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Sow culling decision-making support system using machine learning model

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Abstract. In recent, Korea hog farm industry is facing FTA and stock farms are experiencing difficulties through increase in production cost such as raw & subsidiary material cost and energy cost. Although there are many elements that influence the productivity of hog farm, plan and execution of sow culling is very important. In majority of farms, there are many cases of not considering importantly of the culling of sow with deteriorating production efficiency. Farms desperately need a system that can reduce their feed cost and production cost through sow culling decision-making. Accordingly, the proposed system uses machine learning model to compared data such as sow's corresponding parity and mean parity of sow to provide expected culling status of sow to user. User manages sow by checking the three steps of culling notification status of good, warning and culling and makes decision of culling, thereby expected to reduce the feed being wasted and production cost.

Keywords: Sow, Culling, decision-making, machine learning model

1 Introduction

Korea hog farm industry is faced with a situation of inevitable head-on competition with advanced countries in livestock from opening of import market through FTA signing [1][2]. In addition, many livestock farms are experiencing difficulties due to increase in production cost such as raw & subsidiary material cost and energy cost [3].

In addition, productivity of low that is lower than that of advanced countries in hog farm is not being helpful in advancing the hog farm industry [4].

To overcome such situation and increase the stability and profit of hog farm, it is necessary to enhance national competitiveness, improve productivity and reduce production cost. Although there are many elements that influence the productivity of hog farms, plan and execution of sow culling is very important [5]. In majority of farms, there are many cases of not considering importantly of the culling of sow with deteriorating production efficiency. Accordingly, farms desperately need a system that can reduce their feed cost and production cost by culling sow with low production efficiency.

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Accordingly, this paper proposes a sow culling decision-making support system using machine learning model. The machine learning model of this paper is an automation method of the process of obtaining knowledge by analyzing data through computer, and it plays a core role today in the area of artificial intelligence. Machine learning model is being used in the area of agricultural management to support decision-making in production such as production amount forecast and production abnormal entity discovery or support decision-making in the area of management such as supply chain management and customer management [6].

In the proposed system, hog farm industry worker enters data such as sow parity, piglet production amount, crossbreeding frequency, after estrus, disease number and lactation capability. It comparatively analyzes input data and data stored in database such as sow's average piglet production amount per parity to provide notification GUI indicating that sow with deteriorating production efficiency needs to be culling. Through the three steps of good, warning and culling, notification GUI allows user to make decisions on the raising or culling of sow. Based on this, difficulties of livestock farms can be solved by reducing feed and production costs

The composition of this paper is as follows. In related study, it introduces decision-making system using machine learning model and existing sow culling system, and the main part explains the implementation screen of the proposed system's composition diagram, database composition diagram and process design. The conclusion of this study will discuss the expected effect of system and future study direction.

2 Related Research

The purposed of this study is to apply machine learning model method and existing culling system of specification management to comparatively analyze input data and data stored in database to provide sow culling notification GUI to user. Through the three steps of good, warning and culling notification GUI, user can make decision on sow raising and culling.

2.1 Machine learning model

Although machine learning method has been widely used in the area of business and engineering, studies using machine learning and data mining are increased also in the area of agriculture. It is widely being used in the area of bio-informatics along with the growth of agricultural bio-engineering, and it is also being used in weather information analysis, agricultural product quality decision and precision agriculture. McQueen’s thesis titled Applying machine learning to agricultural data and Scott Mitchell’s An investigation into the use of machine learning for determining estrus in cows were pursued in 1995 and 1996 respectively by applying machine learning method to production data and business data [7][8]. In 2003, diverse studies such as Pietism’s Induction and evaluation of decision trees for lactation curve analysis and Kirchner’ s The analysis of simulated sow herd datasets using decision tree technique were pursued [9][10].

2.2 Sow's culling decision system

The paper titled 'optimization of the decision tree technique applied to simulated sow herd data sets' conducted in 2006 compared 4 kinds of Sow culling decision methods by establishing 3 types of farms(high, medium, low level productivity) having different technical levels. In the experiment comparison, 4 types of methods such as current culling, random culling, culling using C4.5 algorithm and culling using C4.5 algorithm including pruning algorithm of each farm were employed, and the study compared based on the weaning number which shows Sow's productivity. As results of study, it was revealed that Sow's culling decision using C4.5 algorithm is a very superior method and it was also found that culling decision can be automated through mass data [11] [12].

3 System Design

Figure 1 is a composition diagram of the proposed system. Hog farm workers store the data value of sow parity and piglet production amount. The stored data is stored by formatting the data collected through management system. It provides sow data and expected culling status to user through user's PC upon comparatively analyzing the data values stored in database. Based on this, user can make decision and implement sow culling period to reduce feed and production costs.

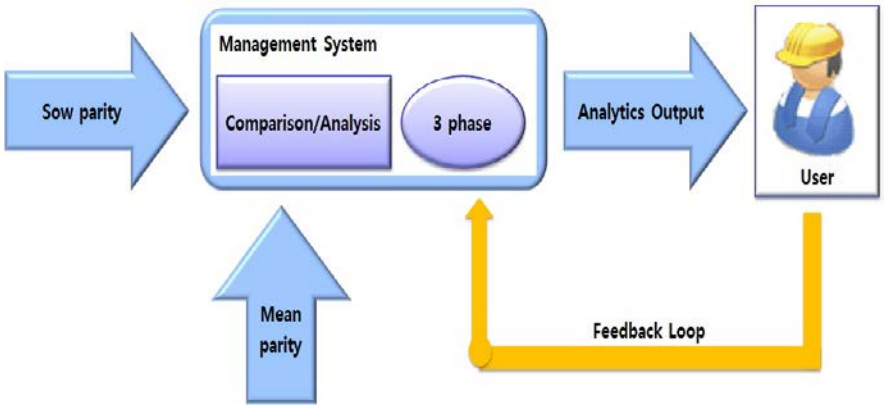

Fig. 1. A composition diagram of the proposed system.

The following table has been established based on the research contents of Choi Y.C 'Machine Learning Application to Support Sow's Culling Decision' which was published in 2010 for the purpose of comparing with/analyzing Sow's data value user entered. Culling decisions from second through fifth calving let user know by comparing/analyzing accumulated weaning number. Decision after sixth calving enables user to make a decision by comparing to weaning number accumulated before third calving after comparing with/analyzing accumulated weaning number.

Table 1. Sow Data Following Table

Parity	Weaning number total	Third parity weaning number total
2	16	-
3	28	-
4	38	-
5	50	-
6	60	26 down
7	70	26 down
8	79	25 down

Figure 2 is the database table composition diagram of integrated management server. As for the composition of table, it consists of corresponding parity and mean parity. The corresponding parity consists of sow parity, piglet production amount, crossbreeding frequency, after estrus, disease number and lactation capability. Mean parity consists of parity, mean number of weaning piglets and mean rut cycle date. As sow's parity proceeds, the number of weaning piglets decreases. It compares the number of weaning piglets according to mean parity of sow in the mean parity with corresponding parity to notify the expected culling status of sow to user. Accuracy of sow culling can be increased by compared data such as crossbreeding frequency according to parity and rut period.

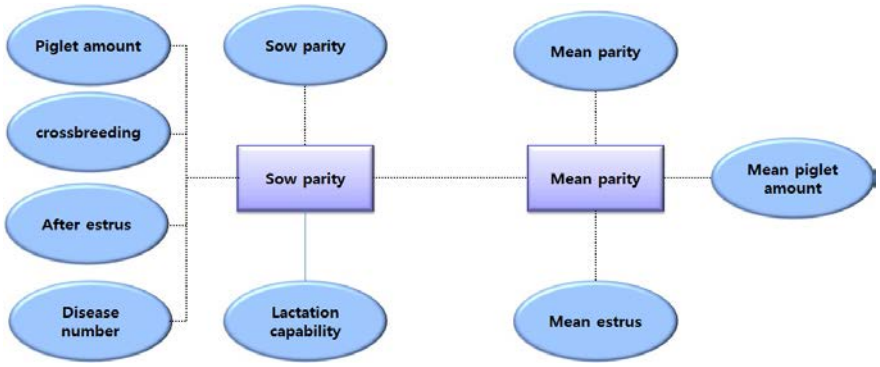

Fig. 4. Implementation of the sow breeding management application

Figure 4 is a GUI of the proposed breeding management application for managing sow. The tab (a) is the expected estrous date of sow, pregnancy status, and expected delivery date, and it notifies to user expected delivery date when pregnancy succeeded and next expected estrous date when pregnancy failed. Tab (b) is the weight, daily feed consumption amount, back-fat thickness, vaccine status and disparity of each sow for the management and inquiry of sow breeding information.

Fig. 5. Sow breeding management application of Message alarm GUI

Figure 5 is a screen of notification message to pig raising workers when the expected estrous date and current date correspond with each other. Since estrous cycle of sow is 19~23 days and continuous estrous time is only 40~60 hours, there are many cases of missing optimal estrous period. Users can conduct artificial insemination during optimal period through the notification of expected estrous of sow. When pregnancy succeeded, it provides to user expected delivery date by adding 16 weeks (112 days) of pregnancy period stored in the database of integrated management server and current date, and it outputs expected estrous date by adding it with 22 days of estrous cycle when pregnancy failed.

4 Conclusions

The current circumstance of the domestic pig raising industry is that it lacks systems on sow breeding management with significant individual differences, and its domestic sow productivity is at a low level compared to that of advanced pig raising countries. For the purpose of solving this issue, there is a need for systematic breeding management such as weekly batch management of sow and maintaining the health of pregnant sow. Since sow estrous cycle and expected delivery date are being manually written in domestic farms, however, there are difficulties in the weekly batch management of sow and breeding management in real-time.

This paper proposes an application that allows the registration, inquiry and management of sow information by extracting the unique key value of QR code. Using the proposed application, existing issues in sow breeding management can be supplemented and the productivity and income of farms can be maximized through systematic sow breeding management. It can provide convenience to users by allowing them to manage the inconvenience of manually writing breeding management through smart phone, and it allows the inquiry and management of sow information in real-time.

Based on this, it is expected to improve productivity to allow our country to become an advanced nation in pig breeding at the national level by providing convenience to users.

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