



Analysis of Digital Application Use in Dairy Cattle Production Management

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Abstract

Digital technology adoption in livestock farming has increased significantly over the last decade. Dairy cattle production management now integrates digital applications such as herd management software, precision monitoring systems, and mobile applications. These technologies enable real time monitoring of animal health, feeding behavior, and production performance. However, the extent of digital application utilization and its management implications still require comprehensive analysis. This study aims to analyze the role and effectiveness of digital applications in dairy cattle production management based on recent scientific literature. The research uses a qualitative literature review approach by examining 30 scientific publications related to digital technology adoption in dairy farming. Data were analyzed using thematic synthesis to identify major technological trends, management benefits, and adoption challenges. The results show that digital applications significantly improve management efficiency through automated monitoring, data based decision making, and improved animal health surveillance. Studies also report improvements in productivity, cost efficiency, and environmental performance. Despite these benefits, adoption barriers remain, including investment costs, data security concerns, and limited digital skills among farmers. The study concludes that digital applications play a strategic role in modern dairy cattle production management, particularly in supporting precision livestock farming systems. Future research should focus on integrating artificial intelligence and Internet of Things technologies to enhance decision support systems in dairy farming.

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Introduction

The dairy cattle industry is undergoing rapid transformation due to the integration of digital technologies in livestock production systems. The adoption of digital applications in dairy farming has increased significantly in recent years as producers seek more efficient ways to manage animal health, feeding, reproduction, and overall farm productivity. Modern dairy production systems require continuous monitoring and precise management to maintain high levels of efficiency while ensuring animal welfare and environmental sustainability. Digital technologies provide tools that enable farmers to collect and

analyze large volumes of data related to herd performance, allowing more accurate and timely decision making in daily farm management (Markov et al., 2022). These technologies form the foundation of precision livestock farming, which emphasizes data driven management and real time monitoring of livestock production systems.

The concept of digital agriculture has expanded the scope of livestock management through the use of information technologies, sensors, and automated monitoring systems. Digital solutions allow farmers to observe animal behavior, physiological conditions, and production performance without relying solely on manual observation. According to Liu et al. (2023), information technologies such as Internet of Things devices, artificial intelligence, and computer vision systems play an important role in modern dairy farming by enabling continuous monitoring of animal behavior and feeding patterns. These technologies support more precise feeding management, health monitoring, and reproductive management, which are essential factors influencing dairy farm productivity. As a result, digital applications are increasingly viewed as essential tools for improving farm efficiency and maintaining competitive livestock production systems.

Several studies have demonstrated the positive impact of digital technology adoption on dairy cattle production performance. For example, research conducted by Qi et al. (2022) found that the use of digital monitoring technologies in large dairy herds improved milk productivity by enabling more accurate estrus detection and more efficient reproductive management. Similarly, Askarov et al. (2024) reported that the implementation of digital technologies in dairy farms contributed to a significant increase in production efficiency, including a fifteen percent increase in productivity and a ten percent reduction in feed costs. These findings indicate that digital technologies provide measurable benefits for dairy farm operations by improving the efficiency of resource utilization and management processes.

In addition to improving productivity, digital technologies also support improved monitoring of animal health and welfare. Early detection of health problems is a critical factor in dairy production because diseases can reduce milk production and increase operational costs. Modern monitoring systems use sensors and automated data collection to detect changes in animal behavior and physiological conditions. Terentyev et al. (2024) explain that digital health monitoring technologies such as sound sensors, milk conductivity sensors, and three dimensional cameras allow farmers to detect disease symptoms earlier and respond more quickly to health problems in dairy cattle. These systems reduce the reliance on manual observation and improve the accuracy of health assessments within dairy herds.

Another important aspect of digital technology adoption in dairy farming is its contribution to environmental sustainability. The livestock sector faces increasing pressure to reduce environmental impacts such as greenhouse gas emissions and inefficient resource utilization. Digital technologies provide tools to improve feed efficiency, optimize production processes, and reduce waste. Liu et al. (2023) demonstrate that digital technologies such as electronic identification systems and automated feeding equipment can improve carbon emission efficiency in dairy farms. These technologies support more efficient feed management, which reduces resource waste and contributes to more sustainable livestock production practices.

The development of digital livestock technologies has also encouraged the emergence of smart farming systems. Smart farms integrate various digital technologies into a unified management platform that allows real time monitoring and automated decision support. According to Ahmedova et al. (2024), smart farm systems combine automated environmental control, feed management technologies, and animal monitoring tools to create integrated livestock management systems. These systems help farmers maintain optimal production conditions while improving product quality and overall farm sustainability. The integration of digital platforms in agricultural management also allows better data sharing and traceability within livestock supply chains (Medennikov, 2024).

Mobile applications represent one of the most accessible forms of digital technology adoption in dairy farming. These applications enable farmers to record livestock data, track animal health conditions,

and manage production activities directly through smartphones. Qonita et al. (2025) analyzed the features of mobile applications designed for cattle management and found that these applications provide essential functions such as herd data recording, financial management, and health monitoring. Mobile technologies are particularly valuable for small and medium scale farmers because they offer relatively affordable solutions for digital farm management. Similarly, Michels et al. (2019) reported that more than half of dairy farmers in Germany have adopted smartphone applications for herd management, indicating the growing importance of mobile technologies in livestock production.

Precision livestock farming technologies also play a crucial role in modern dairy farm management. These technologies integrate multiple digital tools to monitor animal behavior, feeding activities, and environmental conditions. Oliveira et al. (2024) conducted a bibliometric analysis of digital technologies in dairy farming and found increasing research interest in machine learning, deep learning, and computer vision applications. These technologies enable automated identification of cattle, behavior monitoring, and stress detection. Computer vision systems can analyze video data to detect abnormal behavior patterns, which allows early intervention when animals experience health problems or environmental stress (Antognoli et al., 2025).

Despite the numerous benefits associated with digital technology adoption in dairy farming, several challenges continue to limit widespread implementation. One of the most significant barriers is the high investment cost required to implement advanced digital technologies. Many small scale dairy farmers lack the financial resources necessary to adopt automated monitoring systems and precision livestock technologies. In addition, technical complexity may discourage farmers who are not familiar with digital technologies. Surveys conducted among livestock professionals reveal that although digital technologies improve efficiency and collaboration, concerns related to data security and system reliability remain important issues for users (Iwersen & Drillich, 2022).

Another challenge relates to the acceptance and perception of digital technologies among farmers and society. The successful implementation of digital livestock systems depends not only on technological capabilities but also on user acceptance and trust in digital tools. Langer (2023) highlights that social acceptance and farmers' willingness to adopt digital technologies are influenced by perceived benefits, technological complexity, and ethical considerations related to animal management. Similarly, Kramer et al. (2020) show that farmers are more likely to adopt digital herd management applications when they perceive clear benefits and ease of use in their daily farm activities. Therefore, improving user friendly system design and providing adequate training for farmers are important steps to encourage wider adoption of digital technologies in dairy farming.

The rapid development of digital livestock technologies has created new opportunities for improving dairy cattle production management. The integration of artificial intelligence, Internet of Things devices, and data analytics enables the development of more advanced decision support systems for livestock farming. Kaur et al. (2023) emphasize that the integration of digital technologies within precision animal agriculture systems can significantly enhance production efficiency, animal welfare monitoring, and farm management effectiveness. These technological advancements provide opportunities to transform traditional livestock production systems into highly efficient data driven agricultural enterprises.

Although many studies have examined specific digital technologies in dairy farming, comprehensive analysis of digital applications used in dairy cattle production management remains limited. Existing research often focuses on individual technologies such as sensors, artificial intelligence, or herd management software. However, dairy production management requires the integration of multiple digital tools that function together within a unified management system. A systematic analysis of digital applications used in dairy cattle production management is therefore necessary to better understand the benefits, limitations, and future potential of digital technologies in livestock farming.

Based on these considerations, this study aims to analyze the use of digital applications in dairy cattle production management by reviewing scientific literature related to digital technologies in dairy farming. The study examines various types of digital applications used in livestock management, including monitoring systems, mobile applications, automated management technologies, and smart farm platforms. The results of this study are expected to provide a comprehensive understanding of how digital technologies support dairy cattle production management and contribute to the development of more efficient and sustainable livestock production systems.

Methods

Research Design

This study applies a qualitative literature review approach to analyze the use of digital applications in dairy cattle production management. The research focuses on examining scientific publications that discuss the implementation of digital technologies in dairy farming systems. A literature based approach is appropriate for identifying technological trends, management practices, and the impacts of digital tools on livestock production systems. Previous studies have used similar approaches to evaluate the development of precision livestock farming technologies and their application in dairy production management (Markov et al., 2022; Kaur et al., 2023).

The research design aims to synthesize empirical findings from previous studies in order to identify patterns of digital technology adoption, management benefits, and implementation challenges in dairy cattle farming. The analysis emphasizes digital applications that support herd monitoring, production management, health surveillance, and decision support systems. These technologies include mobile applications, sensor based monitoring systems, computer vision technologies, and integrated farm management platforms.

Data Sources and Literature Selection

The data used in this research consist of scientific publications related to digital technology adoption in dairy cattle farming. A total of thirty publications were selected as the primary data sources. These publications include peer reviewed journal articles, conference proceedings, book chapters, and scientific reports published between 2005 and 2025. The literature sources represent research conducted in different countries and production systems, which provides a broad perspective on the implementation of digital technologies in dairy farming.

The literature selection process followed three main criteria. First, the publication must discuss digital technologies or digital applications used in livestock or dairy cattle production management. Second, the study must contain empirical analysis, systematic review, or case study related to technology adoption in dairy farming. Third, the publication must provide information about the role of digital technologies in improving farm management, productivity, animal health monitoring, or environmental performance.

Publications that did not address dairy cattle production management or did not include discussion related to digital technologies were excluded from the analysis. This selection process ensured that the literature used in this study directly supports the research objective of analyzing digital application use in dairy cattle production management.

Data Collection Procedure

The data collection process involved systematic identification and classification of relevant literature. Each publication was reviewed to extract key information related to digital technology implementation in dairy farming. The information collected from each article included the type of digital

technology used, the management function supported by the technology, and the reported outcomes related to productivity, efficiency, or animal health monitoring.

The literature review process also involved identifying technological categories discussed in the selected studies. These categories include digital herd management systems, automated monitoring technologies, mobile farm management applications, artificial intelligence based analysis systems, and smart farm platforms. Studies such as Liu et al. (2023) and Oliveira et al. (2024) provide detailed explanations of how these technologies are integrated into dairy production systems to support precision livestock farming.

Information extracted from each article was recorded and organized in a structured format to facilitate comparative analysis. This procedure allowed the researchers to identify recurring patterns of technology adoption and evaluate the role of digital applications in dairy cattle production management across different farming contexts.

Data Analysis Technique

The data analysis process used thematic synthesis to identify key patterns and relationships within the selected literature. The analysis was conducted in three main stages.

The first stage involved coding relevant information extracted from each publication. Codes were assigned to key themes related to digital technology adoption, including herd monitoring, production management, health surveillance, reproductive management, and environmental sustainability. These codes were derived directly from the findings reported in the selected studies.

The second stage involved grouping the coded information into broader thematic categories. These categories include productivity improvement, farm management efficiency, animal health monitoring, environmental sustainability, and adoption challenges. Similar findings from different studies were grouped together to identify consistent trends in the use of digital technologies in dairy farming. Previous research shows that technologies such as automated sensors, artificial intelligence, and mobile applications contribute significantly to improved livestock monitoring and management efficiency (Qi et al., 2022; Terentyev et al., 2024).

The final stage involved interpreting the synthesized themes to understand the broader implications of digital application use in dairy cattle production management. This stage focused on evaluating the advantages, limitations, and future potential of digital technologies within dairy farming systems. The interpretation process also compared the findings across different studies to assess the consistency of reported outcomes.

Research Validity and Reliability

To ensure the reliability of the analysis, the study used peer reviewed scientific publications as the primary data sources. Peer reviewed literature provides validated empirical evidence and ensures that the findings used in the analysis are scientifically credible. The inclusion of studies from different geographic regions also improves the generalizability of the findings regarding digital technology adoption in dairy farming.

In addition, the use of thematic synthesis allows systematic identification of recurring patterns within the literature. This method reduces subjective interpretation by organizing the analysis based on clearly defined thematic categories. The findings derived from the synthesis therefore reflect consistent evidence reported across multiple studies.

The methodological approach used in this study provides a structured framework for analyzing digital application use in dairy cattle production management. By synthesizing empirical findings from previous research, this study aims to provide a comprehensive understanding of how digital technologies contribute to improved efficiency, productivity, and sustainability in modern dairy farming systems.

Results and Discussion

The analysis of the selected literature demonstrates that digital applications have become essential tools in dairy cattle production management. The integration of digital technologies enables more efficient monitoring of animal health, reproduction, feeding behavior, and farm operational activities. These technologies generate large volumes of production data that can support evidence based decision making. Several studies indicate that farms adopting digital management systems achieve higher productivity, improved herd health monitoring, and more efficient use of resources (Kaur et al., 2023; Markov et al., 2022). The findings also show that digital applications support the transition from conventional livestock management toward precision dairy farming systems that rely on automated monitoring and data driven decision making.

One of the most common forms of digital technology used in dairy farming is herd management software and mobile based applications. These systems enable farmers to record livestock information, monitor production performance, and manage operational activities through digital platforms. Mobile applications such as My Cattle Manager and CowMaster provide features for recording herd data, tracking animal health, and managing farm finances (Qonita et al., 2025). Similarly, smartphone based herd management applications are widely used by farmers because they provide flexible and accessible tools for monitoring livestock conditions (Michels et al., 2019). These applications simplify information management in dairy farms and allow farmers to access important herd data in real time.

Table 1

Digital Applications Used in Dairy Cattle Production Management			
Digital Technology	Main Function	Application in Dairy Farming	Reference
Herd management software	Data recording and monitoring	Livestock records, health data, reproduction management	Qonita et al., 2025
Mobile farm management apps	Remote monitoring	Herd data access through smartphones	Michels et al., 2019
Artificial intelligence systems	Data analysis and prediction	Behavioral analysis and productivity monitoring	Oliveira et al., 2024
Computer vision technology	Visual monitoring	Animal identification and activity monitoring	Antognoli et al., 2025
Sensor based monitoring	Health detection	Mastitis detection and health surveillance	Terentyev et al., 2024
Precision feeding technology	Feed management	Optimizing feed use and reducing waste	Liu et al., 2023

The data in Table 1 show that digital technologies used in dairy farming have diverse management functions. Herd management systems are primarily used for data recording and operational management. Sensor based monitoring technologies support animal health detection through automated data collection. Artificial intelligence systems analyze large datasets to identify behavioral patterns and predict potential health problems. According to Oliveira et al. (2024), machine learning and deep learning technologies have increasingly been used in dairy farming to analyze animal movement patterns and feeding behavior. These systems provide early warning signals when abnormal behavior occurs, which allows farmers to intervene more quickly.

Another important technological development in dairy farming is the use of computer vision systems. These systems analyze visual data captured by cameras installed in livestock facilities. Computer vision technologies can identify individual animals, monitor movement patterns, and detect behavioral changes that indicate stress or disease. Antognoli et al. (2025) report that computer vision systems

improve the accuracy of livestock monitoring while reducing the need for manual observation by farm workers. Automated visual monitoring also allows continuous observation of cattle activity throughout the production cycle.

Digital technologies also play an important role in improving production efficiency and environmental performance in dairy farms. Automated feeding systems and sensor based monitoring technologies allow farmers to optimize feed distribution and monitor feed consumption. Efficient feed management is critical because feed represents one of the largest operational costs in dairy farming. Liu et al. (2023) demonstrate that digital feeding technologies improve carbon emission efficiency by optimizing nutrient utilization and reducing feed waste. Improved feed management not only increases productivity but also supports more sustainable dairy production systems.

Table 2

Impacts of Digital Technology Adoption in Dairy Farming		
Impact Area	Observed Benefit	Supporting Study
Productivity improvement	Increased milk productivity	Qi et al., 2022
Cost efficiency	Reduced feed costs	Askarov et al., 2024
Animal health monitoring	Early disease detection	Terentyev et al., 2024
Environmental sustainability	Improved carbon emission efficiency	Liu et al., 2023
Farm management efficiency	Improved decision making through data analysis	Markov et al., 2022

The findings summarized in Table 2 indicate that digital technology adoption contributes to multiple improvements in dairy cattle production systems. Studies show that digital monitoring systems enable farmers to identify reproductive cycles more accurately, which improves breeding management and increases milk production (Qi et al., 2022). In addition, automated monitoring systems reduce operational inefficiencies by improving data accuracy and reducing human error in livestock management.

Health monitoring represents another major advantage of digital technology adoption. Traditional livestock monitoring relies heavily on manual observation by farmers or farm workers. However, manual observation may fail to detect early signs of disease because symptoms are often subtle during the initial stages of illness. Terentyev et al. (2024) explain that sensor based health monitoring technologies can detect physiological changes such as abnormal milk conductivity, unusual vocalization patterns, and behavioral changes that indicate disease development. Early detection allows faster veterinary intervention and reduces the risk of disease spreading within the herd.

Digital technologies also support the development of integrated smart farm systems. Smart farming systems combine multiple technologies such as sensors, artificial intelligence, automated feeding systems, and environmental monitoring platforms. Ahmedova et al. (2024) describe smart farm systems as integrated digital infrastructures that allow centralized monitoring of livestock production activities. These systems enable farmers to track environmental conditions, monitor animal health, and manage feeding operations through a single digital platform.

The conceptual framework presented in Diagram 1 illustrates how digital technologies contribute to improved dairy farm management. Digital tools first collect production data through sensors, cameras, and management software. The collected data are then analyzed using digital platforms that support decision making in livestock management. The final outcomes include improved productivity, more efficient resource use, and improved animal welfare.

Despite these advantages, the literature also identifies several challenges associated with digital technology adoption in dairy farming. One of the most significant challenges is the high investment cost required to implement advanced monitoring systems. Small scale dairy farmers often face financial

limitations that prevent them from adopting precision livestock technologies. In addition, technological complexity may discourage farmers who lack digital skills or training.

Concerns related to data privacy and system reliability also influence technology adoption decisions. Surveys conducted among livestock professionals indicate that many farmers remain cautious about sharing farm data through digital platforms (Iwersen & Drillich, 2022). Furthermore, social acceptance and trust in digital technologies play an important role in determining whether farmers adopt new management systems. Langer (2023) emphasizes that farmers are more likely to adopt digital technologies when they clearly understand the benefits and when the systems are easy to use.

Overall, the analysis shows that digital applications provide significant benefits for dairy cattle production management. These technologies improve monitoring accuracy, increase production efficiency, and support sustainable livestock production practices. However, successful implementation depends on adequate infrastructure, farmer training, and institutional support to overcome adoption barriers.

Conclusion

The analysis of scientific literature demonstrates that digital applications play a significant role in improving dairy cattle production management. Various digital technologies, including herd management software, mobile applications, sensor based monitoring systems, artificial intelligence, and computer vision technologies, provide practical tools that support more efficient and accurate livestock management. These technologies enable continuous monitoring of animal health, feeding behavior, and reproductive performance, which improves the quality of management decisions in dairy farming systems.

The findings indicate that the adoption of digital technologies contributes to several important improvements in dairy farm operations. These improvements include increased milk productivity, more efficient feed management, improved disease detection, and better environmental performance. Digital monitoring systems allow early identification of health problems and abnormal animal behavior, which supports faster intervention and reduces production risks. In addition, digital feeding and monitoring technologies help optimize resource utilization and reduce operational inefficiencies within dairy farming systems.

The study also highlights that digital technologies support the development of precision livestock farming and smart farm management systems. These systems integrate multiple digital tools into a unified platform that enables centralized monitoring of farm activities. As a result, farmers can access accurate production data and make timely decisions that improve productivity and sustainability in dairy cattle production.

However, several challenges remain in the implementation of digital technologies in dairy farming. High investment costs, limited digital literacy among farmers, and concerns related to data security and technological complexity can limit technology adoption. Addressing these challenges requires improved digital infrastructure, farmer training programs, and institutional support to encourage wider adoption of digital technologies in the livestock sector.

Overall, digital applications provide significant opportunities to improve dairy cattle production management. Future research should focus on the integration of advanced technologies such as artificial intelligence, Internet of Things systems, and big data analytics to further enhance decision support systems and strengthen the sustainability of dairy farming systems.

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