Implementation of a Decision Support System for Optimizing Feed Rations in the Cattle Fattening Industry

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Abstract*: Mentor Village is a village located in Sumberasih District, Kab. Probolinggo. The majority of the population makes a living as farmers and ranchers. Mentor villages are committed to improving the economy through community empowerment, MSMEs, and village-owned enterprises (BUMDES). Mentor Village Empowerment carried out by the proposer is currently entering its second year. In the first year, Mentor Village empowerment was focused on developing fermented feed, developing product diversification, and developing an E-Commerce system for farmer groups. As a result, several diversified processed products made from corn and fermented feed have been formed, used for fattening livestock. The first year of empowerment also produced fermented feed, which was developed to improve nutrition and utilize corncob waste which is widely found in Mentor Village. Currently, BUMDES cattle fattening has been running for one year, but the process of fattening cattle is not optimal. The main problem is that the fattening process is not going well because of the difficulty in determining the optimal feed ratio according to the cows' nutritional needs per day. To solve this problem, a decision support system for determining the feed ratio is used. The system developed uses a genetic algorithm to calculate the optimal feed ratio for the needs of cows per day. The optimal value for the number of generations is more than 700. These tests can be concluded that the greater the number of generations, the better the fitness value obtained. This happens because the process of iteration is more so than the genetic process often occurs. The optimal combination for crossover rate and mutation rate is 0.6:0.3 and 0.5:0.4. The combination results prove that the exploitation process is more likely to occur by increasing the mutation rate to maintain the exploration process. Therefore, the crossover rate has a higher value by considering the mutation rate to maintain exploration. It is hoped that this optimization system for cattle feed rations can help companies determine feed rations by cows' nutritional needs per day. This system has been tested for three months in actual conditions and increases the bodyweight of beef cattle by 20% more than before.

***Index Terms*: Genetic Algorithm, Feed Ratio, Nutrition, Beef Cattle.**

I. INTRODUCTION

In 2019 the BUMDES of cattle fattening was established as one of the business businesses of the Mentor village. Industry fattening cattle is also a means and a forum for people who have been cultivating and fattening cows individually. BUMDES is also an effort from the village government to improve the community's economy in Mentor Village, the majority of whom work as farmers and ranchers. The BUMDES organizational structure consists of the person in charge, secretary, treasurer, and members.

The government has carried out efforts to increase milk production for beef cattle to increase the population with one of its programs, namely SIKOMANDAN. However, farmers must balance these efforts in the development of dairy cattle in terms of productivity. The factor that affects the productivity of dairy cattle is feed (Schmidt, Van Vleck, & Hutjens, 1998). The feed given to livestock for a day and night is called a ration (Ensminger, 1992). The feed has a function to meet the needs of beef cattle to carry out daily functions such as walking, eating, and lying down. The balanced nutrition of beef cattle will help build new tissues and produce milk production (Despal, Permana, Toharmat, & Amirroennas, 2017). In addition, the cost of providing and using it by farmer's feed requires 70% of the total production cost (Shiddieqy, Widiawati, & Ramadhan, 2017). Therefore, the ratio needs to be arranged according to the nutritional needs to avoid a loss in terms of feed costs and productivity.

The preparation of a balanced ratio can be done computationally using linear programming. However, in linear programming, there are still weaknesses in the solution. According to Pesti and Seila (1999), when the variability between feed ingredients is neglected, the chances of achieving their nutritional requirements are only 50%. In addition, the rigidity of the limiting function, where the calculation process only follows the rules of the limiter. This will lead to complex solutions (Anderson & Earle, 1983). Another method is a genetic algorithm that can solve the preparation of rations in a non-linear manner (Furuya, Satake, & Minami, 1997). The genetic algorithm method is a search method based on the idea of natural selection that occurs in the process of evolution and genetic operations (Stjepan, Jakobovic, & Gloub, 2013). This algorithm has advantages compared to linear programming, namely getting global optima search results rather than being trapped in local optima (Russel & Norvig, 2009). Global optima is a genuinely optimal value from all areas of mathematical equations that represent the optimization problem at hand.

Currently, BUMDES cattle fattening has been running for one year but has not experienced a significant increase both in terms of management and increasing business turnover. There are three main problems experienced by BUMDES, namely: The management of the cattle fattening business is carried out poorly without good records, the absence of sound accounting and financial management, and the fattening process is not optimal due to difficulties in determining the optimal feed ration according to the nutritional needs of cows per day.

The fattening process is not optimal because it is difficult to determine the feed ratio for cows according to the nutrients needed by cows. In the previous year's empowerment, a feed fermentation process was carried out by utilizing corncob waste, but the results were still not optimal. The problem in making animal rations is how to manage feed techniques, which include making rations and formulating feed ingredients so that the composition of the ration is by the needs of cattle nutrition standards and the minimum cost of feed ingredients. The composition of feed ingredients is essential in the manufacture of rations to not reduce the nutritional value of the resulting rations. Many breeders provide rations without regard to the quality, quantity, and technique of giving. As a result, the growth and productivity of livestock kept are not achieved as they should.

II. NUTRITION NEEDS IN COW

The calculation of fitness in the preparation of beef cattle rations uses the minimization function to be inversely proportional to the objective function. The objective function, in this case, is calculated from the total cost and optimization of the nutritional content that will meet the needs of beef cattle. Furthermore, in optimizing the function of the nutrient content, it is necessary to have a constraint function so that the solution provided is by the existing rules. The rule, in this case, is the nutrient content that the feed ratio must meet. If the nutritional content of the feed ration is less than the nutritional requirements of beef cattle, a penalty will occur. The penalty is obtained by calculating the required fitness value according to the nutritional needs in Table 1. The chromosomes indicate the feed ingredients used, while the real code value of the chromosomes will be the weight of the feed ingredients. Each content provided by each feed ingredient will be multiplied by the weight variable (pi), where pi is the i-order feed ingredient. The order of i=0 indicates elephant grass feed ingredients, i=1 indicates corn feed ingredients, i=2 indicates tofu dregs feed ingredients, and i=3 commercial concentrate feed ingredients. In the calculation process, each feed ingredient will be converted into dry matter. The following is an example of the calculation of elephant grass feed ingredients (p0) that contain nutrients, namely BK (23.17%), TDN (57.92%), PK (11.46%), Ca (0.050%), and P (0.320 %) can be seen in Table 1.

Table 1. The nutritional content of each feed ingredient

Feed Ingredients	BK (%)	TDN (%)	PK (%)	Ca (%)	P (%)	Price
Elephant Grass	23,17*	57,92*	11,46*	0,050*	0,320*	Rp500,00
Corn	20,18*	47,86*	4,63*	0,050*	0,150*	Rp3.300,00
Tofu Dregs	16,20*	78,51*	21,08*	0,433*	0,181*	Rp3.700,00
Commercial Concentrate	76,37*	61,27*	8,34*	0,379*	0,069*	Rp3.500,00

Source: (Despal, Permana, Toharmat, & Amirroennas, 2017)

III. GENETIC ALGORITHM MODELING

The application of genetic algorithms begins with representing the chromosomes. The coding used is real code which states the weight of each type of feed material in kg. In this case, the selected feed ingredients are elephant grass, tofu dregs, corn, and commercial concentrate to form chromosomes consisting of 4 weight values—the value of the weights formed in the interval [0,100]. Figure 1. represents the chromosomes that make up the composition of the beef cattle ration.

Elephant Grass	Corn	Tofu Dregs	Commercial Concentrate
Feed Weight	Feed Weight	Feed Weight	Feed Weight

Figure 1. Chromosom Representation

In the genetic algorithm process, several chromosomes will be randomly generated as many as the population size that has been inputted. The genetic algorithm has the main component to run the process. These components include encoding techniques, initialization procedures, evaluation functions, crossovers, mutations, and selections. Flowchart Genetic algirithm can be seen in Figure 2.

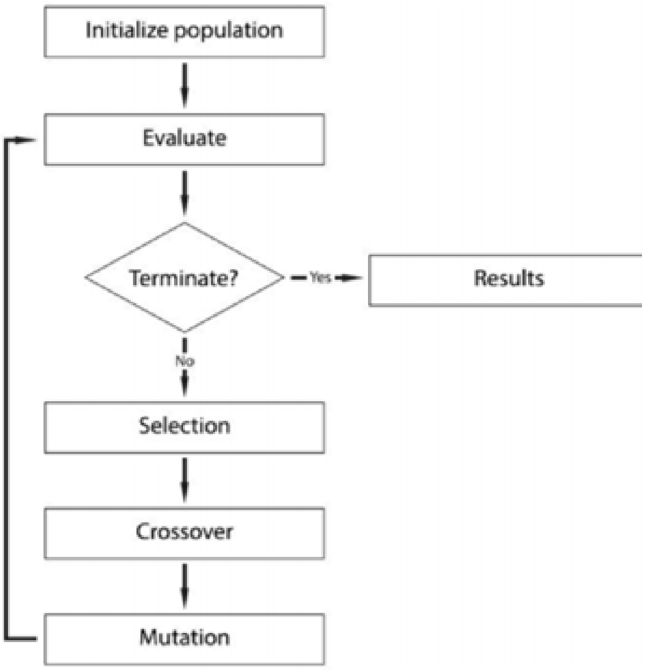

Figure 2. Flowchart Genetic Algorithm (Jacobson & Kanber, 2015).

IV. Decision Support System For Optimizing Feed Rations in The Cattle Fattening Industry

The problem in making animal rations is how to manage feed techniques, including making rations and formulating feed ingredients so that the composition of the ration is by the needs of cattle nutrition standards and the minimum cost of feed ingredients. The composition of feed ingredients is essential in the manufacture of rations to not reduce the nutritional value of the resulting rations. Many breeders provide rations without regard to the quality, quantity, and technique of giving. As a result, the growth and productivity of livestock kept are not achieved as they should. Therefore, it is necessary to build a system that can facilitate cattle farmers in determining the optimal combination of feed rations and minimum cost of feed ingredients. A genetic algorithm can be used in this problem because it has advantages in producing optimal output (Aribowo, Lukas, & Gunawan, 2008). Using the concept of biological evolution will produce an output in the form of the optimal composition of feed ingredients to meet the nutritional needs of cows per day.

The mechanism carried out is made systematic to make it easier for partners to receive the given science and technology. In this mechanism, evaluation is always carried out to see how far the solutions provided have an impact on the business of the Cattle Fattening industry. The achievement of this solution is that partners can implement and use a decision support system for cattle feed rations properly. The features of a decision support system that can optimize feed rations consist of features: input type of feed ration, input number of livestock, display feed ration recommendations, and print feed ration results. In more detail, the features of the system can be seen in Figure 2.

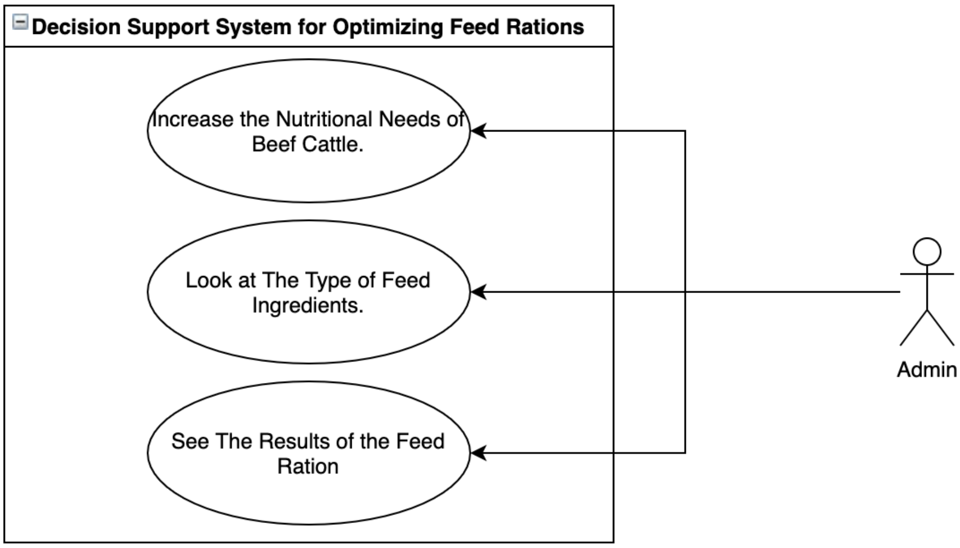

Figure 3. Usecase System

V. RESULT AND DISCUSSIONS

The optimization process for the preparation of dairy cattle rations is carried out using the optimal parameter values obtained from the testing process. In dairy cattle, the weight of elephant grass was 64.0521 kg, corn was 0.0235 kg, tofu dregs was 0.0245 kg, and commercial concentrate was 0.0011 kg. The nutrients contained in the ration were BK 14.8504 kg, TDN 8.6017 kg, PK 1.7019 kg, Ca 0.0074 kg, and P 0.04751 kg.

Overall, the dairy cow ration interface consists of two tabs, namely the first tab entitled Cow-Feed and the second tab entitled Optimization. Figure 4 shows the contents of the first tab, which contains data on beef cattle and feed ingredients. In Figure 5, it can be seen that there are two sub-headings, namely Dairy Cow, which functions for the user to input data on beef cattle. Data on beef cattle consisted of lactation, body weight, total production, milk fat content, and changes in body weight. In addition, on the right, there are results from the calculation of nutritional needs. Calculating the nutritional needs of beef cattle begins with entering dairy cow data, then pressing the Input button. The result of the calculation will be automatically filled after the button is pressed. The nutritional needs that appear are BK, TDN, PK, Ca, and P. Another sub-heading is Feed Ingredients which shows the nutrition of each type of feed ingredient used. The list of feed ingredients is shown in a table which can be seen in Figure 4 The columns of the table are the name of feed, BK, TDN, PK, Ca, P and price.

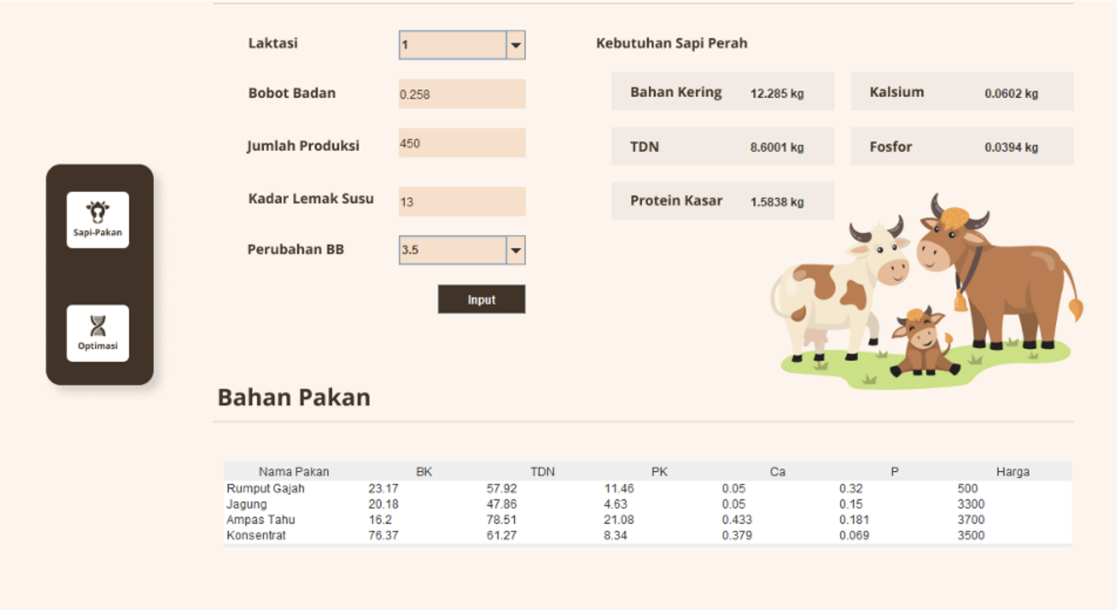

Figure 4. Feed ration tab page view

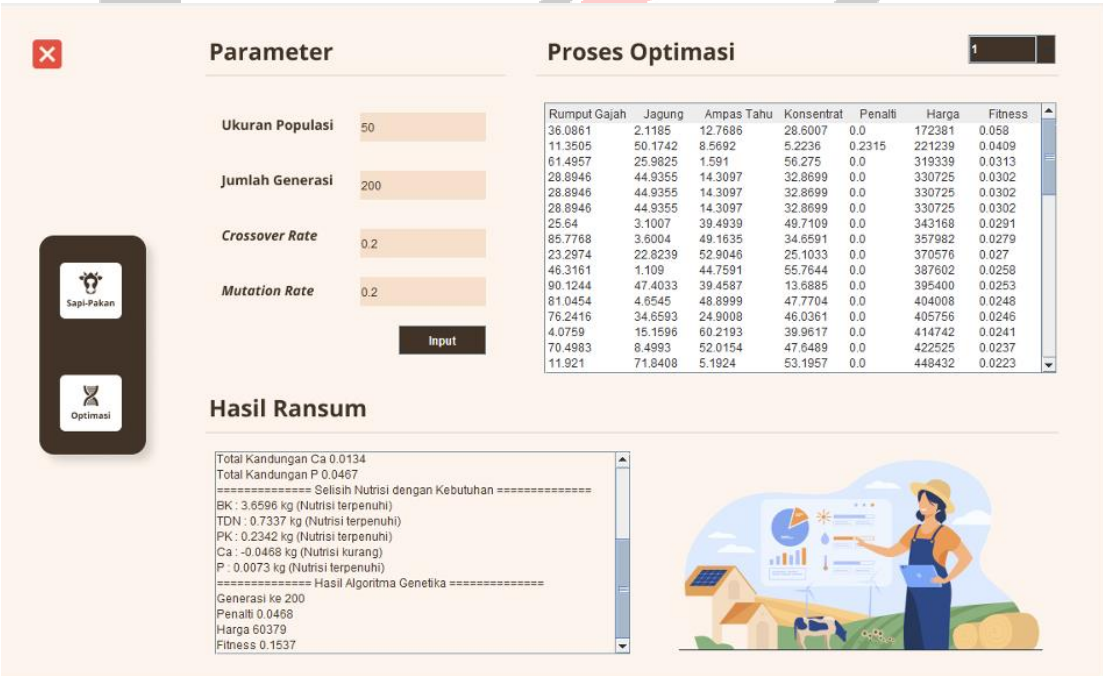

Figure 5. Genetic algorithm tab page view

VI. Conclusions

The optimization process is carried out by testing parameters, namely population size, number of generations, and crossover rate and mutation rate has an influence on the fitness value. Testing on the optimal population size is more than 3250. The larger the population size, the results obtained will be optimal and convergent. The optimal value for the number of generations is more than 700. These tests can be concluded that the greater the number of generations, the better the fitness value obtained. This happens because the process of iteration is more so than the genetic process often occurs. The optimal combination for crossover rate and mutation rate is 0.6:0.3 and 0.5:0.4. The combination results prove that the exploitation process is more likely to occur by increasing the mutation rate to maintain the exploration process. Therefore, the crossover rate has a higher value by considering the mutation rate to maintain exploration. It is hoped that this optimization system for cattle feed rations can help companies determine feed rations by cows' nutritional needs per day. This system has been tested for three months in actual conditions and increases the bodyweight of beef cattle by 20% more than before.

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