Technology Model of Aquaculture Production System

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Abstract. The high market demand has led to the rapid growth in fish farming. The young generation are inexperienced in determining the estimated results of fish farming and the preparation of fish pond during the period of fish farming. These need a complete guide as their reference which includes the knowledge of fish farming. The main objective of this project is to develop a practical design of real pond appropriate with aquaculture technology and fish farming production. There are three parts of study in this project which include fish farming cage, growth of fish and water quality of fish farming pond. Few of experiments were carried out involved the collection data in terms of growth of fish and parameters of water quality.

1. Introduction

For the last thirty years, supply and demand for fish has been increased tremendously. As human population become larger, the consumption per capita of global demand for fish increased. This demand has met by a rapid growth in production and increased global trade. Aquaculture becomes the fastest growing component nowadays. Aquaculture expanded about 12 times of the world food fish production. Aquaculture supplied the world with 59.9 million tonnes of fish in 2010 and increased production of 63.6 million tonnes for 2011 indicate increased production [1]. As expected in the future, aquaculture production will overcome the supply of food. Factors affecting fisheries production are the preparation, management of fish ponds and fish breeding types. Therefore, monitoring of pool quality parameters and water quality parameters is required. Fish pond management which includes fish food size, water quality and fish growth. Comprehensive preparation before planting fish will help to get a good return.

This study aims to provide information on the preparation and management of real fish ponds. It will also estimates results in fish harvest over a certain period of time. Aquaculture production systems emphasize the methods of water quality and growth of fish in real cage. Practically caged fish farming is very easy and complex and it can be done if the farmers able to access native or artificial lakes. The usage of cage system is appropriate when school of fish share a good water quality and environment. However, most modern farmers from present generation have face problems in understanding the information of water quality, fish pond size and food distribution that had been conducted previously. All previous information
can be obtained through experienced farmers and rarely documented. It will only slow the pace of fish research development which potentially attracting the new generation involved. This study provides guidance to farmers regarding pH, salinity, temperature, ammonia concentration and oxygen in water. The rate of growth and harvesting of fish can also be estimated from harvest time. This can help increase aquaculture production and make the aquaculture industry as one of vibrant industry in Malaysia.

2. Model Description
An aquaculture cage system was built with low cost material of PVC piping structure. It has a portable features with cage size of 6m x 6m x 1m. The size of 4” catfish had been released into the pond with approximately about 1500 fish. The parameter of water quality in fish pond need to be monitored to ensure no potential contamination occured due to feeding or from other factors. Thus, it is important to test the every parameters of the water like pH, salinity, temperature, concentration of oxygen and concentration of unionized ammonia. Consequently, these parameters of the water quality can provide health precaution for the fish. The final step is measure the growth of fish. The initial weight of fish, initial length of fish, initial number of fish and date of fish farming start were measured and recorded. Mortality of fish, length and weight were measured every week. The amount of fish food was controlled by automatic feeding machine. The machine operated with timer and feed the fish two times per day.

3. Methodology
Several steps used to develop of aquaculture cage system, control feeding system, investigate the parameter of water quality and growth rate of catfish.

3.1 Fish Feeding Machine
The microcontroller, PLC uses timer to control operating time at one presetting duration. Figure 1 (a) shows an automatic feeding machine with a maximum capacity of 6 kg. Other components and devices used in automatic fish feeding systems include toggle switches, emergency stop buttons, relays, warning lights, adjustable logical controllers (PLCs) and power supply units. However, the machine can be set to 3kg, 4kg, 5kg and 6kg for fish food distribution. Experiments were conducted to determine the quantity or weight of the fish pallets that would fall into the transmission plate when the motor was switched on. The total weight of the minimum discharged food is 3kg, but the weight of the pelleted food needed for catfish is about 500g. The electronic timer works to control the timing of the motor to remove the amount of food it deserves. The periods of 10s, 15s, and 20s were used. Each time period is repeated six times to get accurate results.
3.2 Cage System

The pH and DO water levels were measured to ensure the appropriate water quality. Once an aquaculture cage is built, the feeding system and pump will be installed. Fish cage design is done using the sketch design and Solidwork as shown in Figure 1 (b). This cage system is left for at least two to four days to ensure there is no leakage, sufficient water flow, and no flaws exists.

3.3 Water Quality Parameters

The measurement of water quality include pH, dissolved oxygen, ammonia-hydrogen, salinity and temperature of the fish ponds as described below; and the instruments used as depicted in Figure 2.

i) pH: accurate result obtained by fully immersed the device in the middle water of cage

ii) Temperature: the thermometer time was allowed to come to equilibrium and read immediately.

iii) Salinity: to measure salinity, the protective cap was taken off and the meter immersed into the sample and swirled slowly

iv) Dissolved Oxygen (DO): The tip of probe was immersed into the water to make sure the velocity of the water coming into contact with the probe at least 0.2 - 0.3m/s.

v) Concentration of Unionized Ammonia: measurement of concentration of unionized ammonia in similar way to measure water salinity. The meter was immersed into the water and swirled slowly.

4. Results and Discussions

4.1 Experiment on weight of pelleted feed distribution

The results for this experiment were repeated six times each when motor operates for 10, 15 and 20 s. The average reading have been evaluated. From experiments conducted, it was found that the average weight of fish pallet released from motor for time period of 10s, 15s, and 20s are 331.67g, 504.17g and 660.83g, respectively. In the case of fish food distribution for 500g, the motor required about 15s to complete the operation. The cage system and fish feeder machine as shown in Figure 3. The time taken approximately to distribute food at different weight is shown in Table 1.

| Weight of Fish Food (g) | Approximate Time (s) |
|-------------------------|----------------------|
| 330                     | 10                   |
| 360                     | 11                   |
| 400                     | 12                   |
| 430                     | 13                   |
| 460                     | 14                   |
| 500                     | 15                   |
| 530                     | 16                   |
4.2 Growth rate of fish

In fish growth period for 11 weeks, the weight of the Patin fish has been recorded. The average weight for three fish was taken and recorded. Figure 4 shows detailed data of changes to the weight of the Patin fish. It also shows that the weight of the Patin fish increases in the line of curvature. The average length of three fish was taken and recorded. The measurement data were recorded and plotted as in Figure 4. The average length of the initial length is 6.3 cm whereas the final length is 22.7 cm. The average length of fish increased by 16.4 cm. This shows the change in length of fish increased by 1.5 cm a day. Figure 4 shows that the length of fish increased 1.5 cm per day. The result of length changes in eleven weeks shows that the fish grow is linearly increased.

![Figure 4 : Weight and length changes of Patin fish](image)

For mortality, the number of death of Patin fish was recorded week by week. The mortality rate is calculated with the formula \( M% = \frac{100\%}{N} \times n_i \) where \( n_i \) is number of dead fish for day \( i \), \( N \) is the number of fish for day \( i-1 \) and \( M \) is the extinction of fish every day. From Figure 5, it shows that the number of death of fish in week 1st was decreases compared with week 7th. In addition, there was no death of fish found in the continuous week until week 11th. The fish death is most probably due to phenomenon of “New Tank Syndrome”. This is common name given when fish become ill or die in a new environment. Most of the fish cannot adapt in new environment with different temperature or concentration of dissolved oxygen. Besides, there were some predator like fish and bird near the cage which may cause the death of fish.

The feeding frequency was 2 times per day to ensure optimum growth performance of Patin fish. The time set of feeding was about 9.30am to 10.30am and 4.30pm to 5.30pm. However, 500 grams of pallete have been distributed iniially and will changed week by week according to the number of fish remaining and the appetite of fish.

4.3 Parameters of water quality

The results for water quality include pH level, temperature, concentration of oxygen and concentration of unionized ammonia and water salinity. The pH level of water can provide information on potential contamination. Consequently, testing the pH of the water can be an important public health precaution for the fish. The result of pH of the water was from 6.89 to 7.10 during the period of the experiment. The average pH value for each week is 6.98. The growth rate of fish was the best at pH 7.5 – 8.0. For best Patin fish grow at pH 5.0 – 7.0, however the ideal pH of water is pH 6. The value of pH should be maintained in the range at 6.5 – 7.0 for the perfect cycle.

Meanwhile the measurement of water temperature is almost same which is in range from 29.8 °C to 30.3 °C. Therefore, the average temperature is 29.9 °C per week. The result shows that the temperature of the pond is suitable for the Patin fish as the optimum water temperature for the life of Patin fish between
28 °C – 32 °C. Patin fish prefer deep with low temperature fluctuations. Life was disrupted if the water temperature drops to 14 °C or up to 35 °C [6]. Figure 6 shows the measurement of pH level and its temperature during the period of fish farming.

![Figure 6: Measurement of temperature](image1)

![Figure 7: Concentration of dissolved oxygen](image2)

The concentration of dissolved oxygen obtained from the experiment is from 7.4 mg/L to 8.4 mg/L. The concentration of dissolved oxygen is at average of 7.9 mg/L per week. The most suitable range of concentration of dissolved oxygen for Patin fish is from 4 mg/L to 15 mg/L [7]. Figure 7 shows that the measurement of concentration of dissolved oxygen in the experiment during the period of fish farming. It was also found that salinity and unionized ammonia were measured at 0.1ppm and no value or zero reading respectively for every week. This showed that the condition of water is good and suitable for the Patin fish farming because the optimum water salinity for Patin fish is less than 4 ppt [7].

5. Conclusions
The project successfully develop a practical cage and determine the water quality with use of feeder machine to feed the fish. From the project, it had concluded that the cage size of 6m x 6m x 1m is directly proportional to the number of fish and size of fish. For water quality, the pH is between 5.0 – 7.0, the water salinity should be less than 4.0 ppt, the ideal temperature for Patin fish life is from 28 °C to 32 °C, the concentration of dissolved oxygen is from 7.4 mg/L to 8.4 mg/L and the concentration of unionized ammonia is less than 0.02 mg/L. These parameters will help to reduce the mortality of fish and help to increase the growth rate of the fish. The operational time of feeding machine is concluded with the weight of the fish pellets distribution.

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