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A BIBLIOMETRIC ANALYSIS OF INTERNET OF THINGS (IOT) APPLICATIONS IN DAIRY FARMING

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ABSTRACT

This research aims to analyze the development of studies related to the application of the Internet of Things (IoT) in dairy farming using a bibliometric approach. Data were obtained from Google Scholar using the Publish or Perish application with relevant keywords and a publication period from 2016 to 2025. A total of 200 initial articles were selected using Mendeley Reference Manager, resulting in 187 documents that were analyzed using VOSviewer. The research results show that the number of publications has significantly increased, peaking in the 2020–2021 period, and then tending to stabilize until 2025. Citation analysis indicates that the research is dominated by the topic of livestock farming digitalization, such as IoT, smart farming, and precision livestock farming. Co-word visualization shows a shift in research focus from production aspects to the utilization of digital technologies such as sensors, machine learning, and artificial intelligence. However, IoT has not yet become the main focus and is still often studied separately from other technologies. Therefore, future research needs to focus on the integration of IoT with other digital technologies in a more comprehensive smart dairy farming system, supported by improvements in infrastructure and digital literacy among farmers.

Keywords: Internet of Things; dairy farming; bibliometric; smart farming; digital transformation

INTRODUCTION

Dairy farming contributes significantly to national food security, particularly by providing milk as a source of animal protein (Mulyati et al., 2025). As demand for dairy products rises, the dairy farming business must continually enhance productivity, efficiency, and product quality. However, the dairy farming sector continues to suffer a variety of issues. Limitations in access to capital, weak institutional and managerial capacity, and low levels of technology adoption (Puspita & Hardiyani, 2025).

The advancement of digital technology in recent years has created new options to address these diverse concerns. The use of IoT not only improves efficiency and productivity, but it also allows farmers to collect more precise data to aid in strategic decision-making (Melfazen, et al., 2024). In the context of dairy farming, the use of IoT devices that are equipped with sensors, including human sensors, is a crucial factor in ensuring the health and productivity of dairy farming by enabling the real-time collection of each individual's condition data (Tangorra et al., 2024).

Despite its immense promise, the use of IoT in dairy production confronts numerous challenges. Sensor equipment, software, and supporting infrastructure such as an internet

network require a significant initial investment, particularly for small and medium-sized farmers. Furthermore, the lack of electricity and connectivity in rural areas, as well as farmers' low digital literacy, pose significant barriers to the use of digital technologies, widening the gap between large-scale farms and smallholder farms with limited resources (Putra, 2025).

Previous studies, on the other hand, demonstrate that research in the field of dairy cattle farming is still dominated by a focus on production concerns, rather than the use of IoT technology as a significant enabler of digital transformation. The lack of technological integration, as well as the scarcity of studies that comprehensively trace the evolution of research in this subject, point to a research gap that must be addressed.

To solve these limitations, a bibliometric technique can be utilized to objectively and methodically analyze research progress. Bibliometrics can examine scientific publications, cooperation between researchers, and citation trends in relevant literature (Julianti et al., 2025). Thus, the goal of this study is to provide a full picture of the direction of research advancement as well as future research potential.

METHODS

The database used in this study was obtained from Google Scholar (GS) due to its broad literature coverage, free access, ease of use, and provision of citation data supporting comprehensive scientific analysis. The data gathering method was carried out using the Publish or Perish (PoP) tool, which searches and analyzes academic citations from diverse sources, resulting in various citation metrics. To improve the search's accuracy and efficiency, appropriate keywords were generated. The keywords used in this study include "dairy cattle," "good dairy farm practice," and "milk production," along with "Internet of Things" or "IoT," all within a publishing time frame of the last 10 years, specifically from 2016 to 2025. Furthermore, to maintain focus and convenience of data administration, the number of search results is limited to no more than the top 200 articles based on relevance.

The resulting data was then exported and selected using the Mendeley Reference Manager application. Document screening was carried out using particular criteria, which included the elimination of irrelevant documents, invalid websites, duplicate papers, and book-length pieces. Following the selection procedure, 187 papers meeting the requirements were retrieved for further review. The final data were analysed with VOSviewer to map and visualise the bibliometric network, which included author collaboration, keyword co-occurrence, citation, co-citation, and bibliographic coupling, and then interpreted to detect research trends and gaps (Ratnasari & Dwisusanto, 2024).

RESULTS AND DISCUSSION

Figure 1 shows that publications on the application of the Internet of Things (IoT) in dairy farming have increased dramatically over the last decade. In the early years (2016-2018), the number of publications was still relatively low, showing that IoT technology use in the farming industry had not yet spread significantly. Beginning in 2019, there was a noticeable increase in research interest, which then skyrocketed over the 2020-2021 timeframe, with the most publications. After peaking, the number of publications tended to stabilise between 2022 and 2025, with a minor reduction observed. This implies that the study has matured, with the emphasis shifting away from initial inquiry and toward the development of more specific applications such as precision dairy farming, IoT-based sensors, and milk production automation systems.

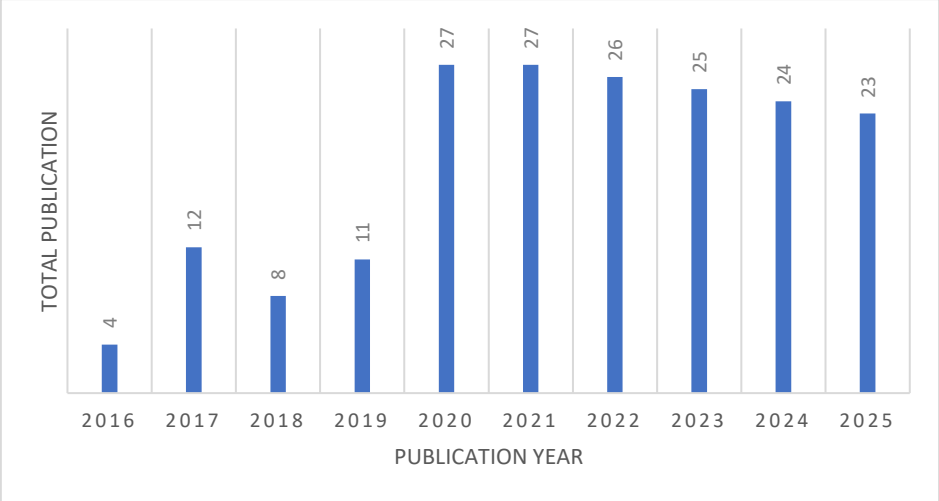

Figure 1. Trend in Total Publications from 2016 to 2025

According to Table 1, the papers with the most citations are primarily about digitalisation and the use of smart technologies in livestock farming, such as IoT, smart farming, and precision farming. The work by Alonso et al (2022). had the most citations, followed by Neethirajan and Kemp (2021), who discussed the concept of digital cattle husbandry. Other research delves deeply into the modelling of smart farming systems, sensor-based animal health monitoring, and the use of machine learning and artificial intelligence. This demonstrates that the research is not only focused on IoT, but also on its integration with other digital technologies to improve efficiency, animal care, and productivity in dairy farms.

Table 1. List of The Top 10 Articles Identified by PoP

No	Author	Year	Citation	Research Title
1	(Alonso et al., 2022)	2020	436	An intelligent Edge-IoT platform for monitoring livestock and crops in a dairy farming scenario
2	(Neethirajan & Kemp, 2021)	2021	415	Digital livestock farming
3	(O'Grady & O'Hare, 2017)	2017	333	Modelling the smart farm
4	(Crowe et al., 2018)	2018	279	Reproductive management in dairy cows-the future
5	(Sharma & Koundal, 2018)	2018	250	Cattle health monitoring system using wireless sensor network: a survey from innovation perspective
6	(Morrone et al., 2022)	2022	249	Industry 4.0 and precision livestock farming (PLF): an up-to-date overview across animal productions
7	(Farooq et al., 2022)	2022	209	A survey on the role of IoT in agriculture for the implementation of smart livestock environment
8	(Taneja et al., 2020)	2020	193	Machine learning based fog computing assisted data-driven approach for early lameness detection in dairy cattle
9	(Caja G, Castro-Costa A, 2016)	2016	189	Engineering to support wellbeing of dairy animals
10	(Kutyauripo et al., 2023)	2023	177	Artificial intelligence applications in the agrifood sectors

The co-word network visualization of research on Internet of Things (IoT) Applications in Dairy Farming is categorized into five distinct clusters, as illustrated in Figure 2.

- Cluster 1 (red) includes 10 terms: artificial intelligence, big data, challenge, dairy farmer, dairy industry, example, precision dairy farming, production, research, and smart dairy farming.
- Cluster 2 (green) consists of 8 terms: cow health, dairy production, integration, milk quality, opportunity, paper, sensor, and use.
- Cluster 3 (blue) contains 8 terms: dairy cattle farming, demand, disease, health, machine learning, precision livestock farm, productivity, and quality.
- Cluster 4 (yellow) comprises 6 terms: blockchain, dairy, dairy product, development, implementation, and raw milk.
- Cluster 5 (purple) includes 2 terms: internet and thing.

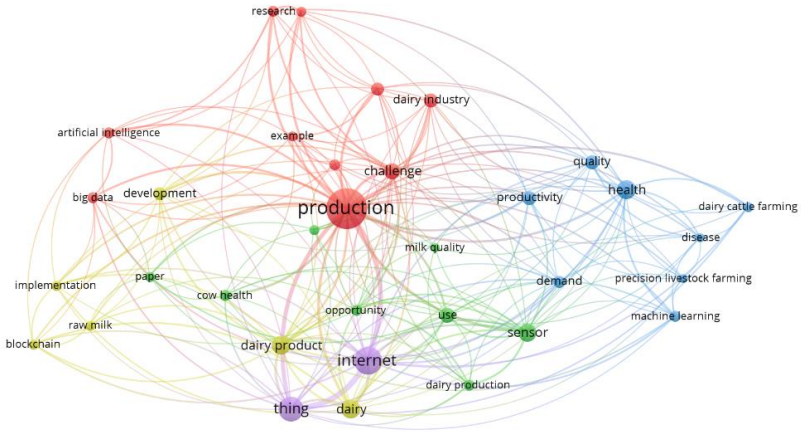

Figure 2. Co-Word Map Network Visualization

Figure 3. overlay visualisation VOSviewer shows a noteworthy movement in research patterns from an initial focus on production concerns to the use of digital technology in dairy cattle farming. Keywords such as production dominated the research in the beginning, but in recent years, terms such as sensor, machine learning, and precision livestock farming have emerged, indicating a greater emphasis on the use of technology to improve efficiency, animal health, and productivity. Furthermore, the rise of terminology like artificial intelligence and big data suggests a shift toward more advanced technology integration. However, the concept of IoT has not yet fully taken center stage, signalling prospects for research into the creation of more integrated and comprehensive smart dairy farming systems.

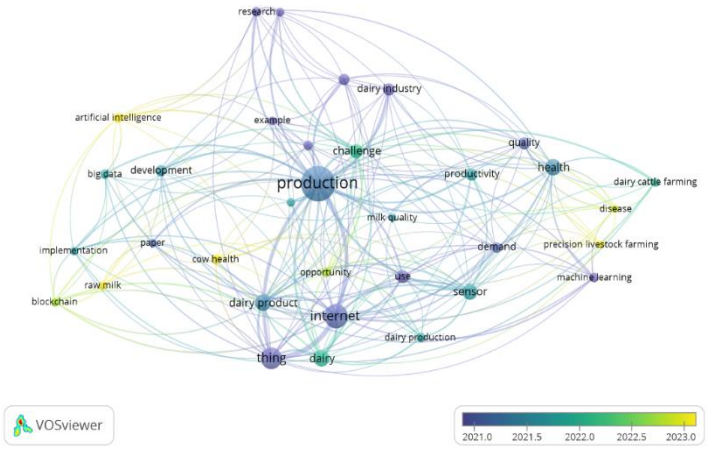

Figure 3. Co-Word Map Overlay Visualization

Based on the density visualisation results in Figure 4, it is clear that the keyword "production" has the highest density level, as represented by the brightest yellow colour, making it the primary focus of dairy farming study. In addition, several other terms, like internet, dairy, sensor, and dairy product, have relatively high density, indicating a significant association with the core theme. Meanwhile, keywords such as machine learning, artificial intelligence, and blockchain have a lower density, indicating that these areas are still evolving and have not been thoroughly investigated. These findings show that research is still dominated by production aspects, whereas the use of digital technology, notably IoT and its interaction with other technologies, still offers great development potential in enabling a more integrated smart dairy farming system.

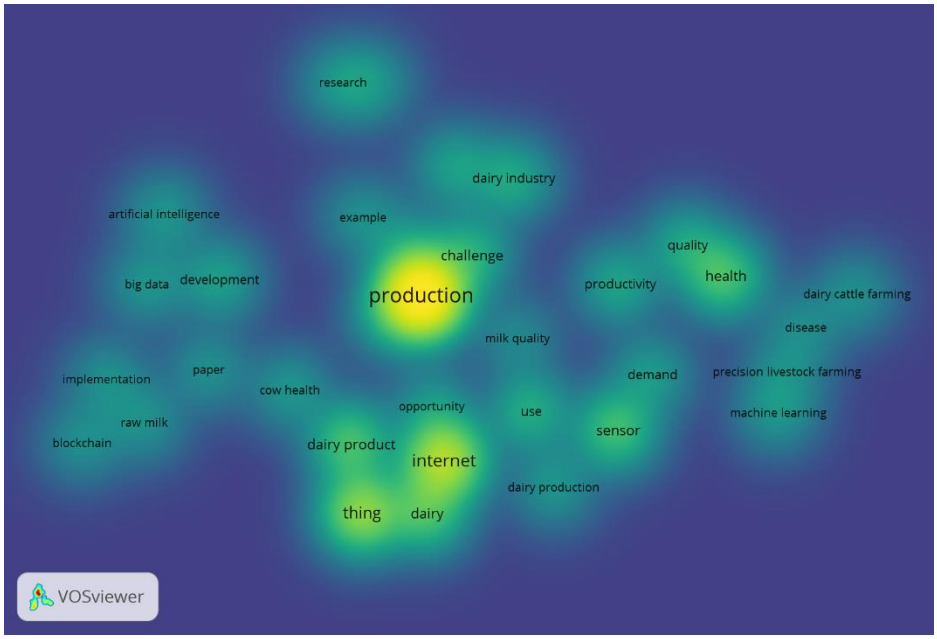

Figure 4. Co-Word Map Density Visualization

CONCLUSION

Based on the research findings, it is possible to conclude that the development of studies related to the application of the Internet of Things (IoT) in dairy farming has shown an increasing trend over the last decade, with the initial focus of research dominated by production aspects, then shifting toward the use of digital technologies such as sensors, machine learning, and precision livestock farming. Nonetheless, IoT has not yet been the primary emphasis and is frequently investigated separately from other technologies, thus integration into a holistic smart dairy farming system is restricted. The bibliometric analysis also shows that research tends to focus on enhancing productivity and efficiency, whereas factors such as technology integration and the creation of comprehensive intelligent systems remain research potential in the future. To make digital-based livestock management systems more relevant and inclusive, research is needed that blends IoT with technologies such as machine learning, artificial intelligence, and big data, as well as suitable infrastructure and enhanced farmer literacy.

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