The Design of the Network Remote Interactive Livestock and Poultry Feed Formula System

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Abstract. In response to the current scientific requirements for livestock and poultry feeding, combined with current network technology, a remote livestock and poultry feed formulation system is proposed. In this system, the requirements of the system are analyzed first, and then the overall system architecture is constructed according to the requirements. Based on the construction of the overall structure, the main feed formula of the system is optimized by algorithm. Finally, the result of feed formula optimization is given.

Keywords: Network Remote, Linear Programming, Feed Formula

1. Introduction

In the past, manual calculation was mainly carried out by trial and error method in feed formula. In this method, it is necessary to determine the ratio of various feeds based on experience, and then multiply it with the ratio of nutrients in the feed, and finally add up to determine the sum of various nutrients. [1] Finally, it is tested whether it meets the feed standard. If it does not meet the standard, the ingredients need to be increased or decreased, and the final requirements can be reached after reasonable adjustment and calculation. [2] This method is widely used, the operation is relatively simple, and the calculation difficulty is relatively low. However, it is relatively cumbersome, low in efficiency, and has a certain degree of blindness. It has been difficult to meet the requirements of production in the development of modern animal husbandry. With the development of computer technology, it has gradually penetrated into all areas of production and can be applied to feed formula calculations. The application of this technology has certain advantages. Compared with the traditional manual calculation mode, it has higher efficiency and accuracy and is helpful to improve production efficiency. [3-5] At present, many companies have launched different types of special formula software in response to the needs of the feed formula field, but these software functions are relatively single, most of which are concentrated in the feed formula design, and lack the overall consideration of the feed design process, which should involve raw material procurement and formula design and multiple processes such as production and sales. Therefore, the above factors should be fully considered in the design of the feed formula decision-making system, the relationship between the various factors should be clarified, and the design should be carried out from a systematic perspective to meet the needs of actual production. [6-8]
2. System requirement analysis

In this study, the related work of system research was first conducted, and experts in this field were invited to propose the requirements for the dairy cow feed formula decision-making system. Through understanding, it is found that the requirements of the system are mainly concentrated in the following aspects:

In the system design, it is necessary to analyze the actual production needs first, and summarize the shortcomings in the feed formula design business. Among them, the user provides target planning and linear planning, which provide a basis for the system design.

At present, there are certain shortcomings in the formulation design. Most of them are designed for a single product, considering the cost and other factors, and are committed to achieving the highest cost performance. [9-10] This design method is also called single recipe design. However, this model is not universal and cannot be effectively applied in many cases. In practice, feed companies do not just produce a single product. In the production process of multiple products, it is necessary to consider the distribution of restrictive raw materials to ensure that the cost is reduced on the basis of meeting production requirements, thereby forming the best formula design technology.

In some systems, many commonly used formulas have been provided to users. In addition to these formulas, users can design by themselves to meet the requirements of actual applications.

Since the design of the formula cannot be guaranteed to be completely reasonable, the user may put forward certain opinions and suggestions during the use process, which needs to be optimized and adjusted according to the user's feedback information, such as adjusting the ratio of raw materials to improve the effectiveness of the formula. Therefore, the feedback information is actually the place where the original formula is adjusted, thereby forming an improved formula or a new formula.

Various types of historical formulas have been uniformly stored in the library, and can be retrieved and inquired during use, and then analyzed and optimized for these formulas to meet the application requirements of the current stage.

Considering the analysis requirements of users, the formula analysis system provides a detailed list of nutrients, amino acid balance maps, etc. The staff may have insufficient experience when designing the formula, so the expert experience information is stored in the database in advance, and the formulator can set certain query conditions for inquiries, as the basis and guidance of the work, and improve the rationality and scientific nature of the formula design based on this method.
3. Process design of milk cow feed formula preparation activity

For the dairy cow feed history formula record, the stored information is mainly the past operation process information, which is oriented to the single formula operation process. In the specific design, it needs to follow a certain process. The first is the process of user identity information verification. The user here is mainly a formulator who needs to enter his login information for verification. If the login information is correct after comparison, you can log in to the system smoothly. After entering the homepage, you can select other modules. If the verification fails, it will automatically exit and prompt the user with the corresponding error message. You need to enter the login information again for verification. After successfully logging in, you need to continue the follow-up process, including selecting the appropriate planning algorithm, setting the feed standard, etc. During this process, you need to operate according to expert tips, select the appropriate raw material and perform the calculation process. Then calculate and analyze the raw material information. The process needs to use the formula model. If the calculation results are obtained, continue to analyze the cost, compare and analyze different formula methods, and output and store the calculated results, which can be used as historical records; If there is no solution, you need to select the appropriate planning algorithm again, and continue to calculate and compare. According to the above process, the optimal formula can be obtained. The activity diagram of the above process is shown below.

![Activity Diagram](image)

Figure 2. Milk cow feed formula design activity diagram

4. Feed formula optimization algorithm design

4.1. Linear programming algorithm design
Linear programming method can be used in the optimization design of feed formula, which has been applied in many fields. From the principle point of view, the algorithm is actually implemented based on the principles of operations research. It can describe the constraints and influencing factors in the feed formula through a specific linear function, and then set appropriate constraints and calculate the target based on this value. The specific process of this method is as follows:

4.1.1. Basic conditions of linear programming
Certain prerequisites need to be met when using linear programming to provide necessary support for feed formulation design. The specific conditions are as follows:

(1) There are different ingredients in the feed, corresponding to different raw materials, and the amount of various raw materials used is expressed as a basic decision variable \((x_j)\), the nutritional components and the price of raw materials change little, and the amount of raw materials used is within a certain range change.

(2) Mainly realize the minimized formula cost and use it as the only objective function. The nutrient content in the raw material is positively correlated with the specific usage.

(3) Each linear function is the corresponding constraint condition. Since there are many linear functions, a set of constraint conditions for linear programming is formed.

(4) The interaction relationship between different chemical components in the raw materials is ignored in the planning, and the component data can be added.

(5) At the benefit level, the formula that meets the maximum benefit under the constraints is the best formula; at the cost level, the best formula is the formula with the lowest production cost.

4.1.2 The realization process of linear programming
The specific process of the linear programming algorithm can be divided into the following steps:

(1) First, a preliminary design of the linear programming model is required, where the execution function is expressed as, lineprogramming() continues to execute the next step.

(2) The process of performing parameter initialization settings, including variable counter sum, etc., where sum is initially the quantity of raw materials; flag=1; M is a constant, and a larger initial value is set.

(3) Subtract each decision variable from the corresponding minimum value, and then input it into the model, so that new variables can be obtained. In this process, the substitution method is used.

(4) The process of model standardization includes the following stages:
   ① Analyze and set according to the characteristics of the objective function. For the case of calculating the maximum value, set a coefficient less than zero.
   ② Set according to the value of \(b_i\) in the constraint condition. If it is lower than zero, set the inverse setting.
   ③ Combine the specific signs of the inequality for processing. For the case of "\(\geq\)", you need to add \(\text{sum} + 2\), while adding artificial variables and subtracting the slack variable; for the case of "\(=\)", you need to add \(\text{sum} + 1\), just add artificial variables; in the case of "\(\leq\)", you need to add \(\text{sum} + 1\) to add remaining variables.
   ④ Make a reasonable design for the variable coefficients in the objective function. The coefficients of artificial variables, slack variables, and residual variables are M, 0, and 0 respectively.
   ⑤ Store the inequality coefficients through the array \(A[i,j]\), and \(C[n]\) and \(B[k]\) respectively store the variable coefficients and \(b_i\), which will be executed after standardization.

(5) Then construct the initial simplex table, and continue with the subsequent steps after obtaining the initial basic feasible solution.

(6) Judging according to the sign of the inequality, select the simplex method when there is only "\(\leq\)", and then jump to the following step ①, if the above conditions are not met, perform (1).

① First judge whether the optimal solution is obtained, and judge the test number
\[ \sigma_j = c_j - \sum_{i=1}^{m} c_j \sigma_{ij} \] of xj. If the condition is met \( \sigma_j \leq 0, j = m + 1, \cdots, n \), then flag=1, and continue to execute (2’’), if the condition is not met, jump to (3’’).

② The objective function value is output, which is the return value of lineprogramming(), and the coefficients of all decision variables are obtained, and the program operation ends.

③ If there is a \( \sigma_k \) corresponding situation \( P_k \leq 0 \) in \( \sigma_j \leq 0, j = m + 1, \cdots, n \), the problem is determined to be unbounded, and the execution process is terminated. If this condition is not met, proceed to step (4’’).

④ Determine the swap-in variable and swap-out variable, combine with \( k_j = \max(\sigma_j) \), to get the input variable \( X_k \), and then calculate according to the rules, the formula is as follows:

\[
\theta = \min_i \left( \frac{b_i}{a_{ik}} a_{ik} > 0 \right) = \frac{b_k}{a_{ik}}
\]

From this, the swapped out variable is xj, and then continue to execute ⑤.

⑤ Perform the iterative calculation process, where the main element is \( a_{ik} \), and the corresponding column vector of \( X_k \) is,

\[
P_k = \begin{bmatrix}
a_1 \\
a_2 \\
\vdots \\
a_m \\
a_{1k} \\
\vdots \\
a_{mk}
\end{bmatrix} \quad \text{Transform to} \quad \begin{bmatrix}
0 \\
0 \\
\vdots \\
1 \\
0
\end{bmatrix} \quad \text{The first line}
\]

After replacing x1 in the XB column with xk, a new simplex table can be obtained, and then steps ①-⑤ can be repeated. Then execute:

(1) Determine whether there is a solution. When there is no non-zero artificial variable in the base variable, it means that there is a solution, and then continue to jump to (2); then continue to determine whether there is a feasible solution, and when it is satisfied \( \sigma_j = c_j - z_j \leq 0 \), it still exists Non-zero artificial variables indicate that there is no feasible solution.

(2) Solve according to the specific steps of the simplex method to obtain the optimal result.

If linear programming is implemented in the feed formula system, inequalities need to be added to the formula model, but the traditional solution method cannot be used to solve the problem because of the high complexity and difficulty in solving. In this research, the above-mentioned problems are analyzed and improved methods are proposed, which can reduce the complexity of the solution. This method is mainly to subtract the decision variable from the minimum value. In this process, the substitution method is adopted. Based on this method, new decision variables can be obtained and then input into the model, thus simplifying the process of solving.

5. System verification result
Taking the formula of a dairy cow weighing 600 kg as an example, suppose the milk production of the dairy cow is 25 kg and the milk fat rate is 3%. According to the feeding standard, the energy required by the cow is 140.01MJ, the crude fiber is 20% of the dry matter of the diet, and the protein, calcium, phosphorus, and salt are 1605.03g, 143.44g, 98.62g and 46.65g, respectively. Therefore, according to the above criteria, under the lowest cost objective function, optimization is performed through linear
programming, and the optimization results in Table 1 are obtained.

| Project            | Linear programming |
|--------------------|--------------------|
| Premix             | 0.2                |
| Salt               | 0.042              |
| Dicalcium Phosphate| 0.23               |
| Stone powder       | 0.122              |
| Soybean cake       | 2.936              |
| Urea               | 0.1                |
| Corn               | 7.897              |
| Corn silage        | 13.79              |
| Leymus chinensis   | 1                  |
| Corn stover        | 2.5                |
| Total weight       | 28.817             |
| Fine to rough ratio| 11.527/17.2        |
| Cost/day•head      | ¥12.364            |

6. Conclusions
It can be seen from the above research that the feed formula system constructed in this article can not only realize the remote management of the feed formula, but also realize the optimization of the feed formula. Of course, the above design is only a preliminary design for some of the main functional modules. The next step is to design the system in detail again.

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