Study on feeding cast distance of automatic hanging fish feeder at different feeding time and height

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Abstract. Feeding techniques commonly applied by fish farmers in Indonesia consist of manual, semi-automatic, and fully automatic. Manual technique is a traditional approach which depends on the operator’s capabilities in feeding the fish or prawns directly into the pond with a simple device. Semi-automatic technique is a modern approach which uses more advance device than in traditional approach while still depends on the operator in triggering the device to regulate the feeding time as well as the volume of the feed. Fully automatic technique is a more sophisticated approach than the previous techniques in which the device releases the feed automatically in an already determined time and quantity without interference of operator in triggering the device at certain time and determining the volume of the feed. This research used self-designed automatic hanging fish feeder called APAGAN which automatically control the feeding time and regulate the quantity of the feed. The purpose of this research was to examine the distance of feed cast at different time and height using APAGAN as feeding device. The results showed that using APAGAN at different time of feeding does not affected the cast distance (p>0.05) while at different height APAGAN feeding device significantly affected the average cast distance of the feed with 95% confidence interval (p<0.05) and coefficient of variation at 8.21%.

1. Introduction
Fish feeding practices in many of aquaculture fish and prawn ponds in Indonesia were still performed manually by hands. Feeding routines, especially in prawn ponds, usually carried out in three to four times a day depends on their age or weight [1,2]. There were some drawbacks if these routines done manually, such as uneven distribution of feed at certain range of the pond as well as longer gap at each delivery time. Generally, the area of fishpond is quite large, typically more than 5000 m². It would be a really challenging works for the farmer to deliver the food manually. In addition, these feed dissolved shortly in water which makes it harder for the prawn to feed on them. Furthermore, water turbulence from aerator would disperse these dissolved feed. Consequently, the still-intact food is easier to get for the prawn rather than chasing the diluted one [3,4]. After a several amount of time, the dissolved feed would converge at some certain spots at the bottom and decomposed into toxic...
material such as ammonia (NH\textsubscript{3}). This decomposed food would be shunned by the prawn and later would disturb the water quality, subsequently affect the health and growth of the prawn [5].

Indication of fish and prawn growth can be observed by the increase of their weight. Above-average weight is in correlation with feed conversion ratio (FCR) value [6]. FCR is a comparison value between fish or prawn feeding aptitude and their age. Fish farmers would likely to obtain low FCR since it correlates to feed cost and environmental factor which affects growth rate [3]. For this reason, an applicable and appropriate technology development were needed to help the fish farmer improve the cost efficiency, for example by utilizing automatic hanging fish feeder which designed with mechanical function and system to control periodic feeding time [7].

The design of automatic hanging fish feeder features a combination of mechanical and electrical engineering where the function of this device is to store some amount of feed and spread them into the fishpond in a regulated time. With a definite feeding time and feed distribution, his device would help to improve the health and growth of fish and prawn, which consequently would increase their market value.

According to Andriyawan (2013) a decent design and development of automatic fish feeder must consider the factors of price, effectiveness, and availability of spare parts [8]. In order to deal with these considerations, APAGAN were designed and developed based on following criterias [9]:

1. Flexible time control
2. Practicable and space efficient
3. Sequential volume and selective picking of feed, and
4. Environmentally friendly

This research used self-designed automatic hanging fish feeder called APAGAN which automatically controls the feeding time and regulates the quantity of the feed. The purpose of this research was to examine the distance of feed cast at different time and height using APAGAN as feeding device.

2. Materials and methods

2.1. Study locations
This study performed at West Java, Indonesia, at two locations: machinery workshop in March 2021 at Cibinong for design and development of APAGAN, and fish farming facility in August 2012 at Bogor.

2.2. Study materials
This study uses APAGAN with specifications as follows (Table 1):

| Component       | Specification                        | Material       |
|-----------------|--------------------------------------|----------------|
| Body            | length = 60 cm; height = 40 cm;      | Plastic        |
|                 | weight= 10 kg                        |                |
| Battery/Accumulator | 12 VDC, 5 A                           | Metal          |
| Thrower         | length = 13.5 cm; width = 6 cm;      | Sponge         |
|                 | quantity = 4 unit                    |                |
| Timer           | minute sequence at 6 cycle           | Electronic circuitry |
The detailed explanation of this device is described in Figure 4. The automatic hanging fish feeder consist of tubelike body which size can be accustomed to a desirable feed quantity. The body material was made of plastic or other rust resistance entities with minimum 3 mm thickness which can hold centrifugal force and feed weight momentum, clockwise and counter-clockwise. This device also has a hanging apparatus made of steel wire at the uppermost part.

The automatic hanging fish feeder in this study (APAGAN) employs a knockdown structure on some of its components to make it easier for development and improvement in the future. However, some other components have to be constructed permanently since they require a much stronger structure, such as feed ration valve which is the main support of the feed before going to rationing segment. The APAGAN assembly sequences are as follows:

1. Put the controller in the feed container enclosure.
2. Attach the throwing blade to electric motor fin [10]
3. Mount the electric motor to the lower strainer plate. The installation of this electric motor must be done before mounting the feed ration part for easier bolt attachment at the strainer plate.
4. Mount the feed ration part to the upper strainer plate, tightened using bolt and nut.
5. Put the ration plate to the lower part of electric motor. This ration plate is to be attached at lower strainer plate connected with metal strip, tightened using bolt and nut.
6. Mount the battery/accumulator on inside the body frame within the bracket under feed ration valve. After the battery well-mounted, the entire electrical components such as controller and others can be connected to the electric motor using cables [11].
7. Join the upper and lower sections by connecting the feed container with upper strainer plate, tightened using a knockdown key.
8. Put the cover of feed container in its upper position.

The details of APAGAN assembly sequences described on the picture below:

Figure 1. Automatic hanging fish feeder (APAGAN)

After all the components of APAGAN assembled, it is now ready to operate with procedures as follows:

1. Prepare the feed in order to make it ready to deliver.
2. Put around 26 litres of the feed into the feed container. Make sure the feed ration valve is in closed position.
3. Set the time controller. According to Djoekardi (1996), this time setting will automatically control the time when the electric motor would perform a day [12]. This setting will regulate the quantity of the feed and control the feeding time of fishpond per day.
4. Close the feed container and the APAGAN is ready to operate
5. APAGAN will work for a day with the amount of feed already determined

2.3. Feed scatter distribution analysis

This study analysed the appliance of feed scatter distribution which is correlated to the capacity of torque power of casting or throwing of the feed out of the automatic hanging fish feeder into the fishpond, calculated based on throwing angle. The calculation for the angle of casting rendered from the comparison of tangential angle [13], figured as follows:

![Figure 2. Feed scatter distribution](image)

3. Results and discussion

In this study, the experiment of APAGAN feed cast distance were adjusted accordingly with its dimension, mechanical function, and automatic function [14]. The results of the feed cast distance experiment at different time and height were described in tables below.

| Replicate | Height (m) | Time of feeding (minute) |
|-----------|------------|--------------------------|
|           | 1-2        | 2-3                      | 3-4 | 4-5 | 5-6 | 10 | 15 | 20 | 10 | 15 | 20 | 10 | 15 | 20 | 10 | 15 | 20 |
| 1         | 5 | 5.5 | 4 | 6 | 5.5 | 7 | 4.5 | 6 | 4 | 7 | 5.5 | 4 | 6.5 | 6 | 6 |
| 2         | 5 | 4.5 | 5 | 4.5 | 5.5 | 5 | 5.5 | 6 | 7 | 6.5 | 7.5 | 5.5 | 5.5 | 7 | 5.5 |
| 3         | 4 | 5.5 | 6 | 4.5 | 6 | 4 | 5 | 6.5 | 7 | 5.5 | 6.5 | 6.5 | 6 | 7.5 | 6.5 | 5.5 |
| 4         | 5.5 | 4 | 6 | 6.6 | 5.5 | 7 | 6 | 6 | 6.5 | 6 | 6 | 7.5 | 7.5 | 7 |
| 5         | 7 | 5 | 5.5 | 5.5 | 6 | 4 | 5.5 | 5 | 5 | 6.5 | 7 | 7 | 6.5 | 7 | 7 |
| 6         | 4.5 | 5 | 5 | 5.5 | 4 | 4.5 | 6 | 5.5 | 6 | 5.5 | 6 | 6.5 | 7 | 5.5 | 6 |
| 7         | 6.5 | 5.5 | 5 | 6 | 6.5 | 4 | 7 | 6.5 | 6.5 | 6.5 | 6.5 | 6 | 6.5 | 5 | 6.5 |
| 8         | 4 | 5.5 | 6 | 6 | 5 | 5.5 | 6 | 6.5 | 5.5 | 7 | 7.5 | 7 | 5.5 | 7 | 7.5 |
| 9         | 5.5 | 5 | 5 | 6 | 5.5 | 7 | 7 | 7.5 | 6 | 6.5 | 6.5 | 5.5 | 6.5 | 7 | 7 |
| 10        | 6 | 5 | 5.5 | 4.5 | 5.5 | 5 | 6.5 | 6 | 6.5 | 7 | 7.5 | 7 | 7.5 | 6.5 | 6.5 |
Table 3. Average feeding cast distance at different height

| Replicate | Height (m) | 1-2  | 2-3  | 3-4  | 4-5  | 5-6  |
|-----------|------------|------|------|------|------|------|
|           |            | Average cast distance (m) | | | | |
| 1         | 4.833333   | 6.166667 | 4.833333 | 5.5  | 6.166667 |
| 2         | 4.833333   | 5     | 6.166667 | 6.5  | 6   |
| 3         | 5.166667   | 4.833333 | 6.166667 | 6    | 6.5 |
| 4         | 5.166667   | 6.366667 | 6.166667 | 6    | 7.333333 |
| 5         | 5.833333   | 5.166667 | 5.166667 | 6.833333 | 6.833333 |
| 6         | 4.833333   | 4.833333 | 5.333333 | 5.833333 | 6.333333 |
| 7         | 5.666667   | 5.5    | 6.5    | 6    | 6.666667 |
| 8         | 5.166667   | 5.5    | 6      | 7.333333 | 7.333333 |
| 9         | 5.166667   | 6.166667 | 6.833333 | 6.166667 | 6.833333 |
| 10        | 5.5        | 5      | 6.333333 | 7.166667 | 6.833333 |
| **Average** | **5.216667** | **5.453333** | **5.95** | **6.333333** | **6.683333** |

* Notes are significant difference (p<0.05) with 95% confidence interval based on Tukey’s HSD test

The automatic hanging fish feeder was supposedly positioned above the fishpond surface. However, the throwing experiment in this study was performed on solid ground in order to obtain an accurate drop point of the feed. The target area was marked to indicate where exactly the point of the feed dropped. The device was arranged accordingly to acquire certain position where the casted feed would evenly distributed and cover the target range. The most substantial variable for this work is the height (h, in meter) of the device towards the surface area.

Five tables were used to described the randomized block design which were applied to analyse each different height of the device. The statistical analysis of these randomized block design indicates that using APAGAN at different time of feeding does not affected the cast distance (p>0.05). Therefore, the average feed cast distance on each replicate at different height (Table 3, Appendix) can be used for next analysis. The statistical analysis of APAGAN at different height showed that APAGAN positioned at different height significantly affected the average cast distance of the feed with 95% confidence interval (p<0.05) and coefficient of variation (CV) at 8.21%.

According to Sumanto (1989), the rotary movement of electric motor, defined as round per minute (rpm), is greatly affected by the length of the blade [15]. The longer the blade (b_m, in cm), the lower the torque or spin power. Conversely, the shorter the blade, the higher the torque. Therefore, the shorter the blade, the higher the rpm. In the case of fish feeder, the longer the blade, the farther the feed would travel.

The feed throwing performance is also correlated with its drop angle (a_n). The smaller the drop angle, the nearer the feed would travel. The optimum length of the blade can be calculated by comparing the throw angle (C) with the drop angle, and selected correspondingly to the condition of the fishpond.

4. Conclusion

Some drawbacks in feeding routines, such as uneven distribution of feed at certain range of the pond and longer gap at each delivery time, causes quite challenging works for the fish farmers in delivering the feed in fish and prawn pond. Fish farmers demands to reduce feed cost and improve environmental factor which affect the fish health and enhance growth rate. The use of APAGAN would help to improve the health and growth of fish and prawn, which consequently would increase their market value.
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