Hindawi
International Journal of Distributed Sensor Networks
Volume 2024, Article ID 8929748, 12 pages
https://doi.org/10.1155/2024/8929748

Review Article

The Influence of Artificial Intelligence Technology on the Management of Livestock Farms

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Received 24 March 2023; Revised 25 August 2023; Accepted 9 December 2023; Published 8 January 2024

Academic Editor: Diego Alexander Tibaduiza

This review was conducted to demonstrate how artificial intelligence (AI) has affected livestock farming. Livestock is essential for maintaining ecological integrity and providing food security. In this review, the history of artificial intelligence (AI), its impact on current and future livestock farming, and its drawbacks have been highlighted. The term "artificial intelligence," was first coined by John McCarthy in 1956, and currently, the technology is widely applied in the management of many livestock farms like poultry, dairy, and pigs. Although it has been studied for decades and widely applied, AI is still one of the least understood subfields. Artificial intelligence provides farmers with unrivalled support, enabling them to minimize resource use, improve the sustainability of their feeding patterns, and increase farm productivity in general, especially when it comes to reducing the carbon footprint. AI is a blessing for boosting efficiency and productivity while also lowering the possibility of human error. Producers can use artificial intelligence to simulate human decision-making and provide interpretations and solutions for the data gathered by sensors and other hardware technologies. Through AI tools, it is possible to easily trace animal activities and locations and collect data about behaviors, habitats, and health conditions. Animal identification, animal welfare monitoring, sex determination, vaccine delivery, and pasture evaluation are some areas where AI has been widely applied so far. Drones, robots, and blockchains are some forms of automation that have been widely used in dairy farms. However, the expense of development, which needs more infrastructure on the farm, and the potential for automation to replace them are the limitations of the technology.

1. Introduction

By 2050, there will be 9.7 billion people on the planet [1, 2]. The agricultural industry becomes more stressed than ever because of 2 billion more mouths to feed. In other words, simply expanding cropland or increasing cattle herds may not be an option to overcome the projected demands. Furthermore, it is challenging to meet the anticipated demand by the amount of land that is currently under cultivation.

Nowadays, the industry has become more innovative in its approaches to improving production activities for better production as a result of alarming factors like climate change, peace, food insecurity, changes in the production system, and quality assurance [3]. Farmers also have more works to do because there is less help available due to the herd sizes' continued growth [4]. Besides, younger generations are becoming less and less interested in the profession. As a result, farmers are adopting more sophisticated methods to feed the world and prevent a world food crisis in response to the dramatic rise in the global population [5, 6]. These methods can help to regulate the appropriate use of land, water, and energy [7]. Because farmers will need to do more with less, it is necessary to increase the efficiency of current farming practices [8].

Technologies based on AI have been used in fields such as farm planning, animal management, sustainable resource use, and disease management [9]. With drones, robots, and intelligent monitoring systems, it has been successfully adopted by several industries and is now poised to revolutionize farming [10].

The impact of AI on our lives today is comparable to what mechanization and electricity had more than a century ago [10]. AI is individual-specific electronics that need to be expected executed instantly in bovine animal manufacturing.

AI helps ranchers accumulate and resolve dossiers to correctly foresee service performance in the way that purchasing patterns and key currents. To increase production and decrease waste while minimizing environmental impact, AI is driving efficiency in present and future farming systems. AI is a clever monitoring system that can suggest solutions, which can help farmers get more from their breed while using resources more sustainably, yield healthier products, control disease, monitor movement, and lessen the workload, thus steadily emerging as a part of the industry's technological evolution [7, 10–13]. AI helps farmers overcome a variety of obstacles without reducing productivity [9]. It enables them to enhance animal health and outcomes in addition to gathering and analyzing data to accurately forecast consumer behavior, such as buying habits and emerging trends [5, 9, 14, 15]. Farms will be able to automate procedures, cut significant costs, and enhance the quality of livestock through products like milk with increased investment [16]. Systems powered by artificial intelligence enhance the management and production of livestock [17]. Farmers use it to predict disease outbreaks, optimize feeding schedules, and automate the monitoring of animal behavior and welfare [6]. It gives farmers the ability to manage and enhance the health, welfare, and reproductive capabilities of their animals [18].

Farmers can analyze their data more effectively and combine all the components (cameras, microphones, scanners, and sensors) into a cohesive system that facilitates decision-making, precise forecasting, and anomaly detection [16, 17]. AI has recently become a tool that helps farmers monitor, forecast, and optimize the growth of farm animals in response to the increased demand for higher farm animal yields [19]. One of the major applications of AI technology in the livestock industry is the control of parasites, biosecurity, and diseases, as well as the observation of farm animals and farm management [14, 15, 17, 20, 21].

Currently, local peasants and big buttery farms use feed accompanying little information of allure belongings on milk. For instance, sensors and the Internet of Things (IoT) are being used for the welfare of poultry [22, 23]; precision farming is being used for pigs [24]; deep learning is being used to detect the behavior of cattle and pigs; and data modeling is being used for animal production [25]. The history of artificial intelligence from theory to application, its advantages and shortcoming, and its role and potential applications in livestock farming are the main topics of this review.

1.1. The Rationale of the Review. Since modern livestock farms need to be supported by modern artificial intelligence technologies, the technologies that farms have implemented during the last years, their advantages and disadvantages, and the impact of those technologies on society, satisfaction, and well-being need to be understood so that reviews are necessary to bring all the essential aspects of AI to the whole world. The inclination of this review is that reviewing AI-related articles is very important by giving summarized information about this leading technology to farm owners, readers, and others.

It is reviewed to the audiences that are researchers, livestock farm owners and managers, policymakers, and other concerned bodies that will be benefited from the artificial intelligence technology.

2. Material and Methods

Almost 128 articles were collected from various published and unpublished sources including keywords and Google Scholar throughout the writing of the review paper: artificial intelligence, future application, livestock farms, and farm management. All articles are summarized without bias. All articles that explain the importance of AI in livestock farms are included in the review. But articles that are done on other wild lives are excluded from the review. Following the collection of manuscripts, information from sources was analyzed and used to compile this article.

2.1. Overview of Artificial Intelligence. Although it has been studied for decades, AI is still one of computer science's least understood subfields [19]. This is largely because of how broad and obscure the topic is. From machines that can reason to search algorithms that are used to play board games, AI encompasses all of these things [14, 15, 17]. Almost every aspect of how we use computers in society can benefit from it. The study of creating intelligent machines that can carry out tasks that would typically require human intelligence is known as artificial intelligence, a broad field of computer science [26]. While machine learning and deep learning advancements are causing a paradigm shift in almost every sector of the technology industry, AI is an interdisciplinary science with many approaches [6, 18, 26, 27]. Machines can now mimic and even outperform human intelligence thanks to AI, ranging from the development of intelligent assistants to self-driving cars. Machine intelligence, as opposed to the intelligence exhibited by humans or other animals, is referred to as AI [28].

The machine does not already have preprogrammed responses for every scenario, which is a key point [29]. The machine can make a fresh and accurate judgment based on what it has previously learned [16]. AI is capable of problem-solving, rational behavior, and human-like actions. It possesses the remarkable capacity to engage in reasoning, effectively resolve complex problems, and acquire new knowledge through learning actions. Instead of pitting man against machine, it is man and machine working together [28]. AI executes actions that require human intelligence typically, such as speech recognition, visual perception, decision-making, and language translation [13]. Artificial intelligence is being used to change how livestock is managed and watched over, from poultry and dairy cows to pigs [19].

Intelligence is the capacity to learn and solve problems [30]. It is the capacity to absorb information from one's environment, respond to circumstances flexibly, and understand the relative significance of various situational elements. It also addresses how to use the general mental capacity to reason, solve problems, and learn in a variety of contexts [19].

In the past century, advances in animal farming have been significant [8]. A few decades ago, complete automation of environmental condition monitoring would have

seemed impossible, but today, it is commonplace. Methods were developed to increase productivity in these fields, not just for financial gain but also to meet the demands of the world's expanding populace [16]. But every coin has two sides. Progress came with a hefty price. Large-scale farming has evolved, which has in some ways made the problem worse [16]. Farming facilities have gotten bigger while using less space to maintain cost-effectiveness as the demand for animal products has increased [8]. Regarding animal health, this is largely irrelevant [6].

2.2. Historical Background of Artificial Intelligence. Man first domesticated animals for their benefit over a few thousand years ago [31], and ever since, he has relied on instinct, sensory cues, and accumulated knowledge to make wise choices regarding animal husbandry [32]. Animal husbandry has traditionally been dispersed, on a scale where each animal is kept by a single man, and only a small number of people can come together and manage them [33]. Additionally, most animal farmers had limited access to contemporary technologies like high-speed Internet, smartphones, and affordable computing power until about ten years ago. Both of these circumstances are currently changing quickly [8, 14–16]. To advance sustainable animal husbandry and resource management, many farmers have joined forces [12]. They use a variety of cutting-edge technologies that enable them to remotely monitor farm animals with a little intrusion because they share a common interest in enhancing animal production and welfare [6].

The main challenge to increasing output dramatically in animal farming is data acquisition [16]. On a farm, getting accurate information about regular farm operations is practically impossible. Farms, especially big ones, have no idea how much a single cow eats, moves, drinks, her body temperature, stress levels, ideal housing conditions, sickness, and so on [17]. Without accurate, clever, and timely data, managing individual cows is all but impossible [14, 15]. However, new digital technologies have the potential to close the data gap [20]. Second, smartphones and computers are now used by more than 50% of the world's population to access the Internet [5]. As a result, countless numbers of farmers who raise animals now have simple access to computing power [7]. In addition, technological progress is still being made in many areas. New technology is created every day for the benefit of people and their comfort [10].

For all of the aforementioned benefits and increased production from animals, artificial intelligence is essential [11]. In this sector, artificial intelligence will fundamentally alter the playing field. Today, local farmers and large dairy farms use fodder without fully understanding how it affects milk [13]. The quantity and quality of milk are affected by changes in the animal's diet and way of life, as well as by changes in the climate and environment [11].

The earliest mentions of intelligent robots and artificial beings can be found in Greek myths [10], and Aristotle's development of syllogism and its use of deductive reasoning marked a significant turning point in humanity's quest to understand its intelligence. Despite having long and deep roots, the history of AI as we know it today is less than a century old. The 1950 publication of English mathematician Alan Turing's article "Computing Machinery and Intelligence" was instrumental in the birth of artificial intelligence [10, 26, 34]. The term "artificial intelligence," which the community later adopted, was first coined by John McCarthy in 1956 at his first academic conference on the subject [28]. However, the investigation into whether or not machines are capable of thought began much earlier. By the middle of the 1960s, major funding for artificial intelligence research was coming from the Department of Defense in the United States, and AI labs had been set up all over the globe [30]. The Lawrence Radiation Laboratory in Livermore also launched its artificial intelligence group at the same time, under the direction of Sidney Fernbach [20]. Over the ensuing years, as researchers investigated strategies for performing tasks deemed to require expert levels of knowledge, such as playing games like chess and checkers, the field quickly advanced [30].

2.3. Widely Used Automation in the Dairy Sector. Automation has assisted dairy farm owners in overcoming the challenges of locating workers willing to perform manual labor at dairy farms with the aid of lasers, sensors, and data collection [29, 35]. One benefit of automation is that animals appear to have adapted to this new technological trend and prefer robots [36].

2.3.1. Drones. Drones are quickly becoming an important tool in the dairy sector [9]. While farmers are familiar with traditional technologies, they are increasingly calling for the use of drones to take on more complex tasks. For example, drones can be used to check fences and the herd in general, as well as to help herd cows from fields to barns [6]. Furthermore, drones are being used by modern dairy farms to map, examine, and photograph pastures in order to monitor growth [28]. The sophisticated algorithms powering the drones are even capable of recognizing cows specifically and distinguishing them from deer or other similar animals. This has been a great asset to the dairy industry, as it can help farmers save time and money by automating the process of herding cows. In addition, drones can be used to monitor animal health, identify and track diseases, and provide early warnings of potential issues [9]. The data collected by drones can then be analyzed to improve herd management strategies. Taken together, the use of drones in the dairy sector has been a major boon for farmers, offering a host of benefits that would not be possible with traditional technologies.

2.3.2. Robots. Robots are becoming increasingly popular in the dairy sector, thanks to their ability to increase productivity, reduce labor costs, and improve biosecurity measures [17, 26, 35]. The most common use of robots in the dairy sector is robotic milking machines or milk bots. These machines are designed to automatically identify the teats and milk of the cows, while also cleaning the udders. Milk bots have been found to be both efficient and time-saving, with some studies suggesting that they can reduce the time spent on milking by as much as 30% [17]. Furthermore, they can also reduce labor costs, as they do not require human labor to operate [26].

Robots can also be used to clean and sanitize the barn, improving biosecurity measures and creating a healthier environment for the cows [35]. This is especially important in the dairy sector, where the presence of bacteria, viruses, and other pathogens can cause serious harm to the cows and their milk production. By using robots to regularly clean and sanitize the barn, farmers can significantly reduce the risk of disease transmission and contamination [35]. Additionally, robots can also be used to monitor the cows and provide farmers with valuable data on their health, such as temperature, body weight, and milk production [17].

2.3.3. Utilizing 3D Printing. 3D printing is a revolutionary technology that has been rapidly gaining popularity in recent years. It is commonly used to produce complex machine parts, which can be particularly useful to farmers in rural areas as it can save them valuable time and even money, depending on the part required [26]. 3D printing can also be used to reproduce food, which has a wide range of potential applications. One example is cheese, which, due to its simplicity in changing states from solid to liquid, is one of the simpler foods to reproduce using 3D printing [16]. According to some studies, printed cheese is softer, less sticky, and more dependable than nonprinted cheese [11, 16, 29]. However, not all consumers may be interested in the idea of printed food, so the challenge is to create food that has a benefit, in terms of price, taste, or nutrition [36]. For example, some researchers have proposed creating new shapes for cheese that would be more attractive to consumers and also easier to store and serve [36]. Furthermore, 3D printing can be used to combine different food layers, creating a product that is both visually appealing and nutritionally balanced [36]. In this way, 3D printing can be a powerful tool for improving the quality and variety of food available to consumers.

2.3.4. Augmented Reality. Augmented reality (AR) is an innovative technology that enables the real-time blending of digital data with the environment experienced by the user [28]. It has been found to be highly beneficial in many different applications, such as increasing the visual appeal of food and accurately determining the right serving sizes [36]. Furthermore, AR can also be used to monitor and assess cows for producers. For example, AR can provide farmers with real-time data on the health and well-being of their animals, allowing for more efficient and effective management of their livestock [37]. Additionally, AR can be used to improve the accuracy of milk yield estimation and to better identify potential health issues [38].

The use of AR in the agriculture industry has a number of potential benefits. For instance, it can help to reduce the labor costs associated with traditional methods of animal monitoring and assessment, while also providing more accurate data [39]. Additionally, it can help to reduce the risk of human error when recording and analyzing data, thus improving the accuracy of results [40]. Furthermore, AR can also be used to provide farmers with helpful information about their animals such as body temperature, body composition, and nutrition levels [41].

2.3.5. A Virtual Reality. Virtual reality (VR) is a digital environment created by technological apparatus that can be manipulated to appear real [28]. It is a powerful tool for customers to get a better understanding of the origin of their dairy products [17]. For example, a dairy farm owner can create a virtual tour of their barn for their customers to explore. By using a VR headset, customers can experience the farm and learn all about the origin and production of the dairy products they purchase. The virtual tour can also include a detailed description of the process of milking the cows or the entire process of cheese making.

VR also provides customers with an immersive experience and allows them to interact with the environment. For example, customers can scroll from side to side to get a better view of the entire dairy barn. They can also click on different objects and get more information about them. This experience can give customers a better understanding of the origin of their food and make them feel more connected to the producer.

Finally, VR can also be used to educate customers about the importance of animal welfare and sustainability in the dairy industry. Through virtual tours of the barn, customers can see how the animals are treated and how the production process is conducted. This can help to raise awareness of animal welfare and the importance of sustainability and encourage customers to make more informed decisions about their dairy purchases.

2.3.6. Blockchain. It is increasingly being explored as a means to provide food traceability and safety, as consumers become increasingly curious about the origins and production processes of the food they consume [9]. Blockchain is a distributed ledger technology, which is a form of distributed database system, which allows for data to be securely stored and shared [42]. It can be used to connect each link in the food supply chain, from the producer to the consumer. This allows for better transparency and trust between the stakeholders involved in the food supply chain [43].

The potential of blockchain technology to provide food traceability and safety is significant. For example, by connecting the points of origin, production, and distribution, it can be used to track food items from farm to fork, providing a detailed view of the food's journey [44]. This can help to ensure that certain safety standards are met and that food is not contaminated or adulterated during the journey from producer to consumer. It can also be used to detect food fraud and counterfeiting, as it can be difficult to trace the origin of food items in traditional supply chains [44].

Blockchain can also be used to store and share product data, such as expiration dates, nutritional information, and allergens [42]. This can help to ensure that consumers have access to accurate information about the food they consume, allowing them to make informed decisions. Additionally, blockchain can be used to provide access to more detailed information about the production process, such as the use of chemicals and pesticides, the labor practices used, and the environmental impact of the production process [42].

2.3.7. The Internet of Things. The Internet of Things (IoT) is a revolutionary technology that is transforming the dairy

industry. It enables the connection of multiple devices and systems, allowing for the collection of data and sharing of information [26]. This data can be used to improve the efficiency and profitability of dairy farms [21]. For example, IoT allows for the operation of automated milking systems and the monitoring of animal health and feed intake [21]. By leveraging the data from these systems, farmers can determine the health of their animals and make adjustments to their management practices accordingly. Additionally, the data can be used to generate reports, such as daily herd performance, which can help farmers make more informed decisions about herd management [21].

IoT also enables the integration of other overhead technologies, such as sensors and tracking devices [21]. These technologies can be used to monitor the environment in the barn, allowing farmers to make adjustments to ensure optimal conditions for their animals [21]. Furthermore, IoT can be used to connect the dairy farm with the marketplace, allowing farmers to market their products more effectively and efficiently [21].

Together, these overhead technologies are opening doors for the dairy industry to increase productivity, profitability, and efficiency [21]. By leveraging the power of IoT and connecting it to other technologies, farmers can gain access to data that can be used to make informed decisions and ensure the success of their operations. With the continuing advancement of IoT technologies, the dairy industry is certain to benefit from improved efficiency and profitability.

2.4. Application of Artificial Intelligence in Livestock Farming. Livestock farming can be streamlined by artificial intelligence in a variety of ways as presented in Table 1. Advanced predictive analytics and computer vision are used in many of them. To better understand the range of AI's potential in this field, let us look at some of the most typical use cases.

2.4.1. Animal Identification. Previously, farmers would keep manual records of their animals to learn information about them, including their health history, age, reproductive status, growth rate, and eating habits [23, 45]. Processing this data and gaining insights from it are made easier by artificial intelligence [14, 15, 20, 28]. The farmers can fully automate the identification of livestock by using computer vision [35]. To access all the pertinent details about the status and past of a specific animal, one only needs to scan the identification number of the code [20]. Even smaller animals, such as chickens, can now be individually identified rather than as a flock thanks to artificial intelligence [35]. This lessens the epidemiological risk and makes it possible to improve welfare in these particularly difficult circumstances [6].

2.4.2. Automated Weighing Systems. Weighing is essential for ensuring quality control [46]. Both individual and group animal weigh-ins are possible (again, this applies more to poultry and other small animals) [35]. What matters is that animals that try to avoid using the scale frequently experience stress when doing so [47]. This has an impact on both their well-being and the efficiency of the procedure [48]. Making the process as quick and easy as possible is essential in light of this [49]. This is made easier by automation. Sensitive sensors eliminate the need for manual scanning by accurately detecting weight in a fraction of a second and automatically registering the results in the database [20, 23]. This data can be processed by an artificial intelligence system, and insights can be drawn from it to help improve farming practices [17]. The system can determine relationships between an animal's weight and history by identifying that animal [19]. Processes for quality assurance are streamlined as a result [8].

2.4.3. Animal Welfare Monitoring. Artificial intelligence has the potential to significantly enhance animal welfare while simultaneously lowering epidemiological risks [6]. Using sound analysis, animal activity, feeding and water intake patterns, radio frequency identification, and other precision livestock farming technologies, animal health and welfare can be monitored using AI [23, 26].

2.4.4. Monitoring Drinking and Feeding Habits. The Internet of Thing (IoT) devices equipped with computer vision can record the patterns in the drinking and feeding habits of the livestock, giving the farmers useful information [34]. The sensors assist in that process by tracking levels and rates of consumption both during the day and at night to track animal behaviors and spot anomalies [11]. Farmers can recognize animals with unusual eating habits, which may be an indication of behavioral or health problems, using the data processed by the AI system [34]. Additionally, they can use the data they have collected to discover relationships between a specific food and the weight and health of the livestock [36]. As a result, it develops into a crucial quality control tool [28].

Analysis of movement patterns, posture, and activity patterns can be done using the same tools as those mentioned above. These patterns are crucial for efficient quality control [18]. Animal health can be significantly predicted by factors like activity levels during the day and night, movement, and posture [50]. Computer vision and machine learning algorithms can locate them, categorize them, and link them to the symptoms of the specific issue, automatically raising an alert [7]. Technologies in livestock farming to enhance animal handling include cow movement analysis, which identifies cow behavior and activity and monitors feed intake and rumination [17].

2.4.5. Identifying the Feces. The feces can provide valuable information about the welfare of animals [51]. Farmers can automate their inspection using computer vision to find anomalies rather than having to do it by hand [36]. The animal's feces will also contain bacteria if it is infected with them. Based on the examined sample, the artificial intelligence system can identify contamination risks quickly and give the farmer insights [6]. A mechanism like that is an important part of practices for preventing epidemics.

2.4.6. Monitoring Heat Stress Using Temperature Analysis. Monitoring heat stress is another way artificial intelligence can enhance animal welfare [36]. Farm animals are

Table 1: Different applications of AI in livestock.

Application	References
AI in animal surveillance and conservation	Kumar et al. [61]
AI for automated milking	Costa et al. [62], Fuentes [63]
AI detection of mastitis	Sun et al. [64]
Modern precision of livestock farming	Vaintrub et al. [65], [66], Nääs et al. [67]
AI in FCR improvement	Neeteson-van [68]
AI in temperature measuring and controlling in chicken	Bloch et al. [69], Detsch [70]
AI in data collection	Nabwire [71], Arel et al. [72]
AI for detecting estrus	Dineva et al. [73]
Use of robot for doing vaccines for poultry	Thomas et al. [74], Patel [35]
AI to increase the quality of feed	Sahni [75], Kumar [76]
AI to track one's health	Ezanno [36], Alonso et al. [77]
AI (facial recognition technology) to enhance animal health	Billah [78], Kakani et al. [79]
AI to the food supply chain	Monteiro [80], Dora et al. [81]

frequently subjected to high temperatures due to the high density of livestock in a relatively small area, which frequently has a detrimental impact on both their physical and mental health [52]. To detect heat stress early and determine health status, a livestock management system and camera technology are used [23, 53]. The sensors built into the AI-based system can gather data on temperature, extract insights about its rises and falls, and link it to specific actions or behaviors [11]. The machine learning model recognizes patterns that increase the risk of heat exhaustion and sends a real-time alert when the temperature reaches the level that has been designated as dangerous [8]. The farmers can introduce improvements in this area by using the data they have collected [19].

2.4.7. Monitoring Livestock. Much like animal excrement, livestock vocalizations can provide farmers with important information about the welfare of their animals [54]. Animal vocalization anomalies can be recognized and categorized using a machine learning algorithm that has been trained on audio data taken from the recordings [18]. The farmer can obtain a thorough picture of the condition of his livestock by combining this information source with the earlier mentioned [30]. Live recordings can also be used to manage the interactions and interactions between farm animals [18]. The system gives the farmer the ability to stop the spread of any pathological behaviors and take immediate action if they do occur [13].

2.5. Monitoring and Changing the Conditions for Aquaculture and Sheds. Artificial intelligence is useful for managing conditions in addition to managing the welfare of livestock [26]. It is essential not only for the caliber of their goods but also for everyone's safety and regulatory compliance [16]. Conditional modifications of a minor nature (humidity, temperature, space, brightness, etc.) may have a significant impact on other crucial processes, including the breeding process' productivity [14, 15].

2.5.1. Creating Feeding Routines. It has already been mentioned that feeding and drinking habits can be used as signs of an animal's welfare [6]. Finding the best feeding schedules to boost productivity and maximize product quality while minimizing costs can be done using the data gathered for monitoring purposes [16]. Given a large dataset, the algorithm (ideally a deep learning algorithm) can determine the relationship between specific feeding patterns and the desired behaviors/quality of the product [29]. The farmer can test different setups and identify the best ones with the help of advanced analytics [35]. This has a positive impact on farming productivity as a whole, of course.

2.5.2. Evaluation of the Pasture. Using computer vision, livestock farming businesses can automatically monitor the pasture conditions to determine whether they offer the animals the best possible conditions for feeding [12]. The pasture can be rated by the AI recognition system, which uses a trained algorithm to generate recommendations [7]. It may, for example, record bare patches and pastures that do not meet the standards for quality due to fungus, dryness, or other pertinent factors [26]. The farmers can also estimate the amount of pasture that is available for the animals based on the registered image and then determine whether these figures are in line with the daily allowance that is recommended based on the weight of the animals [35].

Hatcheries can be made better so that farmers can provide the best environment for the development of the embryos inside the eggs [29]. The conventional method of production that uses animals cannot be used in industrial settings [16]. Replicating the environmental conditions that the eggs experience during natural hatching is a challenge for farmers [35]. Because the incubation process can be impacted by changes in humidity and temperature, it calls for accuracy and continuous monitoring. The artificial intelligence system connected to the incubators and sensors can extract and assess the pertinent data to find any condition changes that might prevent the embryos from developing normally [35]. The farmer can implement improvements to keep an incubation process going based on these realizations [12]. While doing so, it keeps track of how specific health issues affect fertility, learning from this data and adjusting its suggestions as necessary [36].

2.5.3. Detecting Live Embryos in Eggs. Early detection of nonhatchable and infertile eggs shields farmers from unnecessary expenses while maximizing hatchery space use and raising productivity [11]. It can be accomplished by combining near-infrared hyperspectral imaging methods with machine learning [13]. To quickly remove the latter from the hatchery, farmers train machine learning algorithms with datasets containing images of fertile and infertile eggs. Computer vision can be used to monitor the development of embryos as well as identify fertile eggs [34]. Poultry producers are beginning to make incubators available that have a time-lapse imaging system and the right software to process the visual data and make inferences from it [12]. The machine learning model, which was trained using images that show the proper embryo development, is capable of spotting anomalies at each stage and notifying the hatchery managers so they can prevent waste and keep productivity as high as possible [7]. In addition, if such a system is coupled with sensors, it gives them perceptions of the influence of the circumstances on embryo development [9].

2.5.4. Sex Determination. Using artificial intelligence to determine sex could end the contentious practice of killing male chicks on farms [35]. The livestock producers can switch to a more moral, yet also more successful, model by determining the sex during the first few days of incubation. Magnetic resonance imaging (MRI) and artificial intelligence models that assess and categorize the images can make it possible [13].

2.6. Reproduction Monitoring and Identifying Breeding Seasons. For breeding program optimization, livestock producers can also use predictive analytics. The artificial intelligence system can track the female animals' cycles and when they go into heat, recommending the ideal time for insemination [17]. What is crucial is that different environmental factors affect the likelihood of fertilization. Based on the fusion of all these data, the system suggests the ideal times for breeding [7].

2.6.1. Artificial Intelligence for Estrus Detection. Dairy farms depend heavily on their ability to accurately identify heat (or estrus) [55]. Farmers are now able to avoid losses brought on by incorrect estrus detection thanks to advancements in AI technology and its applications [56]. Throughout the day, the motion sensor-equipped collar fastened to the cow's neck gathers all kinds of information about the animal [21]. Data is processed by artificial intelligence components of the dairy automation system to reveal information about heat stress, changes in feeding efficiency, and cow estrus [17]. Special hormones that influence the cow's behavior and movement are released when the estrus cycle occurs [57]. A cow in standing heat, for instance, is more likely to stop moving for a prolonged period so that others can mount her [58]. The AI component can anticipate the cow's ovulation period by comparing recently collected data (about movements) with previously stored data [21]. The ovulation period begins 24 to 32 hours after the onset of "Standing heat," giving the farmer enough time to get ready for artificial insemination of the cow in heat [58].

2.6.2. Robotic Vaccine Delivery System. Today, dairy farm animals must receive hundreds of vaccinations and reproductive medications from farmers [59]. Each dairy farm would need to invest significantly in labor and training if it intended to administer vaccines manually [23, 60]. Modern dairy farms administer vaccines and reproductive drugs to domestic animals on the dairy farm using a robotic injection system to ensure a sustainable economic future for dairy farms and to achieve a 100 percent compliance rate [36]. With a dairy automation system, the robotic system is integrated [8]. The robotic injection system reads the tags that are attached to the cow's ear to obtain data on the cow's health and vaccination history [7]. If the cow needs an injection, the needle is pointed in that direction, and the injection mechanism positions itself to deliver the medication to the cow's neck [18].

2.6.3. Facial Recognition. Facial recognition is nothing new, but it is now being applied to domestic cattle as well as to humans. The use of physical tracking devices is still largely required by existing systems, even though "smart" cattle monitoring is becoming more widespread [35]. By removing the hassle of installing these devices, facial recognition technology will make it simple to keep an entire herd under observation with little human interaction [17]. This is intended to allow for individualized group behavior monitoring, early lameness detection, and precise feeding habit recording [28].

2.6.4. System for Automatic Milking. The automatic milking machines have sensor cups that can be individually fastened to the teats of cows [21]. The teats can be automatically cleaned and sanitized by the machines as well. Machines can also detect the milk's color, impurities, and quality [26]. The milk is diverted to a different container if it is unfit for human consumption [9].

2.6.5. Automatic Robot Feeder. This device feeds farm animals a concentrated mixture of roughage based on their nutritional needs [8]. Slatted floors were cleaned by a scraper robot. It relentlessly pushes and scrapes, easily navigating narrow spaces and ensuring clear, slurry-free surfaces.

2.7. Artificial Intelligence for Prediction of Breeding Values of Livestock. Machine learning techniques such as decision trees and artificial neural networks (ANNs) are increasingly used in agriculture because they are fast, powerful, and flexible tools for classification and prediction applications, especially applications including nonlinear systems [82]. These techniques have been used to detect mastitis [83], detect estrus [84], and discover the reasons for selection. Decision trees and related methods are also used in the analysis of breastfeeding curves [85], interpretation of somatic cell count data [86], and assessment of reproductive management efficiency [87, 88]. In addition, ANN is used to predict total agricultural milk production [89], 305-day milk yield prediction [90, 91], and detection of mastitis [92]. Fuzzy logic, which involves the classification of variables into fuzzy

sets with a degree of membership between 0 and 1, recently found a way into agricultural research [93]. The application included the development of a decision support system for analyzing test day milk yield data from the Dairy Herd Improvement (DHI) program. Currently, there are various contemporary groups focused on the identification and monitoring of mastitis and estrus through automated milking systems and genetic evaluations. The contemporaneous groups for the detection of mastitis and estrus from an automated milking system and genetic assessment [94]. The creation of appropriate membership functions is the main obstacle when using membership functions (MFs). The time and computational effort required to make MF decisions can be decreased by using ANNs, which are relatively easy to build. Developing a morphological evaluation utilizing artificial intelligence involves both conceptualizing and executing a comprehensive approach. Designing and implementing a morphological assessment with AI [14, 15]. It can be used for character development based on an animal's shape (through edge detection).

2.8. Artificial Intelligence in Transforming Genomics and Gene Editing. One area in that AI is significantly evolving is genomics, the study of the complete set of genes within an organism. When researchers can sequence and analyze DNA, AI systems make faster, cheaper, and more accurate; with this insight, they can make decisions about care, what an organism might be susceptible to in the future, what mutations might cause different diseases, and how to prepare for the future [95]. It is estimated that 90% of the entire world's digital data is less than five years old [96]. As AI is being used, it has already been used to solve several genomic-related issues, including locating nucleosome positions, splice sites, promoters, and enhancers. There have been documented successes in "editing out" disease-causing genes or "editing in" genes that produce high-yielding, disease-resistant animals [96].

2.9. Advantages and Disadvantages of AI. Livestock farmers now can significantly enhance the welfare of their animals thanks to artificial intelligence technology [29]. Not only from an ethical and legal standpoint but also for the quality of their products, it is crucial [8]. Smart technology and cutting-edge software make it simpler than ever to keep an eye on the living conditions of the animals and spot any anomalies that might harm them [9]. The system also keeps track of animal behavioral patterns and connects them to specific variables and their combinations. This enables the farmers to maintain the highest standards of quality while increasing production [29]. Livestock farmers can lessen their industry's negative environmental effects and stop questionable, unethical, and unsustainable practices [35]. Artificial intelligence provides farmers with unrivaled support, enabling them to minimize resource use, improve the sustainability of their feeding patterns, and increase farm productivity in general, especially when it comes to reducing the carbon footprint [18]. Artificial intelligence makes it simple to enter data into farm records, monitor farm activities, analyze economic performance, improve animal health, and increase soil fertility [16]. In general, AI is a blessing for boosting efficiency and productivity while also lowering the possibility of human error [50]. AI promises precision in livestock farming, but if farmers are unable to understand the data and put it to use, the information is useless [36]. Producers can use artificial intelligence to simulate human decision-making to provide interpretations and solutions for the data gathered by sensors and other hardware technologies [13].

A few drawbacks exist as well, such as the expense of development and the potential for automation to replace them [50]. However, it is important to remember that the artificial intelligence sector has the potential to generate jobs, some of which have not even been imagined yet [9]. Therefore, unemployment, the high cost of technology such as drones, which can be expensive to build, rebuild, and repair, and the large amount of data needed to train AI are all issues [8]. Additionally, hackers can use AI solutions to gather private information [6].

2.10. AI Model Development for Livestock Farming. AI has the potential to drastically improve efficiency in livestock farming, from identifying and tracking livestock to predicting the most optimal feeding and breeding strategies. This review proposes a well-defined model for the implementation of AI in livestock farming, outlining the various steps and challenges that need to be addressed.

AI-based models can be used to analyze data from various sources such as sensors, imaging, and other digital systems to provide insights into animal health and performance. AI can also be used to predict disease outbreaks, identify animal health issues, and provide early warnings for potential threats to production. For instance, the AI-based cattle health monitoring system developed by Roulston et al. [97] is used as an example of how AI can be implemented in herd health monitoring. Furthermore, the AI-based feed management system developed by Zhang et al. [98] is highlighted as an example of AI's application in feed management. Additionally, the AI-based disease detection system developed by Li et al. [99] is discussed as an example of AI's potential in disease monitoring. Thus, any proposed AI model for livestock farming should be tailored to the specific needs of the farm and should include various components as follows:

Therefore, the first step in developing a model is data collection, which involves gathering data that can be used to develop AI models. This can include data from sensors and cameras that have been installed in the livestock farms, as well as data from other sources such as weather and soil data. Once the data has been collected, it needs to be cleaned and preprocessed before it can be used in the AI model development process. The second step of the proposed model is data analysis. Here, the data is analyzed and visualized to gain insights into the behavior of the livestock and the environment. This is done by applying various techniques such as machine learning, deep learning, and natural language processing to the data to identify patterns and trends. The third step of the proposed model is model development, which involves creating AI models that can be used to predict the behavior of the livestock. This can include predicting the optimal feeding and breeding strategies, as well as

forecasting the future health and productivity of the livestock. The fourth step of the proposed model is model deployment, which involves deploying the AI models on the livestock farms. This can be done using a variety of platforms, such as cloud-based solutions or embedded systems. The fifth step of the proposed model is model evaluation, which involves evaluating the AI models to ensure they are performing as expected. This is done by collecting data from the deployed model and analyzing it to identify any areas of improvement or potential risks. The sixth and final step of the proposed model is model refinement, which involves using the feedback from the model evaluation to improve the AI models. This can involve tweaking the model parameters or incorporating new datasets to improve the accuracy of the model.

In conclusion, the proposed AI model for livestock farming should be tailored to the specific needs of the farm and should include components for data acquisition, model development, model validation, model deployment, and model maintenance. This model should be regularly monitored and updated to ensure that it continues to provide accurate and reliable results.

2.11. Futuristic Applications of AI. The impact of AI on the day-to-day activities of the traditional family farm has not yet been fully determined, even though it has been hailed as the farming industry's future [30]. The "digital farm" of the future, however, might be closer than we realize thanks to new agritech companies that are producing increasingly affordable technology [19].

Due to consumer pressure, farmers' attention will likely shift from minimizing their environmental impact to improving the conditions in which the animals are kept [100]. According to that reasoning, over the past few years, artificial intelligence has significantly advanced several different industries [36]. And over the coming decades, there is a strong possibility that the impact could grow even more [11]. The agricultural sector must keep up with the rest of the world's digitization [10]. Farmers can optimize livestock farming and enhance animal welfare by utilizing new technologies and artificial intelligence [6]. Given that many consumers place a high priority on animal welfare, it is crucial to pay attention to this issue [36]. Animal welfare must be taken into account if agriculture is to continue being profitable and sustainable [54].

3. Summary

Because it lessens the workload of the manager and other farm staff, artificial intelligence is a crucial alternative for the management of livestock farms around the world. Artificial Intelligence is an appropriate and effective technology in livestock as it optimizes resource use and efficiency. It is also a suitable technological advancement to feed the world's expanding human population. It largely resolves the issue of resource shortage. Artificial intelligence and machine learning in general are all about enhancing human effort rather than replacing it.

Conflicts of Interest

There is no known conflict of interest.

Authors' Contributions

Awoke Melak participated in the conception/design of the work or the acquisition, analysis, and drafting of the review paper; Tesfalem Aseged participated in drafting the review and revising it critically for important intellectual content; Takele Shitaw participated in the final approval of the version to be published. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved is subjected to all the authors.

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