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USING SIMULATION AND MACHINE LEARNING TO INNOVATE LONG-TERM PRODUCTION AND OPERATIONAL PLANNING

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ABSTRACT

In this study, machine learning and simulation technologies are applied to forecast future egg production operations on the basis of production cycles of egg laying hens. Internal business data and related historical external economic data are used to provide information that is more accurate for decision-making in production and operational planning, extending until the end of the production cycle. The key performance indicators required for long-term production planning, including average fodder costs, production output, and total sales of a production cycle, are designed and collated to help long-term production planning and operation, including fodder procurement and egg marketing strategies as well as financial decisions for each poultry production cycle.

1 INTRODUCTION

Long-term production and operational planning are highly complicated in poultry production. Managers of poultry production operations constantly attempt to improve estimates within biological constraints, established by the life cycle of hens, and external constraints from the business environment, such as egg sale prices between poultry farms and egg dealers, the total poultry supply of specific regions, and the domestic importing amount for eggs. Long-term production and operations plan resulting from this study is to provide significantly more accurate information, including average fodder costs, production output, and total production cycle sales, regarding operational and financial data from poultry farms.

2 DECISION-MAKING PROCESSES USING MACHINE LEARNING AND SIMULATION

Ainan Farm is one of the largest long-established poultry farms in Chita town, Aichi Prefecture, Japan. The main chain farms in Ainan are primarily engaged in hen breeding poultry operations for producing consumption eggs. The business has one egg hatching farm and one fertilization factory which recycles fowl droppings to promote environmental conservation. This study targets poultry production cycles of the main chain farms on the basis of related actual business data inside and outside the farms.

An example of a decision-making process using machine learning and simulation is shown in Figure 1. The steps involved in the decision-making process to aid a long-term production and operational planning are described below.

[Step1]: Data preparation involves extracting data from actual historical business data warehouses. Data include the historical egg-laying intensity, poultry viability, fodder consumption, and other information from decision-makers.

[Step2]: Data analysis using machine learning is responsible for providing appropriate data for Step 3. For example, egg sale prices between poultry farms and egg dealers could be forecast using linear regression models based on historical sale price data, total poultry supply of specific Tokai region, and domestic egg importing volume.

[Step3]: Input data and input parameters are then prepared to be used in the simulation models of Step 4.

[Step4]: Simulation models are created which represent real poultry production operation activities. The simulation models will use input data as prepared in Steps 1 through 3.

[Step5]: Simulation results are used to make long-term operational management decisions, including average fodder costs and production output for each week, plus estimates of total sales and costs of a production cycle.

[Step6]: Evaluation of simulation results is gathered from Step 5 to aid long-term production and operational planning, addressing fodder procurement, egg marketing strategies, and financial decisions for each poultry production cycle.

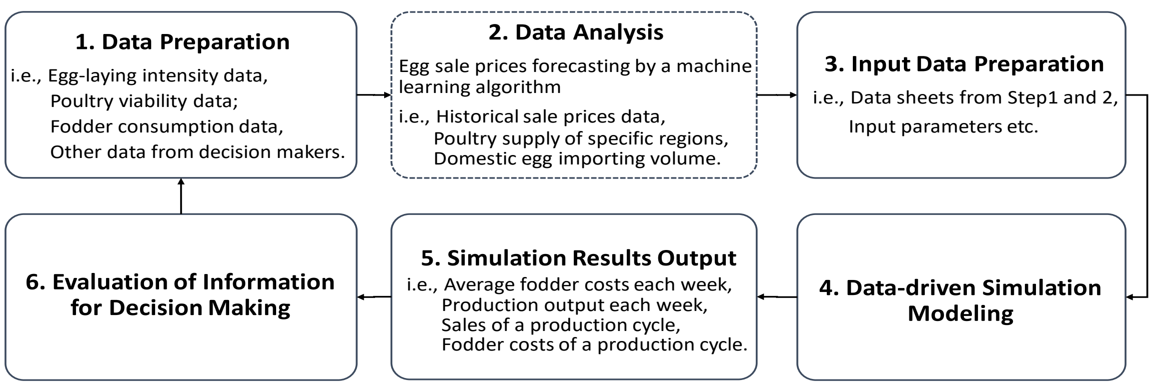

Figure 1: Decision-making processes using simulation and machine learning.

3 CONCLUSION

This study applies machine learning and simulation technologies to actual poultry production planning and operation management. A machine-learning algorithm is designed to learn the complicated relationships between internal business data and related external economic data to forecast egg sale prices more accurately. Then, data-driven simulation models are presented to analyze the operating performance for each poultry production cycle. As a result, overall modeling flexibilities of machine learning and simulation can be key drivers to dramatically innovate and aid long-term production and operational planning in the poultry industry.

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