Technology and Prospects of Smart Precision Livestock Management in Korea

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Abstract

Globally, the livestock industry is facing serious problems such as meeting the demand for livestock products that have increased exponentially with population growth, decreasing the number of livestock farms and increasing the size of farms, global warming, overall environmental destruction, and overuse of antibiotics. In addition, in Korea, the average age of the livestock industry is aging, resulting in a shortage of livestock workers, and livestock productivity is also low compared to advanced countries in livestock farming.

Precision Livestock Farming (PLF) is an innovative animal husbandry practice that uses modern technology to collect data on every animal on the farm and uses that data to optimize management practices by reducing inputs or increasing overall farm productivity. Although PLF is still in its infancy, it is emerging as a viable and promising solution to this problem. The Rural Development Administration of the Korean government actively supports the introduction of ICT-integrated PLF in the livestock industry, providing large-scale policy funds every year to help farmers introduce the necessary technology for PLF.

PLF is a key technology that solves the problems facing the livestock industry in Korea and around the world. Through PLF, farmers will be able to increase production, expand farms, maximize productivity, and meet growing livestock demand while remaining conscious and responsible for their environmental impact.

Keywords: Smart Precision Livestock Management, Sensor Technology, Cow, Internet of Things

1. Introduction

The problems facing the livestock industry show three different problem trends globally. First of all, as the world's population continues to grow, the demand for livestock products such as meat, eggs and dairy products is growing almost exponentially. Second, while the number of livestock farms and arable land area have been continuously declining for several years due to limited land availability, livestock farming is becoming larger. Finally, serious global environmental problems such as global warming, deforestation and general environmental degradation and the overuse of antibiotics are increasing the detrimental effects on livestock. In addition, in Korea, the average age of the livestock industry is in a situation where sufficient manpower is not supplied due to aging. In addition, livestock productivity is low compared to developed countries in livestock farming, so a plan to fundamentally solve this problem is required.

Precision Livestock Farming (PLF) is an innovative animal husbandry practice that uses modern technology to collect data on every animal on a farm and uses that data to optimize management practices by reducing inputs or increasing overall farm productivity. Although PLF is still in its infancy, it is emerging as a viable and promising solution to this problem. The Rural Development Administration of the Korean government actively supports the introduction of ICT-integrated PLF in the livestock industry.

PLF enables farmers to increase production, expand farms, maximize productivity and meet growing demand for livestock products while remaining conscious and responsible for their environmental impact.

2. Status and pain points of the Korean cattle industry

2.1 Enlargement of Farms and Aging of Workforce

The problems of Korean livestock farming are the enlargement of farms and the aging of farm owners. The total number of livestock farms was 99,000 households as of December 2020, down -13.1% from 114,000 households. In addition, the proportion of people in their 60s or older in livestock farms reached a whopping 63%. Intensifying population aging leads to a decrease in productivity and competitiveness of the livestock industry, which is expected to eventually result in a contraction of the production base of the livestock industry. To overcome these difficulties, the government supports ICT-based smart livestock farming technology support budget of several billion wons annually.

2.2 Difficulties in estrus, parturition, and disease detection

● Difficulties in cattle estrus management

Farmers' greatest interest is in cattle breeding management and efficiency in calf production. The

average calf production cycle in Korea is 420 days, and to produce one calf a year, which is the level of developed countries, it is possible to shorten the conception period by 55 days from the current level. A way to shorten the gestation period is to immediately determine when the cow is in heat. Although the farmer can take measures such as artificial insemination for a cow whose heat has been determined, if the heat period is missed, it leads to failure of breeding management and a decrease in milk production. As such, the identification of cow heat has a direct impact on the productivity and profits of livestock farmers. On the other hand, the enlargement of livestock farms, decrease in the number of workers, and aging rapidly increase the number of cows that one livestock manager must manage, making it practically difficult to determine the cow's heat through direct visual observation of the manager as in the past.

● Difficulties in disease control in cattle

Existing cattle disease detection methods rely on manager's self-detection and veterinarian's examination. Most of the managers visually inspected the appearance of the cattle, observed the behavior of the cattle, and checked the remaining amount of feed to prevent diseases based on the appearance, and treated them after the disease appeared. do. In this way, because of the dependence on post-treatment and the absence of disease prevention monitoring technology in advance, the custom of overusing antibiotics to prevent disease in advance has become established in farms. According to a survey in 2017, the use of livestock antibiotics in Korea is at a serious level, twice that of developed countries and 30 times that of Europe. In the government, several ministries under the Prime Minister's Office are jointly implementing national antibiotic management measures. There is a blood collection method as a way to prevent the health condition of cows in advance, but it is stressful for cows and difficult to bear in terms of cost, so it is urgent to develop disease prevention technology that monitors biometric data in real time.

● Difficulty predicting delivery

As a result of factory-style intensive breeding in dense shed environment, it is difficult for cattle to give birth naturally, and the risk of calving accidents is high when there is no human help. The mortality rate of Korean cattle calves is about 13.2%, and such a loss of a calf due to a calving accident, the farm's monetary loss amounts to 3 to 4 million won; thus it is urgent to introduce PLF that can help reduce calving accidents by accurately predicting the upcoming calving events.

3. PLF Technologies in cow shed

3.1 Electronic animal identification

Uses electronic animal identification systems to easily identify individual animals on the farm and automatically maintain separate records. By doing this, the farm can be able to measure the conditions, behaviors, and performance of each individual animal on a farm automatically. Representative electronic animal identification mainly consists of radio frequency identification tags (RFID), including bolus, ear tags and injectable glass tags. RFID provides an easy and inexpensive way to identify, track and monitor livestock, thereby improving the traceability of animals along the supply chain. With the introduction of RFID technology into practical farm management, management software has been developed that automatically stores individual daily records (eg treatment, growth performance, pedigree, breeding performance, etc.) (Ruiz-Garcia and Lunadei, 2011). Currently, the most widespread and used EID in Korea is the electronic ear tag. Recently, rumen bolus is also slowly spreading because of its accuracy. (Rutter, 2017).

3.2 Low-cost feed and water intake recording

Water meters and various types of feed intake sensors are used to record information about cattle feeding and drinking behavior. This information, collected over a period of time, provides historical trends and projected levels of feed and water intake, which can be used to trigger early warning systems should cattle's feeding and drinking habits change due to several factors, such as disease or adverse situaltional conditions.

Water meters and different types of feed intake sensors are used to record information on the feeding and drinking behaviors of farm animals. This information, collected over a period of time provides a historical trend and expected levels of feed and water intake, which can then be used to trigger early warning systems in case the feeding and drinking habits of animals change, which might be due to several factors like disease or unfavorable condition.

3.3 Automated weighing systems

Since weight is one of the most important indicators of cow health and livestock productivity, an automated weighing system is a common technology that comes with all PLF applications in one form or another. A platform known as “Walk-over-Weigh” (WOW) has been developed and applied to the dairy industry (Brown et al., 2015). WOW consists of a box specifically designed for animals to walk on, allowing body mass to be estimated using continuous averaging techniques

(González-García et al., 2018). Information on the weight of farm animals is very important in animal husbandry. For example, by obtaining information about body weight and recording feed letters, a model can be set up and used for prediction and management intervention.

3.4 Reproduction monitoring: oestrus, upcoming calving, disease

3.4.1 Oestrus Detection

Due to the economic importance of breeding productivity and the effectiveness of introducing artificial insemination, new sensor-based computerized methods for estrus detection are being widely introduced in the Korean cattle sector after successful application in the dairy sector. Among the early automated methods for estrous detection, pedometers appear to be the most widespread (Abeni et al., 2019). In recent years, sensors like accelerometers, temperature sensors, and ph sensors fitted to animals and connected to a network become popular in establishing an Internet of Things (IoT), making the basic premise of integrated PLF monitoring systems for monitoring animal activity and predicting oestrus. .

In particular, the need for remote estrus detection in cattle is strongly emphasized in breeding management. Cows in heat show unusual changes in activity, body temperature, and rumen movement. The development of accurate estrus detection machine learning models is critical. Body temperature reflects the physiological activity of the animal's body and therefore reflects the animal's state of health. Rectal temperature is usually the most common and accurate method, but manual measurements are time-consuming, labor-intensive (Zhang et al., 2019). To overcome this problem, other types of measuring devices have been developed and used, such as the bolus (eg WellCare, smaXtec), which is administered by mouth to the cow, stays in the rumen and accurately measures the cow's internal body temperature. Since the bolus device should have a battery life of more than 4 years, the measurement interval and transmission method of the sensor are very important. This well-developed device greatly contributes to the increase in livestock productivity of farmhouses.

3.4.2 prediction of calving time

A reliable prediction of calving time is very important for cattle breeding. In fact, prompt intervention by farmers during calving can help avoid calving losses in cows who are in poor health or require assistance at farrowing and reduce the possibility of calf injury due to maternal or environmental factors. An accelerometer and body temperature sensor were also used to detect labor. In particular, by detecting a drop in body temperature before delivery, an increase in lying time, and a decrease in activity or feed intake, these sensors can predict the delivery time. An accelerometer is also mounted on the tail to detect tail movements associated with delivery. In this way, the farmer can be notified of an impending calving via app notification (WellCare®, CalveSense®, SCR Engineers Ltd.; Moocall®; smaXtec®).

3.4.3 Early Disease Detection

By accurately measuring the body temperature of the object, it is possible to manage the health of the object through continuous alarms by measuring the rise in body temperature due to disease occurrence, the drop in body temperature before childbirth, and the number of drinking water intake (decreased intake compared to the previous day). As a product that provides perfect heat detection and alarm, it helps improve farm productivity through health management of individual cattle.

3.5 Application of advanced data analytics to big data

As more and more technologies are adopted on livestock farms, more and more data and data points are generated every day and continue to grow exponentially. Opportunity to continuously monitor animals regardless of day or night, without time limit, which is practically impossible to observe by humans, and to accumulate large amounts of big data on animal behavior and activities for a long period of time without direct human intervention. , providing access enables advanced data analysis. In case of unusual behavior, you will be immediately alerted, which is a huge advantage for farmers who can intervene immediately (Waterhouse, 2019). In addition, wearable sensors and field technology can collect useful information not only for estrus and farrowing detection, but also for overall livestock management, from disease treatment planning or feed supplementation. In the context of curbing antibiotic use, the development of tools to monitor cattle behavior and detect disease in advance could be of immeasurable importance in supporting farmer decision-making and facilitating interventions in livestock before disease problems begin. To process the accumulated data, the data analysis part must function equally well. Advanced data analytics with big data and machine learning capabilities are needed to ensure that the data generated is used to address pressing issues in animal health and animal husbandry. The advantage of PLF technology is that this advanced data analysis allows farmers to predict and respond to farm conditions in real time.

4. Future perspectives and conclusions

The application of PLF in animal husbandry has several advantages, as discussed previously.

- Optimization of input and maximization of output

through big data analysis

Because the PLF environment provides access to a large amount of information about the grazing behavior and activities of animals over long periods of time that is difficult for human observers to access, farming operations are precise, support a variety of farmer decisions, and solve problems. It has the advantage of facilitating intervention in the gamsul before losing. In this respect, PLF makes livestock operations precise. This also means proper use of limited resources. PLF increases the profitability of livestock farms by reducing costs and increasing overall production of animal products.

PLF makes farming operations precise. This means the appropriate use of limited resources in case of inputs. By reducing costs and increasing the overall yield of animal products, PLF increases the profitability of livestock farms. The economic benefits of applying precision farming are significant and necessary to attract more farmers to livestock farming to meet the increasing needs for animal products.

- Accurate farm management and reduced farm labor.

As the number of farmers decreases and the number of animals on the farm increases, it is impossible for the farmer to keep track of all the animals. PLF does this by reducing farm labor and giving farmers convenient access to critical and reliable information. It enables precise management by helping to make scientific decisions in real time even when the workforce is aging. Many parts, such as animal behavior analysis and real-time monitoring of animal health, are automated, and as a result, many farm workers are not required. A reduction in farm labor means farms are more scalable and therefore more productive and profitable.

In conclusion, precision livestock farming has great potential to solve the pressing problems of today's livestock industry, such as increasing demand for livestock products, decreasing and aging farmers, increasing farm scale, and environmental issues. At the individual farmer level, two of the most important things are increasing productivity and profitability and allowing limited resources and time to be allocated only to what matters. Proven technologies for precision livestock farming can be supported and commercially available for individual farmers to adapt to their needs.

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