Simulation of Tilapia Cultivation Using The Monte Carlo Method (Suggested Simulation for Abdul Hadi Fish Cultivation)

Mad Yusup[1], Muhammad Hardianto[2], Hurun'in[3]

[1,2,3]Universitas Selamat Sri Kendal
Corresponding email: admin@uniss.ac.id

Abstract:
Fish consumption in Indonesia has increased in the last 5 years. Tilapia includes five types of fish that account for more than 80% of the total production. This shows that the cultivation of tilapia using pond ponds also has a great opportunity to become a business. By simulating the cultivation of tilapia first before the cultivation process is carried out, the research costs become cheaper because there is no need to carry out an experimental cultivation process that costs money to buy broodstock and cultivation equipment. Monte Carlo was chosen as the simulation method because Monte Carlo Simulation is a method for evaluating a deterministic model involving random numbers as one of the inputs. The results showed that the number of tilapia harvests at the end of cultivation carried out in 6 months was 802 and the profit that could be obtained at the end of cultivation was Rp. 37,554,274.00.

Keywords:
Tilapia Farming, Monte Carlo Simulation

INTRODUCTION

The trend of fish consumption during 2011-2015 showed an increase of 6.27 percent. Data on the calculation of fish consumption figures from the National Socio-Economic Survey (Susenas) of the Central Statistics Agency states that the average fish consumption is 36.12 kg/cap/year. According to the UN Food Agency report, in 2021 fish consumption per capita of the world's population will reach 19.6 kg/year. Although currently fish consumption is mostly supplied by marine fish, in 2018 freshwater fish production will overtake capture fisheries production because capture fisheries production will decline due to overfishing. Fish in the sea are increasingly difficult to find. Even if there is no change in production models, the researchers predict that by 2048 there will be no more fish to catch. Therefore, it is necessary to increase the production of freshwater fish farming as a substitute for marine fish. This shows that a great passion is needed in the community to develop a freshwater fish farming business. Of course, this production growth refers to market demand that continues to increase.

One of the most consumed fish today is tilapia. Tilapia became popular because the price was cheap, and also delicious. Tilapia (Oreochromis niloticus) has a high potential to be cultivated because the price is more stable, easy to cultivate, easy to maintain and the disease is not so much, tilapia breeding is quite easy, is a type of freshwater fish that grows fast, and is a common fish in restaurants.

Tilapia cultivation can be very profitable because with just one brood it can produce about 1000 eggs. Conditions (external factors) that can make the amount of harvest fluctuate include temperature, water quality, water discharge, acidity, feed quality, and others. Of these conditions, the most difficult to control is the acidity of the water. Fish feed and fish manure containing ammonia and dissolved in the water cause the pH of the water to be out of control. The most vulnerable situation is when the larvae begin to grow into adult fish, because the larvae (seedlings) are still weak so they are sensitive to environmental conditions. Therefore, it is necessary to do a simulation before cultivating to find out the estimated yield of fish that can be harvested is not the same as the number of eggs that can be released by the broodstock because many external factors affect it.

Monte Carlo was chosen as the appropriate simulation method because Monte Carlo Simulation is a form of probabilistic simulation in which a solution to a problem is given based on a randomization process. So that the Monte Carlo simulation is assessed according to the possibilities in the study, namely the growth of tilapia which is random and cannot be predicted easily because it is difficult to control and involves external factors such as temperature, water quality, water discharge, acidity level, feed quality, and others. other. In cultivation in the real world that has been or is being carried out, harvest yields fluctuate due to these factors.

It is enough with the Monte Carlo simulation that has examined the probabilities that may occur during cultivation, then there is already a picture of the number of harvests and profits at the end of cultivation. This simulation process is also fast because it only inputs the desired input (treatment) and then can see the output directly. No need to wait long to know the results of cultivation. If you do a cultivation experiment, it will take 6 months to find out the yield and profit. Therefore, in this study, a simulation of tilapia cultivation will be carried out using the Monte Carlo simulation method using Microsoft Excel 2013 software with pH treatment when the larvae begin to grow into adult fish to determine the number of fish that can be harvested and the benefits for 6 months.

From the background described previously, the formulation of the problem (cultivation in 6 months with pH treatment) can be made, namely:

a. What is the number of tilapia harvests at the end of cultivation?
b. How much profit can be obtained at the end of cultivation?

The benefits obtained from this research are:

a. Can simulate and determine the number of eggs that can hatch.
b. Can simulate and determine the number of live larvae.
c. Can simulate and determine the number of fish that can be harvested for 6 months.
d. Can find out the number of advantages of tilapia cultivation with the number of female sires 4 tails and 2 males.
e. Can find out the income for each cultivation as well as the income earned by cultivators every month.

The limitations of the problem in this study are:

a. The simulation focuses on the number of surviving larvae or fish that will be harvested at the end of the culture.
b. The treatment given was a condition at a different pH when the larvae began to grow into adult fish.
c. The upper and lower limits of the tilapia pond pH are acidic pH 6 (possibly acidic), and the alkaline pH limit is 8.5 (probably alkaline).
d. The research was conducted as a proposal for Abdul Hadi's Fish Cultivation located in Situbondo, East Java.
e. The object of this research is red tilapia (Oreochromis niloticus).

In this study it is assumed that:

a. The Monte Carlo simulation method is used to find the number of fish that can be harvested at the end of the culture.
b. Operating costs (land, feed, electricity, employee salaries, transportation) are considered constant each month.
c. Harvest time is 6 months with grading done every 2 weeks.
d. Tilapia brooders have the best quality as egg producers (selection of broodstock according to SNI).
e. Conditions from fertilization to hatching eggs (temperature, water quality, water discharge, feed quality, etc.) are in optimal conditions because they can be controlled and the cultivation process is carried out according to SNI.
f. The broodstock does not die until the spawning process is successful.
g. Male sires do not refuse with all female sires.
h. All brooders lay eggs in the same number.

i. All larvae were given treatment so that all of them were male.
j. The condition of the acidity of the pool is 50% neutral, 25% acidic and 25% alkaline.

LITERATURE REVIEW

Systems, Models and Simulations

When talking about system simulation problems, there are three basic concepts that must be understood first, namely the system, the model and the simulation itself. In general, the literature on models agrees to define a "model" as a representation or formalization in a particular language of a real system. The real system is a system that is ongoing in life, a system that is used as a point of attention and is disputed. Models help solve simple or complex problems in the field of management by paying attention to a few parts or several main features rather than paying attention to all the details of the real system. The model may not contain all aspects of the real system because many characteristics of the real system are always changing and not all factors or variables are relevant for analysis.

The system is defined as a collection of entities, such as humans or machines, that act and interact together towards the completion of some final logic whereas simulation is used to solve problems in systems that are very complex and therefore very difficult to solve mathematically. Simulation is a numerical analysis tool for the model to see how far the input affects the measurement of output on system performance. The main understanding is that simulation is not an optimization tool that gives a result decision but is only a decision support system, thus the interpretation of the results is highly dependent on the modeler.

Simulation applications can be carried out on several system problems, including: Design and analysis of manufacturing systems, Evaluation of a new military weapon or tactic, Determination of ordering policies and inventory systems, Design of communication systems, Design and operation of transportation facilities, and Analysis of financial or economic systems.

Monte Carlo Simulation

The Monte Carlo Simulation method is a method for evaluating a deterministic model involving random numbers as one of the inputs. This method is often used if the model used is complex, non-linear or involves more than a pair of uncertain parameters. A Monte Carlo simulation can involve 10,000 evaluations of a model, a job in the past only computer software could do. A model requires input parameters and some equations that are used to produce an output (or response variable). By using the input parameter in the form of random numbers, it can change a deterministic model into a stochastic model, where the deterministic model is an approach model that is known with certainty while the stochastic model is uncertain. Monte Carlo simulation is a method for analyzing uncertainty propagation, where the aim is to determine how random variations or errors affect the sensitivity, performance or reliability of the system being modeled. Monte Carlo simulation is classified as a sampling method because the input is generated randomly from a probability distribution for the sampling process from a real population. Therefore, a model must choose an input distribution that is closest to the data it has (Rubinstein, 1981).

Monte Carlo simulation is a technique used to complete a simulation. This simulation model uses random numbers. The Monte Carlo method is a method for generating random data based on input in the form of mean, standard deviation and distribution (normal). There are many software providing Monte Carlo simulation methods, such as Mathlab, Wolfram Mathematica, Python, R, and Microsoft Excel. Command in Ms. Excel is:

=NORMINV(RAND(),mean,standard_deviation)

Dapat juga digunakan fungsi IF/THEN:

=IF(x<y,value_if_true,value_if_false).

Tilapia Hatchery

Tilapia (Oreochromis niloticus) is a type of freshwater fish belonging to the family Cichlidae, Sub-order Percoidea, Order Percomorphi, Sub-class Acanthoptherigii. Tilapia body shape is

long and slender, with large scales. The eyes are large, protruding, and the edges are white. The lateral line (linea literalis) is interrupted in the middle of the body and then continues, but lies further down than the line that extends above the pectoral fins.
Locations and containers for rearing tilapia include:

a. Good soil for pond maintenance is a type of clay / loam, not porous. This type of soil can hold a large mass of water and does not leak so that embankments / pond walls can be made.
b. The slope of the soil is good for the manufacture of ponds ranging from 3 to 5% to facilitate the watering of the pond by gravity.
c. Tilapia is suitable to be kept in the lowlands to somewhat high (500 mdpl).
d. The quality of the water for rearing tilapia must be clean, not too cloudy and not contaminated with toxic chemicals, and oil/factory waste. The turbidity of the water caused by puddling will slow down the growth of fish. Another case when the turbidity of the water is caused by the presence of plankton. Water that is rich in plankton can be yellowish green and brownish green because it contains a lot of Diatomae. Meanwhile, blue plankton/algae are not good for fish growth. For ponds and ponds, a good brightness number is between 20 - 35 cm.
e. The water discharge for calm water pools is 8-15 liters/second/ha. The condition of the waters is calm and clean, because tilapia cannot breed well in fast-flowing water.
f. The value of the acidity of the water (pH) where tilapia lives ranges from 6 - 8.5. While the optimal water acidity (pH) is between 7 - 8.
g. The optimal water temperature ranges from 25-30 0C.
h. The preferred salt content of the water is between 0 - 35 per mile.
i. The quantitative criteria for tilapia reproduction are:

Table 1.
Reproductive Criteria for Tilapia

Sifat	Satuan	Jenis Kelamin	
		Jantan	Betina
Umur	Bulan	6 - 14	6 - 14
Panjang total	cm	16 - 25	14 - 20
Bobot tubuh	g	400 - 600	300 – 450
Fekunditas	butir/ekor	-	1.000 - 2.000
Diameter	telur mm	-	2,5 - 3,1

Sumber: SNI 01-6138-1999
Induk Ikan Nila Hitam (*Oreochromis niloticus* Bleeker) Kelas Induk Pokok

Tilapia Cultivation

a. Tilapia Fish Feed

The feed used is certified feed, such as comfeed, so there is no doubt about its feasibility and quality. Papaya leaves will be used as a natural food. The fish will be fed 2 times, in the morning they are fed with papaya leaves and then in the afternoon they are given artificial food. Provision of the right type and amount of feed has an important role for optimum growth of fish seeds. Applied a combination of live feed (live diet) and artificial feed (formulated diet). Larvae up to 10 days in general are only given live food in the form of silk worms. Day 11 s.d. On day 20, larvae were slowly introduced to powdered formula feed which was served in the form of a paste while live feed was reduced. The 21-day general seed was introduced to granular feed and reduced pasta feed.

b. Media Maintenance And Sanitation

Fisheries with tropical climates usually face problems such as fish will die when winter or rainy season arrives. With the studies developed, the use of Recirculating Aquaculture Systems was found to be able to solve this problem. Recirculating Aquaculture System Technology can also be utilized to control dissolved solids which can be adapted to the aquaculture system. This system is made in a closed which can produce fish all year round.

By using this Recirculating Aquaculture System technology, the fish raised will be healthier and the food circulation rate is lower than conventional fisheries like in other ponds. Fish densities in Recirculating Aquaculture Systems can be made up to 0.350 kg/liter or more, while ponds are usually only at levels of 0.0015 kg/liter. RAS systems come in many forms, from the simplest to those that are fully automated and controlled by a computer system. Recirculating aquaculture is a pond water circulation system by re-using water for the cultivation of aquatic habitats, so as to reduce the use of water from outside the system. Where pond water that has been used for fish cultivation and has decreased in quality, can be reused after undergoing a filtration process. In the filtering process, a mechanical filter and a biological filter are used.

The use of this system has several advantages, including:

1) more efficient use of water,
2) flexibility of cultivation location,
3) more hygienic,
4) relatively small space or land requirements,
5) ease of control and maintenance,
6) ease of maintaining water temperature and quality,
7) environmentally friendly,
8) safe from pollution that occurs outside the aquatic environment,
9) can be implemented all the time.

The filter tool is cleaned periodically once a month. Feed storage is carried out in the feed warehouse, and the sacks do not touch the ground (give a pedestal), and are not exposed to sunlight. Feed is stored at room temperature. Storage of natural feed and artificial feed is done separately. The pool before use is cleaned of adhering dirt, so that there are no remnants of dirt that can cause disease carriers.

c. Oxygenization

To add dissolved oxygen to the water, an aerator with a capacity of 100 watts is used which is spread over several points along the raceway pool. Aeration needs to be regulated so as not to create a current that is too strong which can use up seed energy to fight the current. Aeration is quite small but even.

d. Temperature Control

Relative temperature is not a problem because the difference between night and day temperatures is not too big. If in the season with extreme temperatures, it is enough to put a tarp over the pool to maintain the temperature of the pool.

e. Handling of Solid and Dissolved Stool

Dissolved solid (dissolved solid) or relatively fine material can be carried away by the circulation current and filtered by the filter, but for solid waste (solid waste) it is necessary to siphon (sipon). A swimming pool cleaner is used which is connected to a pump to clean the bottom of the pool from solid dirt, scale and moss while sucking it out of the pool.

f. Control over disease

Prevention is the best medicine. Stress is the main source of disease, both environmental stress and stress due to handling (eg the sorting process). Avoiding environmental stress is done by always maintaining water quality, regulating stocking density, while for handling, for example the sorting process, the use of happa in ponds is proven to simplify and speed up the sorting process so that the seeds are not stressed. Seed health must be monitored continuously and if someone is sick, it needs to be treated immediately by adding salt or isolating diseased seeds for treatment. The use of herbal medicines is prioritized over the use of antibiotics which may cause resistance. Vaccination is an effective way to develop immunity against bacteria. Vaccination of seeds with Hydrovac/Caprivac Aero vaccine is carried out to develop immunity (antibody) against the attack of Aeromonas hydrophila bacteria. To suppress the growth of pathogenic bacteria as well as to maintain water quality, probiotics are applied either in water or for breeding feed.

g. Disinfection

The growth of pathogenic bacteria and fungi must be strictly controlled considering that only one experimental pond is used and if anything happens it will quickly spread throughout the pond. The use of chemical disinfectants is certainly not possible because it will kill the good bacteria that are intentionally cultured. For this reason, maintaining water quality is the main key. The disinfection process is carried out at the beginning of media preparation using chlorine and or PK (Potassium Permanganate) solution.

RESEARCH METHODOLOGY

Company profile

Abdul Hadi's fish farm, located in Situbondo, East Java, is a fish farm that currently cultivates catfish as its object. The cultivation owned by Abdul Hadi has a pond with a length of 3 m, a width of 1.5 m, and a height of 0.5. So the volume of each pool is 3 x 1.5 x 0.5 = 2.25 m3. The number of ponds owned by Abdul Hadi are 8 large ponds (cement ponds) all of which are used to raise the seeds (seedlings/larvae) to become adult catfish. The operating costs (land, feed, electricity, employee salaries, transportation costs) are Rp. 3,000,000.00 per month. The proposal for tilapia cultivation is addressed to Abdul Hadi's cultivation so that the profits obtained will increase by replacing catfish farming with tilapia cultivation.

Data Used

Parameter

1. First Simulation (Determining the Number of Successfully Hatching Eggs)
   a. The fecundity (all eggs that will be released at the time of spawning) of tilapia according to SNI 01-6138-1999 is 1,000-2,000 eggs, so that for the simulation input data, the maximum fecundity data is 2,000 eggs.
   b. The average number of eggs hatched is in percent, which is 54%.
   c. The standard deviation of hatched eggs is in percent, which is 10.11%.
2. Second Simulation (Determining Successful Larvae)
   a. The acidity of the water or the pH of the treated water was pH 7 (normal and the best conditions for growth) and pH 6 and 8.5 (unfavorable conditions for larvae because they were still weak).
   b. The average number of dead larvae is in percent, that is, if the pH is 7, the average larvae that die is 2%, but if the pH is 6 and 8.5, the average dead larvae ranges from 10-60%.
   c. The standard deviation of dead larvae due to the pH of the water in percent is 7%.
3. Third Simulation (Determining the Amount of Harvest at the end of Cultivation)
   a. Sort (grading) for fish size every 2 weeks. The cultivation process is carried out in 6 months, which means there are 12 grading or sorting.
   b. The average number of fish that died in one grading was 1%, so that in 12 gradings the average number of fish that died was 12%.
   c. The standard deviation of dead fish is 5%.
4. Profit Calculation
   a. The price of fish is IDR 35,000.00/kg.
   b. The average weight of fish is 500 grams.
   c. Tilapia cultivation begins with buying the best quality brooders with 4 females and 2 males.
   d. The price of 1 tilapia broodstock is Rp. 100,000.00.
   e. The total operating cost in 1 month is IDR 3,000,000.00.
   f. The condition of the acidity of the pool is 50% neutral, 25% acidic and 25% alkaline.

Variable

1. First Simulation (Determining the Number of Successfully Hatching Eggs)
   Fecundity probability with normal distribution random value because in real conditions the number of eggs that successfully hatch fluctuates because there is a possibility that the eggs are not completely released by the female parent, the eggs are not successfully

fertilized, and so on. The probability was normally distributed because the number of eggs that hatched was not too far from the average and did not deviate too far from the average. The average divides 2 parts of the same data because the cultivation has been standardized according to SNI. The number of harvests is also influenced by the mean and standard deviation.

2. Second Simulation (Determining Successful Larvae)
   a. The probability of larvae dying with random values is normally distributed.
   b. Number of larval seeds (first simulation results).
3. Third Simulation (Determining the Amount of Harvest at the end of Cultivation)
   a. The probability of fish dying with random values is normally distributed.
   b. Number of larvae that grow into adult fish (second simulation result).
4. Profit Calculation
   Number of tilapia that can be harvested (third simulation result).

Data processing

Processing Using Monte Carlo

After all data is inputted into Microsoft Excel software, then artificial data is generated using a random number generator and normal distribution. The Monte Carlo method is divided into 5 stages:

1. Determine/determine the probability distribution, namely the normal distribution for important variables.
2. Calculate the cumulative distribution for each variable in step 1.
3. Assign an interval of random numbers to each variable.
4. Form or select random numbers (generating random numbers).
5. State the simulated sequence of several experiments.
6. Simulations were carried out 3 times with different objectives and sequentially, the results of the first simulation as the input for the second simulation, and the results of the second simulation as the input for the first simulation.*Source Code* dari simulasi budidaya ikan nila dengan metode Monte Carlo dari input data pada Subbab 3.2. adalah sebagai berikut:

a. First Simulation
   The output (number of successfully hatched eggs) from the first simulation is the result of the command
   =NORMINV(RAND(),mean,standard_deviation)*maximum number of eggs contained (fecundity = 2000).
b. Second Simulation
   In the second simulation, the number of larvae that managed to survive was simulated according to the input pH conditions (pH 6, 8.5 and 7). If the pH is 7 then the average dead larvae is 2%, but if the pH is 6 and 8.5, the average dead larvae ranges from 10-60%. The function is =IF(pH=7.2%,RANDBETBEEN(10%,60)). While the output (number of larvae that survived) is the result of the command =NORMINV(RAND(),mean,standard_deviation)* the average of the first simulation results (=AVERAGE(68_data_record).
c. Third Simulation
   While the third simulation is to determine the amount of harvest at the end of cultivation by grading every 2 weeks and there is a possibility of fish dying in the process. The cultivation process is carried out in 6 months, which means there are 12 grading or sorting. The average number of fish that die in one grading is 1%, so that in 12 grading times the average fish die is 1% * 12 = 12%. Then the output of the third simulation (number of fish that can be harvested) is the result of the calculation of the command =NORMINV(RAND(),mean,standard_deviation)* the average of the results of the second simulation (=AVERAGE(68_data_record).

Profit Calculation

In the profit calculation, three simulation records were performed with various pH treatments, namely pH 6 (acidic pool state), pH 7 (optimal state), and pH 8.5 (alkaline pool state). There are 30 data records. In each record, the average number of fish that can be harvested at the

end of cultivation is calculated using the =AVERAGE(record_30_data) command. The condition of the acidity of the pool is 50% neutral, 25% acidic and 25% alkaline. So, to determine the number of fish that can be harvested, use the command =(50%*hasil_record_simulation_pH_7) + (25%*hasil_record_simulation_pH_6)+(25%*hasil_record_simulation_pH_8,5). With the results of the third simulation using the Monte Carlo method, the number of fish that can be harvested at the end of cultivation, with an average weight of fish harvested is 500 grams. The price per kg of tilapia is IDR 35,000.00, so the yield (in kg) is =(number_of_fish_harvested*500)/1000. After obtaining income by multiplying the yield (in kg) and the price of fish per kg (Rp 35,000.00). Then do the calculation of profits, namely income minus expenses (capital). Expenditure for operating costs per month is around Rp. 3,000,000.00, then expenditure in 6 months is = 3000000*6 which is Rp. 18,000,000.00. Meanwhile, the expenditure to buy 6 tilapia brooders (4 females, 2 males) at a price of Rp. 100,000 per broodstock, i.e. = 100000*6, is Rp. 600,000.00. Then the total expenditure is = 600000 + 18000000 which is Rp. 18,600,000.00. So that the income at the end of the cultivation cycle is income - expenditure (Rp 18,600,000.00).

ANALYSIS AND DISCUSSION

Based on data processing and preparation of a simulation system for tilapia cultivation with Monte Carlo simulation, the results of the simulation record are as follows:

Table 2.
Processing Results for Treatment of pH 7

pH 7	Number of fish that can be harvested
1	917
2	988
3	978
4	990
5	978
6	960
7	950
8	966
9	940
10	927
11	1001
12	939
13	954
14	954
15	999
16	975
17	981
18	1022
19	941
20	993
21	996
22	992
23	977
24	991
25	1005
26	977
27	982
28	957
29	974
30	980

Table 3.
Processing Results for Treatment of pH 6

pH 6	Number of fish that can be harvested
1	506
2	402
3	789
4	559
5	723
6	477
7	827
8	745
9	890
10	514
11	553
12	648
13	496
14	695
15	413
16	516
17	421
18	894
19	652
20	845
21	605
22	498
23	560
24	611
25	403
26	714
27	869
28	796
29	709
30	557

Table 4.
Processing Results for Treatment of pH 8.5

pH 8,5	Number of fish that can be harvested
1	438
2	460
3	852
4	464
5	728
6	480
7	690
8	665
9	670
10	650
11	460
12	699
13	634
14	594
15	751
16	533

pH 8,5	Number of fish that can be harvested
17	625
18	821
19	678
20	779
21	461
22	707
23	715
24	531
25	625
26	697
27	414
28	769
29	799
30	619

Obtained results as in table 2., 3 and table 4. that the figures in the table represent the number of fish that can be harvested in each simulation. By using random values, the number of fish each time doing data processing is also different. It can be seen that the difference in the number of tilapia that can be harvested in conditions of optimal pH, namely water in a state of neutral acidity (pH 7), while the number of fish that can be harvested at alkaline pH (pH 8.5) decreased dramatically, which is 34.87% of the yield. harvest with pH 7 treatment. The number of fish that can be harvested at acidic pH (pH 6) also decreased drastically, namely by 35.28% of the harvest yield with pH 7 treatment. This shows that pH has an effect on the number of fish that can be harvested.Dari hasil yang diperoleh dapat diketahui perhitungan keuntungan untuk masing-masing pH:

It can be seen that the number of fish that can be harvested from the combination of the three pH treatments, with 50% pond conditions is pH 7, 25% acidic pH (6), and 25% alkaline pH (8.5), the number of fish that can be harvested is 802 fish. . While the number of harvests from 4 broodstock is 802 x 4 = 3,209 tails. The price of 1 tilapia is Rp. 35,000.00/kg, while the total harvest in kg is 1,604. Then the income obtained is Rp. 56,154,257.00. The capital spent to buy tilapia broodstock and operating costs for 6 months is Rp. 18,600,000.00. So that the net profit that can be taken in one cultivation for 6 months is IDR 37,554,274.00. If the monthly income earned by tilapia farmers is calculated, it is Rp.37,554,274.00 : 6 = Rp. 6,259,046.00.

CONCLUSIONS AND SUGGESTIONS

Conclusion

From the simulation of tilapia cultivation using the Monte Carlo Method with pH treatment when the larvae begin to grow into adult fish and the condition of the acidity of the pond 50% is neutral, 25% acidic and 25% alkaline that has been carried out and an analysis of the simulation is also carried out, it can be concluded conclusions were drawn, among others:

a. The number of tilapia harvests at the end of cultivation carried out in 6 months was 802.
b. The profit that can be obtained at the end of cultivation is Rp. 37,554,274.00.

Suggestion

Suggestions and proposals given based on the results of research that have been carried out include:

a. Replacing the current catfish culture with tilapia cultivation on the grounds that the price is more stable, easy to cultivate, easy to maintain and the disease is not so much trouble, tilapia breeding is quite easy, is a type of freshwater fish that grows fast, and is a common fish in restaurants.
b. Preliminary cultivation was carried out such as research input data, namely 2 male sires and 4 female sires on the grounds of increasing the probability of the number of eggs being fertilized and increasing the number of eggs that can be released with the standard of brooders according to SNI (fecundity 1000-2000).

c. Fish culture is carried out in accordance with SNI to maintain the quality of the fish that are cultivated and can control the number of fish that can be harvested because the conditions of cultivation are according to standards.
d. Grading is carried out every 2 weeks to monitor and control fish growth so that the stocking density can be known after grading and feeding in the right dose.
b. The grading process should be carried out quickly in order to minimize the possibility of fish dying from being too long in the air.

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