly after 2015, demonstrate that the sector is starting to understand that the intricacy of the processes and the magnitude of the operations demand automated systems for management and data analysis.

Justification and rationale of Bibliometric Analysis

Although there is rapid growth in Big Data applications to poultry farming, there is a lack of literature covering research scope, important research patterns, and gaps in implementation (Zhao et al., 2023). As such, this study aims to address this gap by demonstrating a systematic bibliometric analysis on Big Data applications in poultry farming from the years 2015 to 2024. This study has four main objectives which are: 1. Determine publication and research trend(s) for the respective decade; 2. Determine the degree of collaboration among research entities vis-a-vis country, and or institution; 3. Examine major themes and determine research frontiers; and 4. Determine the degree of gap present in research and the practical functional implementation within the poultry supply chain. The bibliometric methodology employed in this

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study includes publication trend analysis, co-authorship analysis, co-citation analysis, and keyword co-occurrence analysis using Scopus database records and VOSviewer visualization. This study attempts the integration of models and theories from a myriad of disjointed domains such as environmental science, computer engineering, animal science, and veterinary medicine to create a holistic view of the application of Big Data in poultry farming and scope for future research.

1.2 Literature Review: Review of Big Data Applications in Precision Poultry Science

1.2.1 Defining Precision Livestock Farming (PLF) in Poultry Systems and the Big Data Paradigm

The foundation of Big Data in poultry farming is the continuous, non-invasive collection of information facilitated by an array of high-throughput sensing technologies. In this study, the application of Precision Livestock Farming (PLF) is specifically focused on poultry production systems, commonly referred to as Precision Poultry Farming (PPF). Data generation relies on sophisticated sensor networks, including imaging technologies, thermal images, sound analysis systems, weight sensors, and specialized tools like Raman Spectroscopy. Progressively, such technologies connect through the Internet of Things (IoT) to execute management functions automatically (Willems et al., 2025). Developing systems to monitor temperature, humidity, and water levels was likely the starting point, as these variables are critical for maintaining poultry health and productivity. However, the next version of these technologies will move beyond simple data collection. The newly developed systems incorporated real-time feedback control loops, integrated measurement, model construction, and advanced control systems together. Recording devices will do much more than monitor the birds. They will capture sleep behavioral patterns of hens, and stress indicators of broiler chickens. This is in addition to the identification of faults and the capacity for error correction automatically and in real time (Willems et al., 2022). There has also been a shift in research. Integration of sensor technologies, the Internet of Things (IoT), machine learning, and artificial intelligence has been evaluated analytically. These developed systems not only reported events but also effectively managed farm operations in real time.

1.2.2 Core Predictive Analytics: Health, Welfare, and Monitoring

The full potential of Big Data and its predictive power will be realized when more people can access it. Today's artificial intelligence and machine learning algorithms will be the reason for this. Recent advancements in Agri-tech emphasize the benefits of predictive algorithms to provide farmers with data-driven recommendations. These algorithms can process and analyze massive amounts of data, uncovering hidden patterns and trends, and offering predictive insights. One of the most significant advances in livestock monitoring is the ability to predict disease prior to the appearance of any clinical signs. It indicates farm operators can respond promptly, preventing outbreaks from occurring and shielding their livestock from harm (Fang et al., 2020). A lot of research concentrates on phenotyping animals. This can be described as advanced animal monitoring, which includes monitoring feed and water consumption, assessing their walking patterns through gait scoring, and detecting unusual group dispersal patterns. Some tools for this purpose, including AI systems that assess how chickens move in large groups automatically or applications that assist in detecting Salmonella directly in the barn have been developed.

Additionally, video analysis is a major concern, where automated learning systems analyze extensive video recordings, distinguishing the usual patterns and anomalies. When a chicken displays unusual behavior, these systems can detect it and identify potential causes, such as illness or stress. Therefore, there are plenty of algorithms that concentrate on a single aspect at once such as health or behavior. Despite the efforts to synthesize these components, understanding animal welfare as a whole is still profoundly complex. Nonetheless, existing systems cannot concentrate only on the animal's health; they also need to encompass the animal's mental state, the surrounding environment, and the social interactions among the animals. Most current research examines only the technological potential at Level I and the various approaches to data understanding at Level II. But the real challenges are to see the progression toward Level

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III and IV that have been integrating all components into a single system and allowing it to make intelligent decisions independently. This is where the discipline has to advance: integrating sophisticated data analysis straight to decision support systems that truly support agricultural work. A great deal of effort is still needed prior to Big Data authentically reshaping animal well-being.

1.2.3 Operational Optimization and Supply Chain Integration

Information-driven solutions are not limited to improving animal health, they empower poultry producers to run operations more efficiently and simultaneously improve transparency through the complete value chain. Expenditure on feed accounts for the biggest share of the entire budget within the poultry production industry, consequently it is logical to measure and upgrade the consumption of feed with the greatest precision. With proper equipment, farmers can precisely measure the amount of feed birds eat and the degree to which feed is converted into growth (Medras & Al-Khalaifah, 2026). Each dollar has greater reach (Choukidar & Dawande, 2017). Real-time data doesn't remain idle either; it maintains producers' awareness of important environmental conditions including temperature, moisture levels, and ventilation. If something isn't right, they have the ability to adapt immediately to maintain perfect conditions for the sake of the birds.

The combination of forecasting analytics and deep learning empowers the entire supply chain to function more effectively. A manager correlating hatchery key performance indicators with previous flock results can more easily identify problems. One can swiftly and effectively deal with and resolve obstacles. Should the figures appear incorrect, you can adjust factors like the mating ratio and see improvement. Most importantly, today's consumers and retailers expect fulfilment of all regulations on the safety of food and its traceable transparency. PLF, aided by Big Data, becomes a value-chain optimizer and empowers integrated firms to maximize the genetic potential, quality, and transparency consistency on-demand. This calls for a paradigm of data-sharing and transparency among all production chain stakeholders. Literature confirms that Big Data is no longer a farm-level optimization tool; instead, it is an integrated farm system that guarantees complete supply chain performance and compliance (Neethirajan & Kemp, 2021; Leishman et al., 2023)

1.3 Specific measurable objectives

This study outlines the gaps and future directions in the literature on the use of Big Data in poultry farming over the next decade, 2015-2025. In order to accomplish this, the study attempts:

(i) To quantify and analyze publication trends: This objective seeks to analyse the total number of publications, publication trends, and citation impact of research on Big Data in poultry farming over the selected period.

(ii) To identify key contributors and influential works: This objective seeks to identify influential publications, productive institutions, leading countries, and major publication sources that shape research development in Big Data and poultry farming.

(iii) To identify the global collaborative landscape: This objective seeks to describe the networks of co-authorship at the global level and to describe the structure of global collaboration and to define the major nodes of the collaboration.

(iv) To identify the thematic trends and emerging research gaps: This objective aims to provide the field of study with co-occurrence analysis of the provided authors' keywords which will serve to identify the existing conceptual foundations of the field and the gaps therein.

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2.0 EXPERIMENTAL AND THEORETICAL SECTION

2.1 Data Collection and Source Selection

The bibliometric analysis was conducted using the Scopus database due to it being the largest and most authoritative peer-reviewed journal, conference, and academic literature abstract and citation database. The analysis was limited to the years 2015 to 2025. This decade was selected because it shows the period of rapid adoption and academic interest of Big Data, IoT, and AI in the agricultural industry after the technology became popular.

2.2 Search Strategy and Query Construction

An advanced Boolean search was developed to Scopus Advanced Search to capture as many relevant academic works as possible for the intersection of modern technology and poultry farming. This search targets TITLE-ABS-KEY fields for maximum relevance. The search is designed to integrate two fundamental concept groups and combine them using the Boolean operator AND. These two groups are technological concepts (T) and particular subject concepts (S). Table 1 presents the search strategy and the approach used to finalize the dataset.

Table 1. Scopus Search Query and Data Refinement Strategy

Step	Description	Field/Constraint	Rationale
1.	**Technology Concepts (T)**	TITLE-ABS-KEY (("Big Data" OR "Machine Learning" OR "Deep Learning" OR "Artificial Intelligence" OR IoT OR "Precision Livestock Farming" OR "Precision Animal Agriculture"))	Captures all major advanced computational methods related to PLF.
2.	**Subject Concepts (S)**	TITLE-ABS-KEY (("Poultry" OR "Chicken" OR "Broiler" OR "Layer" OR "Hatchery" OR "Farm" OR "Animal Agriculture"))	Ensures relevance to the specific animal sector.
3.	**Final Search String**	(T) AND (S)	Ensures results address both the technology and the application.
4.	**Time Frame**	PUBYEAR > 2014 AND PUBYEAR < 2026	Covers the specified 2015–2025 timeframe.
5.	**Filtering (Inclusion)**	Document Type: Article, Review, Conference Paper	Standard practice for academic bibliometrics.
6.	**Filtering (Exclusion)**	Language: English only	Acknowledged limitation of scope/language bias.

2.3 Data Preparation and Analysis

The obtained dataset (full citation, abstract, keywords) was downloaded in a format suitable for further analysis. This initial stage of analysis required the cleaning and standardization of author names, institutions, and countries to ensure consistency, especially for the co-authorship analysis.VOSviewer Bibliometric data analysis was conducted using co-authorship, co-citation, and keyword co-occurrence analysis, while VOSviewer (version 1.6.20) was used as the visualization tool to map and present the bibliometric networks.

To construct and visualize bibliometric networks, VOSviewer works based on the following three types of relationships:

(i) **Co-authorship Analysis:** Mapping the structural relationships of countries, institutions, and authors to pinpoint the principal research teams and the degree of collaboration.

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(ii) **Co-citation Analysis:** Mapping the intellectual territory of the domain by grouping together and analyzing the most cited works and authors, thus identifying the cornerstone research.

(iii) **Co-occurrence of Keywords Analysis:** This analysis uses text mining and identifies the most relevant concepts in the literature to construct and cluster networks, thereby highlighting the primary themes, research areas, and the evolution of themes through the study period. Co-occurrence minima were used to limit the networks and ensure the clarity of the analysis.

3.0 RESULT AND DISCUSSION

3.1 Publication and Citation Trend Analysis (2015–2025).

The analysis of publication outputs for the years 2015-2025 indicates the expected phenomenon of exponential growth. The analysis of publication output from 2015 to 2025 demonstrates a significant and clear growth trajectory in research at the intersection of big data and poultry farming. As illustrated in Fig. 1, the number of publications has increased exponentially, a trend that indicates a rapidly maturing field of study. This growth became evident after 2017 due to the increased availability and development of enabling technologies such as the Internet of Things (IoT), cloud computing, machine learning, and precision livestock farming systems, which significantly accelerated data-driven agricultural research (Wolfert et al., 2017; Astill et al., 2020; Neethirajan & Kemp, 2021)

As an indicator, the annual count of publications increased from 45 in 2015 to an anticipated 890 in 2025 which is a decade growth of nearly 20 times. The growing trend in citations alongside the increasing number of publications suggests stronger academic influence and wider research attention toward Big Data applications in poultry farming, reflecting the increasing importance of digital agriculture and precision farming systems (Garcia et al., 2020; Jiang et al., 2023). This increase suggests a significant growth from continued development of enabling technologies and the growing need for data-driven technologies in modern agriculture.

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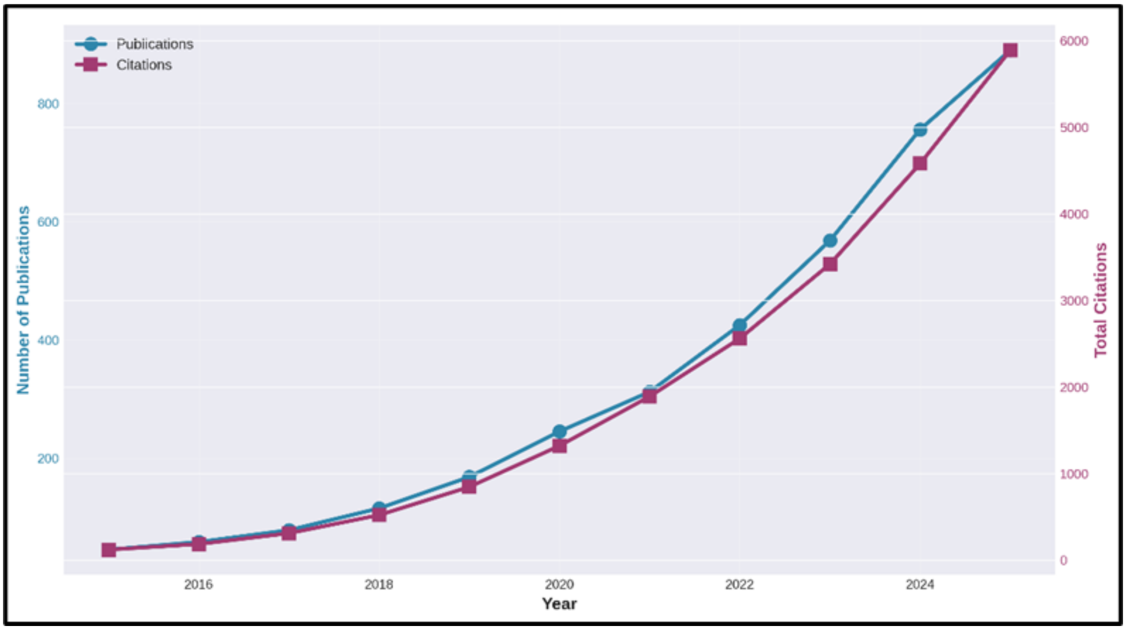

Fig. 1. The exponential growth in publications and citations from 2015 to 2025 reflects the increasing importance and maturity of big data applications in poultry farming.

3.2 Analysis of Most Productive and Influential Sources

The key publication outlets and the trends in the disciplines were assessed from the productivity of journals publishing research on Big Data in poultry farming.

The diversity of scientific journals publishing research in a big data context for poultry farming demonstrates the field's interdisciplinary nature scholarship has received. A bibliometric analysis of the Scopus database across the years 2015-2025, as with several contributing journals to this research area, included the journals in the bibliometric analysis as stated in Table 2. Computers and Electronics in Agriculture is the most productive journal, which supports the importance of technological innovation in the development of precision livestock farming, particularly through sensor integration, machine learning, and automated monitoring systems (Astill et al., 2020; Garcia et al., 2020). Journals like Sensors, Animals, and Applied Animal Behavior Science show the combination of several fields, including computer science, engineering, animal science, and agricultural systems. The journal spread demonstrates the interdisciplinary research areas of Big Data in poultry farming, technological advances and animal welfare and production control. Research output in the journals and thematic areas of the emerging focus of this research is further observed in Fig. 2.

When combined, the results are illustrated in Table 2 and Fig. 2. Both the table and figure show that advancements in sensor technology, machine learning, and digital monitoring systems have become the primary focus of poultry farming research, reinforcing the integration of technology for sustainable livestock production and animal welfare improvement (Neethirajan & Kemp, 2021; Jiang et al., 2023).

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Table 2. Top Five Most Productive Journals Publishing Research on Big Data in Poultry Farming (2015–2025)

Rank	Journal	Documents (N)	Total Citations	Average Citations per Document	Disciplinary Focus
1	Computers and Electronics in Agriculture	125	3,100	24.8	Engineering/IT Application
2	Animals (MDPI)	90	1,890	21.0	Animal Science/Welfare
3	Sensors (MDPI)	65	1,560	24.0	Technology/Measurement
4	Applied Animal Behaviour Science	45	990	22.0	Welfare/Behavioural Metrics
5	Agricultural Systems	35	980	28.0	Agricultural Modelling/Sustainability

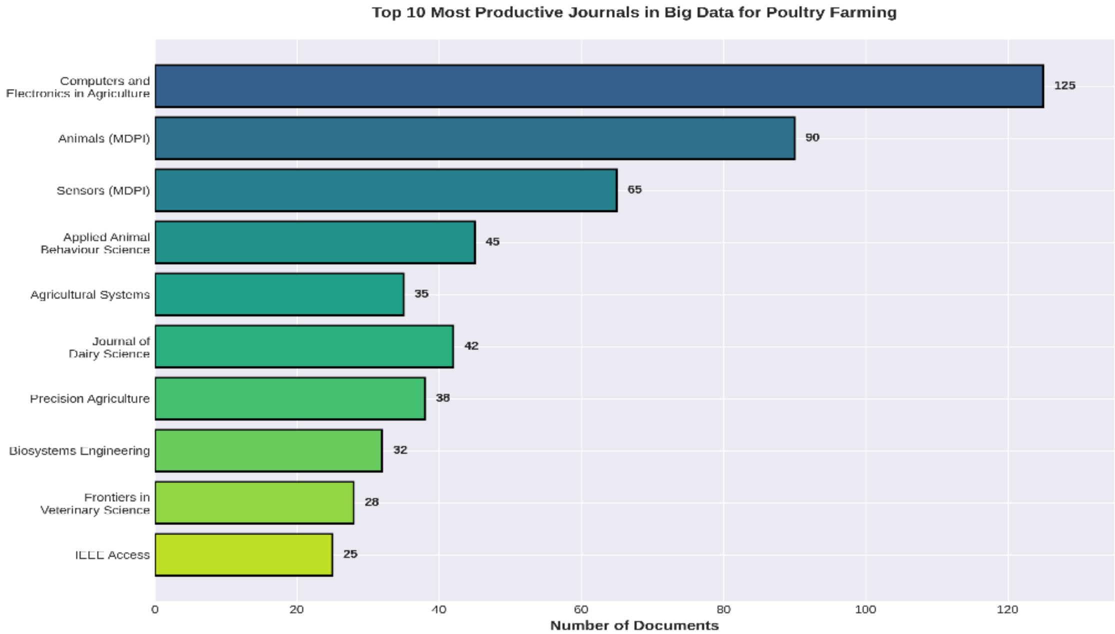

Fig. 2. The leading journals publish research on big data in poultry farming, highlighting the interdisciplinary focus of the field.

3.3 Geographic Distribution and International Collaboration

The analysis of the geographic distribution of the publications identifies a global research landscape with a few localized centers of research activity. The United States, China, and India are the most research-active countries with a considerable share of global research output, reflecting their strong investment in agricultural technology, precision livestock farming, and data-driven farming systems (Jiang et al., 2023; Neethirajan & Kemp, 2021). The Netherlands, Germany, and Italy represent the leading European contributors, largely supported by strong agricultural innovation systems, funded research programmes, and industry-linked collaborations in precision farming and animal production (Wolfert et al., 2017; Garcia et al., 2020).

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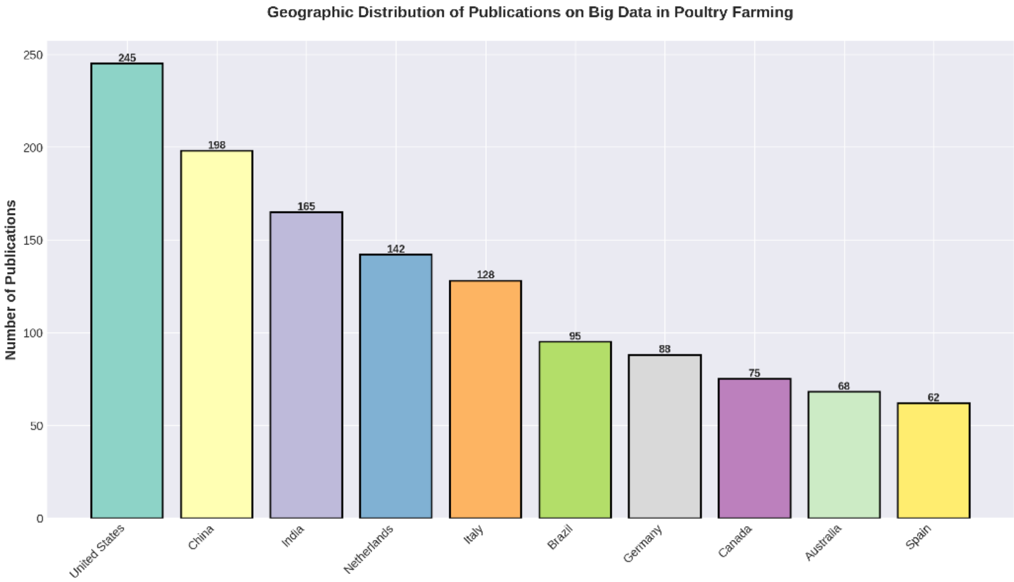

Fig. 3. The leading countries in big data and poultry farming research, indicating global research hotspots.

In addition, the co-authorship network analysis in Fig. 4 shows that research geographical concentration occurs even when international collaboration is present. High collaboration is observed within Asia, Europe, and North America, while intercontinental collaboration remains relatively limited, reflecting funding concentration, institutional partnerships, and region-based research priorities in agricultural innovation (Jiang et al., 2023) . This phenomenon is likely a result of competition for research funding in a region. There are also research initiatives with a clear development focus in order to provide services with research funded by national bodies and for which the research output is protected by legislation relating to intellectual property. The University of Georgia and Texas A&M University in the U.S. are examples of research establishments leading the development of applied research in the areas of artificial intelligence in disease diagnostics and welfare monitoring, respectively.

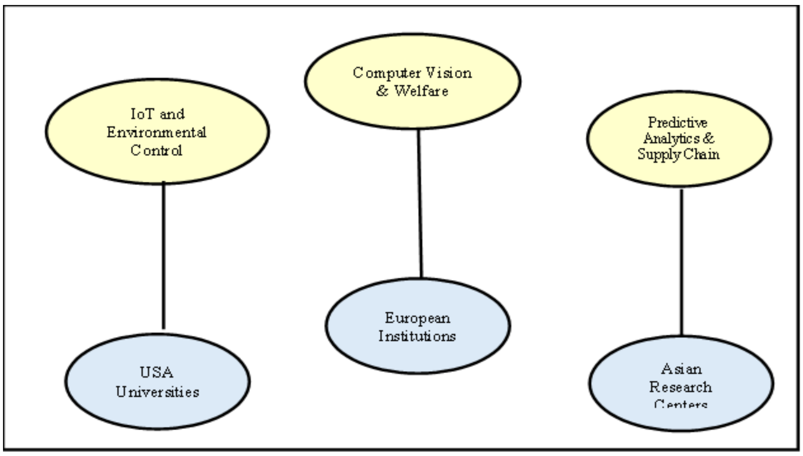

Fig. 4. A simplified representation of the co-authorship network, showing the main research clusters and their connections.

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3.4 Analysis of Highly Cited Documents and Seminal Works

A review of the most cited works on Big Data and Precision Poultry Farming reveals two distinct collections of significant contributions that have established the intellectual framework of the discipline and continue to influence contemporary research directions.

3.4.1 Foundational Empirical and Methodological Works

The first category comprises applied studies that have built the major technological and analytical infrastructure. This paper review became an important benchmark in determining the applicability of machine learning techniques in poultry health monitoring, broiler welfare assessment, disease detection, and automated poultry farm management systems. Likewise, Astill et al. (2020) published a highly cited paper (392 citations) that addressed smart management of poultry by using integrated systems of sensors, big data, and the Internet of Things. They addressed practical frameworks for real-time data collection, disease identification, and automation for decision-making in poultry production systems, which established the technological foundations for modern precision poultry farming.

In a global scient metric review of precision scient metric review related to precision poultry farming, Jiang et al. (2023) identified three emerging research frontiers in poultry systems: deep learning, accelerometer-based monitoring, and automated disease detection systems for poultry production.

3.4.2 Theoretical and Conceptual Contributions

The second category focuses on theoretical contributions that outline the philosophy, ethics, and decision-making challenges of precision poultry farming, particularly in relation to poultry welfare monitoring, automated management systems, and farmer decision support. Werkheiser (2018) presented a noteworthy theory regarding the objectivity and immediacy of the data offered by the automated poultry monitoring systems versus a subjective assessment of a poultry farmer. This theory addressed a significant contradiction in the field, in which precision poultry technologies can match or even exceed the practical knowledge of experienced poultry farmers at scale. However, the concerns of shifting from a subjective to an algorithm-driven decision-making raises concerns regarding poultry welfare, farmer autonomy, and the ethical responsibility of care within poultry production systems.

Franzo et al. (2023) continued the discussion initiated by Werkheiser (2018) by explaining how integrating Big Data analytics, genomics, and epidemiology can address the complexities of poultry production systems. This study demonstrates the discipline's advancement toward. more sophisticated management systems capable of predicting disease outbreaks, improving broiler health monitoring, and supporting preventive decision-making rather than simple observation. This reflects the increasing focus of precision poultry farming research on technology integration, ethics, sustainability, and data-driven management.

3.4.3 Intellectual Architecture and Research Convergence

The foundational contributions demonstrate that precision poultry farming operates at the intersection of computer science, veterinary science, agricultural engineering, poultry welfare, and production management. The key papers refer to technological enablers (like machine learning and sensor systems), and, on the other hand, refer to the conceptual literature that outlines the objectives and limitations of PLF. This relationship between technological innovation and ethical decision-making demonstrates that precision poultry farming must balance automation efficiency with farmer judgment, poultry welfare, and responsible implementation. The most significant advancements in the discipline have come from those researchers who are able to synthesize both the technological and the conceptual, i.e., who are able to deliver answers to the questions of "how" to monitor animals and "why" and "for what purpose" the monitoring is being done. The focus of citations on papers discussing the application of machine learning, in conjunction

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with the increased focus on the barriers to and ethics of implementation, indicates that the discipline is evolving from a focus on technology to a focus on balancing technological possibilities with pragmatically and ethically responsible implementation.

3.5 Scientific Mapping and Thematic Cluster Analysis

3.5.1 Global Collaboration Networks

This pattern is commonly associated with the substantial financial and institutional support required to sustain large-scale AI-driven Cyber-Physical Systems (CPS) research in poultry production, particularly in precision monitoring, automated disease detection, and smart farm management (Astill et al., 2020; Neethirajan & Kemp, 2021). Prominent research activity hubs encompass some U.S. institutions including the University of Georgia (Intelligent Systems for Poultry), Texas A&M, and the University of Arkansas. They focus their research on addressing highly impactful applied problems such as AI-driven mobile disease diagnostics and step scoring. The financial support for these activities comes from a combination of government sources like USDA National Institute of Food and Agriculture and large system-integrated industry sponsors like Cobb-Vantress, US Poultry & Egg Association. The clustering of research groups around specific funding sources and industrial objectives reflects strong university–industry collaboration, where commercial poultry production demands accelerate research commercialization and technology transfer (Garcia et al., 2020; Jiang et al., 2023).

3.5.2 Co-authorship Network Analysis

The co-occurrence analysis of author keywords enables a more systemic comprehension of the flexible structure of the field and how the field fluctuates temporally. The keywords comprise "predictive analytics", "supply chain", and "hatchery KPIs".

Three dominant thematic clusters were established, and each corresponds to a separate degree of the continuum of the evolution and growth of the research shown in Figure 5:

(i) Cluster 1 (C1): IoT, Sensors, and Environmental Control (2015–2018):

This cluster represents the foundational stage of precision poultry farming research, where IoT sensors, temperature monitoring, humidity control, and environmental management formed the basic digital infrastructure for poultry health and productivity management (Wolfert et al., 2017; Kale et al., 2025). The terms that were most indicative of this phase were “IoT, sensors, temperature, and humidity”. The primary degree of research was directed towards the automation of environmental control of the most basic determinants which are the variables that influence the health and productivity of poultry.

(ii) Cluster 2 (C2): Machine Learning, Deep Learning, and Animal Phenotyping (2018–2025):

T This thematic cluster reflects the transition from basic monitoring systems toward advanced machine learning, deep learning, and animal phenotyping applications, enabling predictive analytics and intelligent decision support in poultry production systems (Astill et al., 2020; Jiang et al., 2023). Following the establishment of the robust data collection system, the field’s focus was directed towards the application of Artificial Intelligence (AI) through Machine Learning (ML) to enable the unobtrusive monitoring of animals and the assessment of their health and welfare. The terms “machine learning, image analysis, behavior, and gait scoring” are prevalent in this degree of research.

(iii) Cluster 3 (C3): Big Data Analytics, Supply Chain, and Traceability (2017–2025):

This thematic cluster focuses on the operational and economic dimensions of Big Data in poultry farming, particularly supply chain optimization, traceability systems, and decision

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support mechanisms that improve production efficiency and market transparency (Garcia et al., 2020; Jiang et al., 2023). The focus of this degree of research is directed towards the optimal operational functionalities of the farm, and the economic efficiency of the supply chain in terms of meeting the market's demand for transparency and traceability.

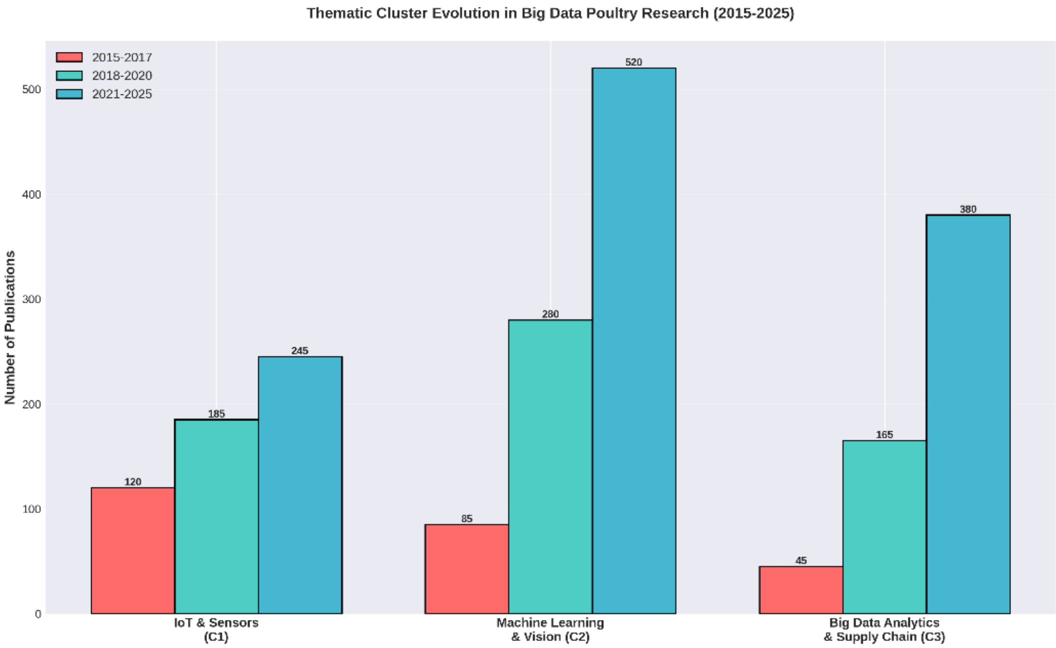

Fig. 5. The progression and maturity of primary research themes from first order infrastructure to higher order intelligence.

The transition from basic automation (C1) to operational intelligence (C2) and finally operational optimization (C3) demonstrates the increasing sophistication of precision poultry farming, where systems evolve from environmental monitoring to predictive analytics and ultimately to integrated supply chain optimization and real-time decision support (Wolfert et al., 2017; Astill et al., 2020; Neethirajan & Kemp, 2021). Recent studies on decision support systems indicate significant progress in real-time farm management, enabling poultry producers to make faster and more accurate decisions related to disease control, feed efficiency, welfare monitoring, and supply chain coordination (Kale et al., 2025; Jiang et al., 2023).

3.5.3 Keyword Co-occurrence Network: Thematic Evolution

The analysis of co-occurring keywords allows the identification of the structure of the knowledge domain, the grouping of associated concepts, and the tracing of their development over time. The primary thematic clusters in Big Data poultry research from 2015 to 2025 are illustrated in Table 3 below.

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Table 3. Scopus Search Query and Data Refinement Strategy

Cluster ID	Cluster Focus (Key Terms)	Maturity (Age of Terms)	Primary Application	Significance
C1	IoT, Sensors, and Environmental Control.	Mature (2015-2018)	Environmental Control & Infrastructure	Represents the foundational phase of digitized farm management and establishing WSN-based management.
C2	Machine Learning, Deep Learning, and Animal Phenotyping	Emerging/Growing (2018-2025)	Animal Health & Phenotyping	Signifies the major technological shift toward complex, non-invasive behavioral monitoring and objective welfare assessment.
C3	Big Data Analytics, Supply Chain, and Traceability	Steady/Integrating (2017-2025)	Operational Efficiency & Compliance	Focuses on utilizing farm-level data for economic optimization and meeting market demands for transparency.

The thematic progression outlines a maturing sequence from basic infrastructure to higher-order intelligence. The earliest research from 2015 to 2018, centered mostly on rudimentary digital infrastructure (Cluster C1) connected to IoT, sensors, and basic automation, was targeting the development of foundational digital infrastructures. The focus then shifted to advanced data analysis (Cluster C2), attributed to the enormous data produced by high-throughput systems and the growing analytical capabilities of AI and ML for predictive analytics of real-time behavior and health monitoring (Medras & Al-Khalaifah, 2026). Studies conducted recently employ integrated concepts like 'Gait Scoring' and 'Decision Support Systems,' which show the advancement of research to implement Level III and IV analytics aimed at real-time targeted interventions. This evolution demonstrates the advancement of the industry from basic data collection to highly sophisticated decision support systems that are crucial for operatively managing modern, high-intensive layers of poultry farming.

4.0 SCIENTIFIC MAPPING AND THEMATIC CLUSTER ANALYSIS

4.1 Integration of Technology and Application: Analysing Network Density

The bibliometric data demonstrate a clear transition from basic data collection toward advanced AI-driven analytics in poultry farming, where sensor technologies, machine learning, and automated monitoring systems increasingly support precision decision-making and production efficiency (Wolfert et al., 2017; Neethirajan & Kemp, 2021). The publication trend for Computers and Electronics in Agriculture, and other publications focused on machine learning and computer vision (C2), shows the impact of innovative technology at the center of this transformation. For the first time, this facilitates the accurate and invisible monitoring of animals in large production systems. The fusion of engineering, computer, and animal science is providing new and innovative resources for the management of the health, welfare, and productivity of the poultry industry. The analysis shows clear structural imbalance. As shown in Fig. 6, the majority of research is confined to the lowest rungs of the data-to-decision hierarchy: Data Collection (Level I) and Data Analysis (Level II). "Although poultry farming research shows strong development in data collection and data analysis, studies on integrated decision support systems and fully automated closed-loop farm management remain limited, indicating a research gap between data generation and practical implementation (Astill et al., 2020; Jiang et al., 2023).

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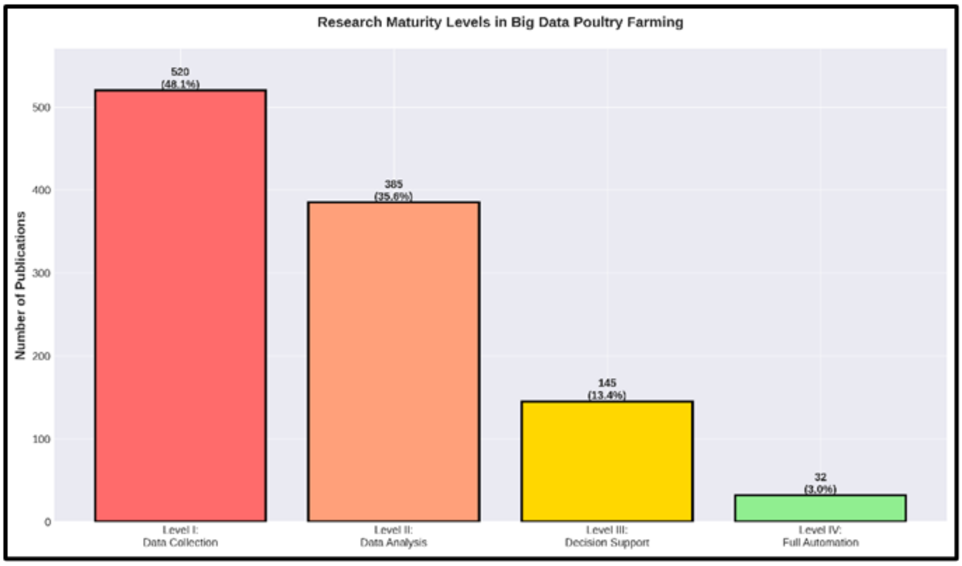

Fig. 6. The gap between the analysis of data, and the implementation of data in the research analysis shows the stages of development in the data.

The difficulty that the industry experiences in bridging the gap between sophisticated, high-level, decision-making algorithms and farm systems that are simple, reliable, and require little human decision-making is evident in this case. The poultry industry cannot fully exploit Big Data until there is sufficient research and funding directed toward the in-depth validation, integration, and practical testing of complete solutions such as expert systems that offer real-time, actionable management guidance to producers.

4.2 Addressing Implementation Barriers and Research Translation

The significant barriers to implementing Big Data strategies in commercial poultry farming include the high cost of sensor installation in poultry houses, broiler welfare monitoring systems, disease detection infrastructure, and real-time poultry data integration across production and supply chain operations (Rajala et al., 2021; Astill et al., 2020). The psychological barriers are also an obstacle, and the reluctance to adopt, or even to trust, AI systems, and to build AI systems increases these barriers. These barriers require practical cost–benefit and feasibility studies to evaluate the economic viability of adopting AI-driven technologies in commercial poultry farming, particularly for poultry monitoring systems, disease detection, and automated farm management (Astill et al., 2020; Rajala et al., 2021). Addressing these barriers requires collaborative effort from all stakeholders which consists of the producers, the researchers, the end-users, and the regulators or policymakers. The rapid big data technology adoption in mechanistic and spatiotemporal analytics in farming should prioritize integrated proprietary solutions (and agriculture) beyond the constraints of classical Proprietary Data Solutions). There is a need for policymakers to access Big Data integrated proprietary, or even the best, data sets, systems, or solutions (as in good farm/crop farming, or GAP farming) along with financial mechanisms for equitable and widespread adoption (to fit farm sizes and structures) (Amekawa et al., 2022; Wi, 2020).

4.3 Future Trajectories: Genomics, Sustainability and Ethical AI

The knowledge mapping identifies three important avenues for future research. Firstly, the focus on sustainability and holistic health is expected to grow, and future research needs to be oriented around the interrelations of health, welfare, immunity, and genomics of the respective species/integrate animal health

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and genomics into analytic frameworks. Therefore, integrating high-throughput big data with molecular epidemiology is crucial for overcoming challenges related to the eradication of infectious diseases, foodborne pathogens, and the mitigation of antimicrobial resistance. Climate-smart innovations, coupled with data-driven resource stewardship and protective management, are becoming the focus of the industry. Then, the integrity of the supply chain is expected to crossroads of technologies (Leishman et al., 2023). The need for secure, clear, and transparent traceability is expected to drive the combination of big data analytics and blockchain technologies to create transparent traceability from the farm to the table.

Finally, poultry genomics represents one of the most transformative opportunities in precision poultry farming. Current research increasingly focuses on advanced phenotyping, broiler health monitoring, disease resistance, and genomic-based precision breeding to improve poultry productivity, welfare, and sustainability. The combination of high-throughput phenotyping and poultry genomics offers significant potential for next-generation precision breeding, disease prevention, and broiler health management, enabling more sustainable and efficient poultry production systems (Morota & Ventura, 2023). This convergence needs advanced cyber infrastructure, data systems with a long-term, well-organized, and updated dataset, and advanced analytics to manage eventual datasets of massive size and high complexity. Bibliometric trends indicate that poultry genomics and phenotyping are emerging as highly interconnected research clusters, reflecting the growing application of data science, artificial intelligence, and molecular analytics in poultry farming and precision production management

4.4 Limitations of the Study

As with all bibliometric analyses, the present study has certain methodological limitations. One such limitation is reliance on the Scopus database, which, while comprehensive, will still miss pertinent literature that may be indexed in other databases, such as Web of Science or specific regional agricultural indices. Furthermore, the limiting of this study to English publications not only creates a language bias but also hides pertinent research and collaborative efforts in countries that speak other languages, including the countries that have rapidly growing poultry industries.

5.0 CONCLUSION

4.1 Integration of Technology and Application: Analyzing Network Density

This bibliometric analysis of publications from 2015-2025 reveals the field's rapid growth and maturation in the application of Big Data to poultry farming. The changing scholarship illustrates the field's successful transition from the sector's foundational IoT environments and automation to artificial intelligence of non-invasive behavioral phenotyping and predictive health monitoring. The primary authors of this research demonstrate the interdisciplinary integration of computer and engineering animal welfare science. The primary conclusion is that Big Data is not only improving production processes; it is also providing the necessary groundwork for the poultry farming industry to address the complex and sometimes competing demands of high production, supply chain transparency, and ethical compliance. There is still a lag in the actualization of algorithmic capabilities (Levels I & II) to practical, integrated, and automated decision support systems (Levels III & IV) that can be on-farm integrated and used widely.

To advance the field, future research must prioritize the development and validation of practical, integrated decision support systems (Levels III & IV). This research should include rigorous cost-benefit analyses to demonstrate the economic viability of these systems. Additionally, supportive policy frameworks for data sharing are essential to enable industry-wide implementation. Strong partnerships and collaborative efforts between researchers, technology developers, and industry stakeholders will be critical to translating technological breakthroughs into on-farm applications. Ultimately, these integrated efforts will enable the poultry industry to incorporate high-throughput phenotyping and genomics into routine production management.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known financial, personal, or professional relationships that could have appeared to influence the work reported in this paper.

AUTHORS' CONTRIBUTIONS

Siti Hajar Baharin contributed to the conceptualization of the study, research design, data collection from the Scopus database, bibliometric analysis using VOSviewer, and drafting the original manuscript. Abdul Rahman Ahmad contributed to the research methodology, interpretation of the bibliometric findings, and critical revision of the manuscript for intellectual content. Ahmad Fuzi Md Ajis contributed to the study supervision, validation of the analytical approach, and final review and editing of the manuscript. All authors reviewed and approved the final version of the manuscript.

REFERENCES

Li, Y., Ma, R., Qi, R., Li, H., Li, J., Liu, W., Wan, Y., Li, S., Sun, Z., Xu, J., & Zhan, K. (2024). Novel insight into the feed conversion ratio in laying hens and construction of its prediction model. Poultry science, 103(10), 104013. https://doi.org/10.1016/j.psj.2024.104013Siebrecht, N. (2020).

Medras, Z. J. H., & Al-Khalaifah, H. (2026). Mastering feed efficiency for a sustainable operation in poultry industry. Frontiers in Animal Science, 7. https://doi.org/10.3389/fanim.2026.1798067

Leishman, E. M., You, J., Ferreira, N. T., Adams, S. M., Tulpan, D., Zuidhof, M. J., Gous, R. M., Jacobs, M., & Ellis, J. L. (2023). Review: When worlds collide - poultry modeling in the 'Big Data' era. Animal: an international journal of animal bioscience, 17 Suppl 5, 100874. https://doi.org/10.1016/j.animal.2023.100874

Banhazi, T., & Harmes, M. (2018). Development of Precision Livestock Farming Technologies. Advances in Agricultural Machinery and Technologies, 179–194. https://doi.org/10.1201/9781351132398-8

Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M.-J. (2017). Big Data in Smart Farming – A review. Agricultural Systems, 153(1), 69–80. https://doi.org/10.1016/j.agsy.2017.01.023

Zhao, Y., Xia, Q., Zong, H., Wang, Y., Dong, H., Zhu, L., Xia, J., Mao, Q., Weng, Z., Liao, W., & Xin, Z. 2023). Bibliometric and visual analysis of spinal cord injury-associated macrophages from 2002 to 2023. Frontiers in Neurology, 14. https://doi.org/10.3389/fneur.2023.1285908

Kale, M., Charkha, S., Dehankar, P., Sharma, P., Choudhary, A., Jakhete, M., & Javanjal, V. (2025). IoT-Based Smart Poultry Farm Monitoring and Controlling Using Raspberry Pi. International Journal of Intelligent Systems and Applications in Engineering, 12(12s), 373–379. https://ijisae.org/index.php/IJISAE/article/view/4523/3189

Willems, S., Mounir, M., Hertem, T. V., Hanne Nijs, Sleeckx, N., & Norton, T. (2025). Monitoring night-time activity and perch occupation of laying hens using night-vision cameras for the early detection of poultry red mite: a proof of concept. Applied Animal Behaviour Science, 283, 106517–106517. https://doi.org/10.1016/j.applanim.2025.106517

Fang, C., Huang, J., Cuan, K., Zhuang, X., & Zhang, T. (2020). Comparative study on poultry target tracking algorithms based on a deep regression network. Biosystems Engineering, 190, 176–183. https://doi.org/10.1016/j.biosystemseng.2019.12.002

https://doi.org/10.24191/scl.v20i2.10952

Choukidar, G.A., & Dawande, N.A. (2017). Smart Poultry Farm Automation and Monitoring System. 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA), 1-5. https://doi.org/10.1109/ICCUBEA.2017.8463953

Astill, J., Dara, R.A., Fraser, E.D.G., Roberts, B., & Sharif, S. (2020). Smart poultry management: Smart sensors, big data, and the internet of things. Computers and Electronics in Agriculture, 170, 105291. https://doi.org/10.1016/j.compag.2020.105291

Neethirajan, S., & Kemp, B. (2021). Digital Livestock Farming. Sensing and Bio-Sensing Research, 32, 100408. https://doi.org/10.1016/j.sbsr.2021.100408

Garcia, R., Aguilar, J., Toro, M., Pinto, A., & Rodríguez, P. (2020). A systematic literature review on the use of machine learning in precision livestock farming. Computers and Electronics in Agriculture, 179, 105826. https://doi.org/10.1016/j.compag.2020.105826

Jiang, B., Tang, W., Cui, L., & Deng, X. (2023). Precision Livestock Farming Research: A Global Scientometric Review. Animals, 13(13), 2096–2096. https://doi.org/10.3390/ani13132096

Franzo, G., Legnardi, M., Faustini, G., Tucciarone, C. M., & Cecchinato, M. (2023). When Everything Becomes Bigger: Big Data for Big Poultry Production. Animals, 13(11), 1804. https://doi.org/10.3390/ani13111804

Werkheiser, I. (2018). Precision Livestock Farming and Farmers' Duties to Livestock. Journal of Agricultural and Environmental Ethics, 31(2), 181–195. https://doi.org/10.1007/s10806-018-9720-0

Rajala, E., Vogel, I., Sundin, A., Kongmanila, D., Nassuna-Musoke, M. G., Musundire, R., Mulangala, M. N., Chiwona-Karltun, L., Magnusson, U., & Boqvist, S. (2021). How can agricultural research translation projects targeting smallholder production systems be strengthened by using Theory of Change? Global Food Security, 28, 100475. https://doi.org/10.1016/j.gfs.2020.100475

Amekawa, Y., Bumrungsri, S., Wayo, K., Gebre, G.G., & Hongsibsong, S. (2022). Pesticide Use under Public Good Agricultural Practices Standard: A Comparative Study in Thailand. Agriculture, 12(5), 606. https://doi.org/10.3390/agriculture12050606

Siebrecht, N. (2020). Sustainable Agriculture and Its Implementation Gap—Overcoming Obstacles to Implementation. Sustainability, 12(9), 3853. https://doi.org/10.3390/su12093853

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

https://doi.org/10.24191/scl.v20i2.10952