**IMPLEMENTATION OF PARTICLE SWARM OPTIMIZATION (PSO) METHOD IN DETERMINING THE COMPOSITION OF ANIMAL FEED IN BROILER CHICKENS WITH MINIMUM COST**

Taslima Dewia) Ismail Huseinb)

Department of Mathematics, Faculty Of Science and Technology, North Sumatra State Islamic University

Medan, Indonesia

a)email: taslima0703191059@uinsu.ac.id
b) email: husein\_ismail@uinsu.ac.id

**Abstract**

*Broiler is one type of vertebrate poultry and the most popular meat for consumption among the people of Indonesia. One of the influences on the growth of broilers is influenced by the feed factor given. The composition of the feed must certainly meet the nutrients needed by broilers at a minimum price. Optimizing the feed composition is done using the Particle Swarm Optimization (PSO) method. The Particle Swarm Optimization (PSO) method is an optimization technique that follows the behavior of a group of living things for their survival such as a group of birds and a group of fish in search of food. In feed optimization using the PSO method, it is determined by looking at several particles and which particle has the largest fitness value. This study aims to see the results of feed composition optimization with the PSO method. From the calculation using the PSO method with the price from the breeder gives a price difference of Rp. 127.5 where the PSO parameters used are and are 0.2 and 0.4 and the values for and are 2.4 and 0.6*.

*Keywords: Particle Swarm Optimization method, optimization, broiler, and feed*

**Introduction**

Food is a basic need that must be met every day, because it functions as a source of energy and can affect growth rates if obtained and processed properly. Good food is food that can maintain health for the body by paying attention to the composition of the food ingredients contained therein [1]. Not only humans must pay attention to the composition of food ingredients but applies to animals, especially those who have livestock businesses (farms) because farms must maintain the health of these livestock.

According to UU No. 41 [2014] on farming and animal health, animal husbandry is all matters relating to physical resources, seeds, breeds, breeding ruminants, feed, tools and machinery, animal cultivation, harvesting, post-harvesting, processing, marketing, business, financing, and facilities and infrastructure. In animal husbandry there is a term known as farm animals, farm animals are animals that are deliberately farmed or raised to meet food needs, help human labour, and as industrial raw materials, for example, such as broiler chickens that are used for meat. The growth of broilers is very fast due to the ability to change the meat produced from the food consumed (feed given) [3].

The broiler farming business was originally a side business of the layer farming business. Over time, many chicken farming businesses have now been established. By producing broiler chickens, businesses that can be established from producing broiler chickens include broiler farming operations and chicken meat processing operations [4]. In Indonesia, the development of the commercial chicken population was recorded starting in the mid-1970s and the development reached its peak in the early 1980s [5].

In feeding the farms want to spend a minimum cost in order to run the livestock business longer. Beef chicken farming is the most efficient and fastest business sector in meeting the consumption of meat needs and does not require a large area of land, and affordable prices [3]. In general, the feed that will be given to broilers comes from manufactured feed and the price of feed is not too cheap. Therefore, this research is intended to provide an alternative to broiler feed, but the mixture of ingredients to be used in making the feed uses ingredients that are easy to find so as not to make it difficult for broiler farms to make feed [6].

From these reasons, an optimisation method is needed in determining the composition of good broiler feed. Optimisation is a stage in finding optimal results or ideal results (the value achieved is an effective value). Another definition of optimisation is an attempt to optimise existing problems or compile and make these problems solved optimally to achieve the goals to be achieved. The purpose of optimisation itself is to find the best results or results that bring a lot of profit and little capital and to make business activities run longer [7]. This research will use the Particle Swarm Optimisation (PSO) method. The Particle Swarm Optimization (PSO) method is an optimization technique by following the social behaviour that occurs in the lives of a flock of birds and a school of fish for survival [8].

The application of the PSO method used from several researchers such as those conducted by Juhardi and Andilala [2019]on motorbike sales optimisation can be known the nominal discount and down payment that will be used to increase the next motorbike sales and can assume the large number of sales for the next year. Furthermore, lecture scheduling conducted by Nugraha, Dodu, and Paloloang [2019] that the PSO method can be applied to lecture scheduling. Then research conducted by Rachmat, Ratnawati, and Arwan [2016] in optimising food composition for endurance athletes provides the results of the difference of each nutrient and calorie weight between nutritional needs and nutritional recommendations not exceeding the tolerance limit of ± 10%. Research on feed formula optimisation in milkfish cultivation by applying PSO conducted by Darmawan, Cholissodin and Dewi [2018] provides the best fish feed results with the characteristics of 10-week-old fish weighing 0.25 kg obtained feed cost expenditure of Rp. 15,017, 625 and fitness value 4.635699E-5. Then the research conducted by Istikomah, Cholissodin and Marji [2017] with the PSO method provides results in saving the expenditure of parents of toddlers on fulfilling the nutritional needs of toddlers by 28.56%, making it easier for posyandu and parents of toddlers to provide daily toddler food according to their nutritional needs, and suggesting variations in food composition automatically.

Therefore, with the optimisation system of feed composition in broiler chickens using the Particle Swarm Optimisation (PSO) method is expected to be able to overcome problems with optimal solutions.

**Methods**

According to Wardhany, Cholissodin, and Santoso [2017] the use of the Particle Swarm Optimisation (PSO) method is described in the flowchart below.

Initial initialisation (velocity and position)

Calculating pbest and gbest

Feed data and PSO initial parameters

Calculate the fitness value based on the initial position value

Search for velocity limits and update velocity & position

*Fitness value update*

Update pbest and gbest

Have you fulfilled the conditions to quit?

No

Yes

**Figure 1**. Flow Chart

**Particle Swarm Optimization (PSO) Method**

The following is the equation contained in the PSO method.

Initial velocity

 (1)

Initial position

 (2)

Normalisation of feed value

 (3)

Nutrient content to be searched (calculated)

 (4)

Find the penalty value

 (5)

Calculating feed cost

 (6)

Find fitness value

(7)

Find velocity limit

 (8)

Update velocity and position

 (9)

From equation 9 (speed update), the speed improvement is obtained by taking into account the conditions in equations 10 and 11.

 (10)

 (11)

Equation 12 is the position update

 (12)

Description:

 ingredient value in feed

 total feed ingredient value

 nutrients to be sought (metabolic energy, phosphorus, calcium, crude protein, crude fibre, crude fat, ash content, and moisture content).

 nutrient content of ingredient i

 feed value of the i-th particle of the j-th dimension

 nutrient requirement

total nutrients

 feed requirement per day (gr)

multiplier constant of 20

multiplier constant of 1000

 cost of feed ingredients

 total cost of i-th feed (i=1,2,3,..)

 i-th total penalty

 velocity lower limit

velocity upper limit

 random number between 0 and 1

 current particle position

previous particle position

 current particle velocity

**Results and Discussion**

The place where the farm was conducted was in Kampung Baru, Lingga Tiga Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra Province.

**Data**

Data ayam potong yang digunakan berumur 10 hari dengan kebutuhan pakan per hari sebanyak 58 gr, bahan baku pembuatan pakan sebanyak 8, jenis kandungan nutrisi yang digunakan sebanyak 8 (energi metabolisme, serat kasar, protein kasar, lemak kasar, kadar air, kadar abu, fosfot total, dan kalsium), harga yang digunakan dalam satuan gr.

|  |
| --- |
| **Table 1.** Raw Materials and Prices |
| Raw Material | Price |
| Yellow Corn | 6 |
| Fish Flour | 8 |
| Tofu Dregs | 6 |
| Gaplek Flour | 12 |
| Stone Flour | 1 |
| Rice Bran | 4 |
| Soya Bean Meal | 8 |
| Coconut Oil | 13 |

 Source: Dinas Perkebunan dan Peternakan Provinsi Sumatera Utara

**Optimisation of broiler feed composition with Particle Swarm Optimization (PSO) method**

**Conclusion**

At this stage, 20 iterations are performed and there are 4 particles, 8 dimensions, and the range of lower and upper limits is 0 to 50. J1 is yellow corn, J2 is fish meal, J3 is tofu dregs, J4 is cassava flour, J5 is stone flour, J6 is rice bran, J7 is soya bean meal, J8 is coconut oil.

**Initialisation of initial velocity and position**

Determination of the initial speed is all zero where the speed does not move (at rest). As for the initial position, it will be shown in table 1. This stage is carried out for the first iteration (iteration (0)).

**Table 2.** Initial Position

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| Yellow Corn | 35 | 15 | 45 | 50 |
| Fish Flour | 4 | 6 | 8 | 10 |
| Tofu Dregs | 3 | 4 | 2 | 3 |
| Gaplek Flour | 2 | 6 | 5 | 6 |
| Stone Flour | 4 | 5 | 2 | 4 |
| Rice Bran | 2 | 12 | 14 | 3 |
| Soya Bean Meal | 10 | 3 | 8 | 2 |
| Coconut Oil | 2 | 4 | 1 | 2 |

**Finding Fitness Value**

Before finding the fitness value, there are three stages that must be found first, first finding the feed nutrition (normalisation and the level of nutrients needed), second finding the penalty value, and third calculating the cost of feed.

**Table 3. Fitness Value 0th Iteration**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 1st particle | 2nd particle | 3rd particle | 4th particle |
| J1 | 35 | 15 | 45 | 50 |
| J2 | 4 | 6 | 8 | 10 |
| J3 | 3 | 4 | 2 | 3 |
| J4 | 2 | 6 | 5 | 6 |
| J5 | 4 | 5 | 2 | 4 |
| J6 | 2 | 12 | 14 | 3 |
| J7 | 10 | 3 | 8 | 2 |
| J8 | 2 | 4 | 1 | 2 |
| *Fitness* | 1,7212978 | 1,530328178 | 1,844726145 | 1,609243495 |

**Personal Best and Global Best Initialisation**

Pbest is shown from the initial position value and fitness, while the largest fitness is the gbest. Where the gbest value is obtained on the 3rd particle with a value of 1,844726145.

**Finding the Velocity Limit**

**Table 4. Velocity Limit**

|  |  |
| --- | --- |
| *Vmax* | *Vmin* |
| J1 | 2.5 | J1 | -2.5 |
| J2 | 0.6 | J2 | -0.6 |
| J3 | 0.25 | J3 | -0.25 |
| J4 | 0.5 | J4 | -0.5 |
| J5 | 0.15 | J5 | -0.15 |
| J6 | 0.85 | J6 | -0.85 |
| J7 | 0.85 | J7 | -0.85 |
| J8 | 0.25 | J8 | -0.25 |

**Update Velocity and Position**

This stage starts the next iteration, namely the 1st iteration and the next iteration until the 19th iteration.

**Table 5**. Velocity Improvement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| J1 | -2,5 | -2,5 | -2,5 | -2,5 |
| J2 | -0,51727 | -0,6 | -0,6 | -0,6 |
| J3 | -0,25 | -0,25 | -0,03727 | -0,25 |
| J4 | -0,03727 | -0,5 | -0,5 | -0,5 |
| J5 | -0,15 | -0,15 | -0,03727 | -0,15 |
| J6 | -0,03727 | -0,85 | -0,85 | -0,27727 |
| J7 | -0,85 | -0,27727 | -0,85 | -0,03727 |
| J8 | -0,03727 | -0,25 | 0,20273 | -0,03727 |

**Table 6.** Position Update

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| J1 | 32,5 | 12,5 | 42,5 | 47,5 |
| J2 | 3,482734275 | 5,4 | 7,4 | 9,4 |
| J3 | 2,75 | 3,75 | 1,962734275 | 2,75 |
| J4 | 1,962734275 | 5,5 | 4,5 | 5,5 |
| J5 | 3 | 3 | 1,962734275 | 3 |
| J6 | 1,962734275 | 11,15 | 13,15 | 2,722734275 |
| J7 | 9,15 | 2,722734275 | 7,15 | 1,962734275 |
| J8 | 1,962734275 | 3,75 | 1,202734275 | 1,962734275 |

**Update Personal Best (Pbest) and Global Best (Gbest)**

 The following is a table of calculation results to find pbest and gbest updates.

**Table 7**. Personal Best (Pbest) and Global Best Iteration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Pbest* 1(1) | *Pbest* 2(1) | *Pbest* 3(1) | *Pbest* 4(1) |
| J1 | 32,5 | 12,5 | 42,5 | 47,5 |
| J2 | 3,482734275 | 5,4 | 7,4 | 9,4 |
| J3 | 2,75 | 3,75 | 1,962734275 | 2,75 |
| J4 | 1,962734275 | 5,5 | 4,5 | 5,5 |
| J5 | 3 | 3 | 1,962734275 | 3 |
| J6 | 1,962734275 | 11,15 | 13,15 | 2,722734275 |
| J7 | 9,15 | 2,722734275 | 7,15 | 1,962734275 |
| J8 | 1,962734275 | 3,75 | 1,202734275 | 1,962734275 |
| *Fitness* | 2,922986991 | 5,701481709 | 3,566455528 | 2,393134301 |

So that the pbest and gbest values are obtained in the 2nd particle. Pbest is shown from the initial position value and fitness, while the largest fitness is the gbest. Where the gbest value is obtained with a value of 5,701481709. Then, the steps for the 2nd iteration and so on can be done by following the steps to find the speed limit to update pbest and gbest. So that the optimisation results obtained from the 0th to 19th iteration are obtained in the 1st iteration with a fitness value of 5,701481709 can be seen in table 8.

**Table 8**. Personal Best (Pbest) and Global Best 19th Iteration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Pbest* 1(19) | *Pbest* 2(19) | *Pbest* 3(19) | *Pbest* 4(19) |
| J1 | 20,23511774 | 12,5 | 42,5 | 47,5 |
| J2 | 5,51404549 | 5,4 | 7,4 | 9,4 |
| J3 | 3,438178023 | 3,75 | 1,962734275 | 2,75 |
| J4 | 3,649801893 | 5,5 | 4,5 | 5,5 |
| J5 | 3 | 3 | 1,962734275 | 3 |
| J6 | 3,649801893 | 11,15 | 13,15 | 2,722734275 |
| J7 | 7,705230693 | 2,722734275 | 7,15 | 1,962734275 |
| J8 | 5 | 3,75 | 1,202734275 | 1,962734275 |
| *Fitness* | 3,875527057 | 5,701481709 | 3,566455528 | 2,393134301 |

So, for the price incurred by a 10-day-old broiler farmer and the daily feed requirement of 58 grams using the PSO method is as follows.

Example 1

**Yellow Corn**

Ingredient weight

Cost

So, the cost incurred with 8 raw materials using the PSO calculation is Rp.394.5 for 1 chicken with a feed weight of 58 grams.

**Conclusion**

Based on the results of this study, it can be concluded that the implementation of the Particle Swarm Optimization (PSO) method can be resolved in the problem of optimising the composition of animal feed in slaughter chickens by using the value of h starting from 0,1 to 1. The feed composition optimisation problem obtained a solution by looking at the largest fitness value obtained from finding the feed value, total cost, and number of penalties. The result of the cost difference from the calculation using PSO with the cost incurred by the farmer is Rp.127,5.

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