Original Research Article

Development of Automatic Fish Feeding Machine for Integrated Floating Cage Aquageoponic System

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ABSTRACT

Aims: The objective of this work was to develop and evaluate the performance of an automatic fish feeder- to enhance aquacultural practices and farmponds

Place and Duration of Study: The research study was conducted at Madakasira, (Latitude: 13°56'55.96″ N and Longitude: 77°18'45.38″ E) which is located in Anantapur district of Andhra Pradesh, India. The mean annual temperature and annual rainfall of the study area are 27.6°C and 532 mm, respectively. Most of the rainfall (~80%) is received during South-West monsoon. The experiment study was conducted from March–June, 2018.

Methodology: Automatic fish feeder includes both electrical and mechanical mechanism. The materials includes for the development of the feeder was cone shape hopper, top covering lid, base, 12V DC motor, 12V 7Ah Rechargeable Lead Acid Battery, Arduino Uno, Bluetooth HC-05 module, 5v Relay, DC-DC step-down converter. The developed feeder was operated with the help of mobile app by using Bluetooth HC-05 module. The spreading distance and amount of feed spread, opening angles of the feeder were evaluated during the research period.

Results: Our results showed that the amount of feed spread was maximum (140 g m^{-1}) with 1.0 m height and was minimum (101 g m^{-1}) at 0.2 m height. This results clearly shows that the fish feeder has to be kept at maximum height so that it covers maximum spreading distance with minimum loss of fish feed by drift. With increase in height of the machine from ground surface, the spreading distance of the fish feed from the feeding machine was also increased.

Conclusion: Farmers were satisfied with this new technology which helps to avoid manual feeding.

1. INTRODUCTION)

'Feeding' is considered as one of the critical factors in fish growth and production [7] [11] and is labour-intensive and expensive. In general, the fish growth and feed conversion increases with feeding frequency. In the intensive fish culture systems, fish may be fed as many as 5 times a day [16] to attain maximize growth at optimum temperatures. Most of the fish farmers adopt the manual feeding system, which is dependent on labour availability, farm size, fish species and size of the fishes. The traditional manual feeding system requires more manual labour for cleaning the feeder, refilling with feed, repair and maintenance etc. All these processes involve considerable energy consumption and requires more time. Moreover, in larger fish farms, the manual feeding system users are facing difficulty in managing the entire feeding schedule. Hence, there is a need to develop an efficient feeder system [19] to overcome the problems encountered in manual feeding system. Many research findings showed that the automatic fish feeder, an electronic device is efficient in

dispensing right quantity of pellets [8], powders and granules in right time and hence can be an alternative for traditional manual feeding system. In general, two basic concepts which are fixed and mobile conceived the automatic fish feeder [12]. This device fed fish in right time and amount pre-defined by user, and hence avoids the problem of overfeeding Moreover, the system resulted in more systematic feeding schedule which decreased the labor cost considerably. Numerous researchers conducted the experiments on automatic fish feeder using different electronic gadgets and software [9]. The efficiency and profitability of aquacultural practice could be enhanced with improved technology like automatic fish feeding mechanisms. El shal et al. [5] developed and evaluated IOT based automatic aquarium. Demand feeders, controlled by the fish needs, could be bait- rod (pendulum) type or submerged plate-type [4]. Prangchumpol (2018) developed a model of mobile application for automatic fish feeder aquariums system which had the capability of sensing uneaten feed. Noor MZH et al. [10] developed an automatic fish feeder using PIC microcontroller. Anyadike et al. (2012) developed a design, utilized a plastic hopper, with a galvanized-metal discharge chute and a valve attached. The device is capable of discharging 240 g of pelleted feed in 120s. Among the various fish spp. Tilapia (*Oreochromis niloticus)* is the second most important cultured food fish in the world after carp. Tilapias[5]are most profitable to aqua-growers as it involves less risk due to their omnivorous diet, mode of reproduction, rapid growth and higher resistance to diseases [17]. These fish attained higher growth when fed 2–3 times per day as compared to single time daily feeding[18].

The objective of this work was to develop and evaluate the performance of an automatic fish feeder- to enhance aquacultural practices and farmponds [6].

This automatic fish feeder was developed to fulfill certain objectives and requirements with added advantages such as a detachable hopper to accommodate various sizes of hopper according to user's requirement. It was also designed to have adjustable height and opening angle to accommodate different sizes of fish tanks and ponds, as well as provide a mobile fish feeder with pneumatic system for safety reasons. These features make it suitable to be specifically used for growing tilapia spp.

2. MATERIAL AND METHODS

2.1. Study Site

The research study was conducted at Madakasira, (Latitude: 13°56'55.96″ N and Longitude: 77°18'45.38″ E) which is located in Anantapur district of Andhra Pradesh, India. The mean annual temperature and annual rainfall of the study area are 27.6°C and 532 mm, respectively. Most of the rainfall (~80%) is received during South-West monsoon. The experiment study was conducted from March–June, 2018.s

2.2. Experimental setup

Automatic fish feeder was designed to spread the fish feed in aqua-pond to maintain the fish growth. Fish feeder consists of cone shape hopper, top covering lid, base, 12V DC motor, 12V 7Ah Rechargeable Lead Acid Battery, Arduino Uno, Bluetooth HC-05 module, 5v Relay, DC-DC step-down converter etc.

2.3. Description of the device

The automatic feeding machine (Figure 1) consists of a hopper, top cover (LID), the base (comprising the motor and feed platform) and the electrical control box. Hopper was designed in the cone shape and made up of stainless steel. The capacity of the hopper was 5 kg. The design of the hopper will affect the rate and type of particle flows in the hopper. Based on the bulk density and angle of repose of material, the hopper was designed. The 12V DC motor fixed on the top of the hopper and a long shaft was attached to the motor. The base consists of feed platform is attached motor shaft. The top cover is made of the lid

and it protects the feed from rain and contaminants. The feed platform opens and closes the discharge outlet as the motor rotates. The diameter, thickness and length of arcs of the feed platform is 10 cm, 18 mm gauge and 10 cm respectively. The electrical control box controls and regulates the feeding operation and the frequency.

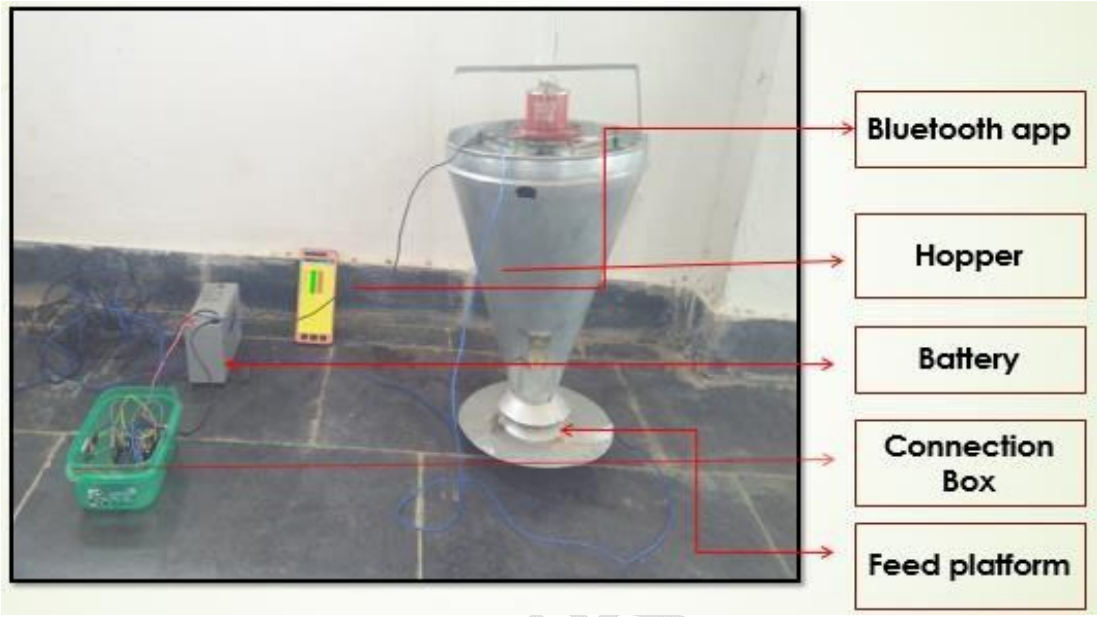

Figure 1: Setup of automatic fish feeding machine

2.4. Description of electrical control box

The electrical control box consists of Arduino Uno, 12V DC motor, 12V 7Ah Rechargeable Lead Acid Battery, Bluetooth HC-05 module, 5v Relay, DC-DC step-down converter etc. Figure 2 shows the different parts of electrical control box.

Arduino Uno is an open source microcontroller board based on the ATmega328 (datasheet). It consists of 14 digital input/output pins in which 6 can be used as PWM output (3,5,6,9,10,11), 6 analog inputs, 16 MHz crystal oscillator, USB connection, power jack, ICSP header and reset button. Arduino Uno contains everything those are needed to support the microcontroller. Arduino Uno could simply connect to a computer with USB cable to upload the required programme. Bluetooth Module (HC-O5) is used to communicate between 2 microcontrollers like Arduino or communicate with any device with bluetooth functionality like a Phone or Laptop. HC-05 has two operating modes, one is the data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed. It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP).

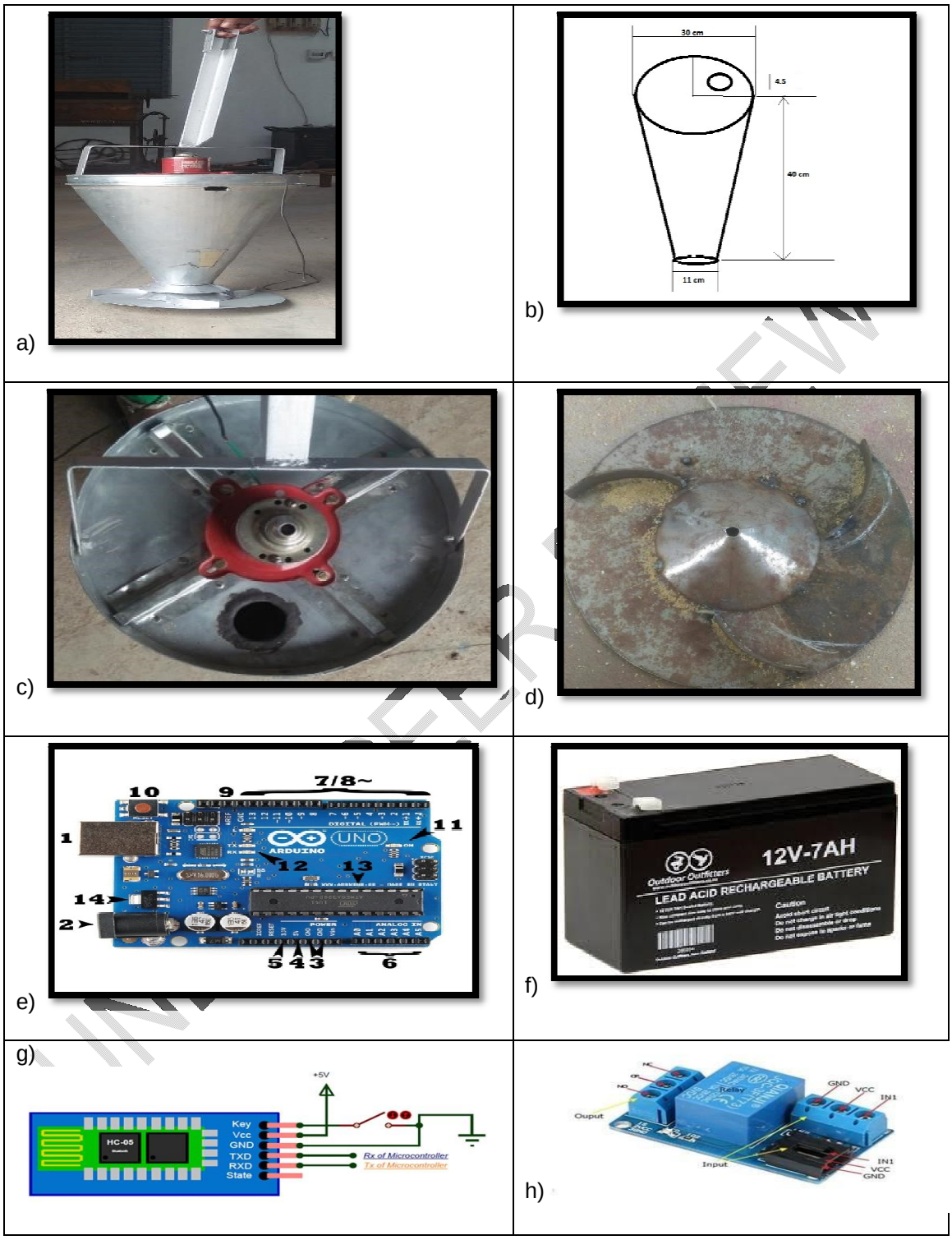

Figure 2: a) Aqua-feeder b) Dimensions of Hopper c) Top view of feeder d) Feed platform e) Aurdino Uno f) 12V-7 AH Battery g) Bluetooth Module (HC-05) h) Relay.

Simply power the module with +3.3 V and connect the Rx (Receive) pin of the module to the Tx (Transmit) of Arduino Uno and Tx pin of module to Rx of Arduino Uno. A relay is an electrically operated device and used as an automatic switch to controlling a high-current circuit with a low current signal. A DC-DC step-down converter is an electronic circuit that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Most DC to DC converter circuits regulate the output voltage. A rechargeable battery, which can be charged and discharged into a load. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network.

2.5 Arrangement of connections of electrical circuit (control box)

12V 7AH rechargeable lead acid battery power is transmitted to Arduino Uno through DC-DC step-down converter and to power the 12V DC motor through relay. Connections are shown in Figure 3. Battery both terminals connected to the same terminals on DC-DC step-down converter input and step-down converter output terminals are connected to 5.2×2.1 mm male power jack which is inserted in Arduino Uno female jack to power the Arduino Uno microcontroller board. Bluetooth module pins GND (ground), Vcc (voltage collector to collector), Tx (Transmit) and Rx (Receive) is connected to Arduino Uno pins i.e., GND, 3.3V, Rx and Tx respectively with female-male jumper wires. 5 v Relay GND, +5v, Signal pins are connected to Arduino Uno GND, +5v, Digital Pin 3, respectively and Relay COM (Common) and NO (Normally open) pins are connected to one of two wires of motor in which one is cut and two ends of broken wire is connected to COM and NO pins. Another wire is directly connected motor from battery terminal. In Bluetooth automation app, when on button pressed the data is sent to Arduino Uno board through serial communication.

2.6. Step by step procedure to operate automatic feeder

Firstly, open the google play store in the Android mobile and search for the Bluetooth farm automation app. Install the app and pair with Bluetooth HC-05. Enter the password and press ON for feed discharge. After discharging the correct amount of feed within the time limit press OFF to stop.

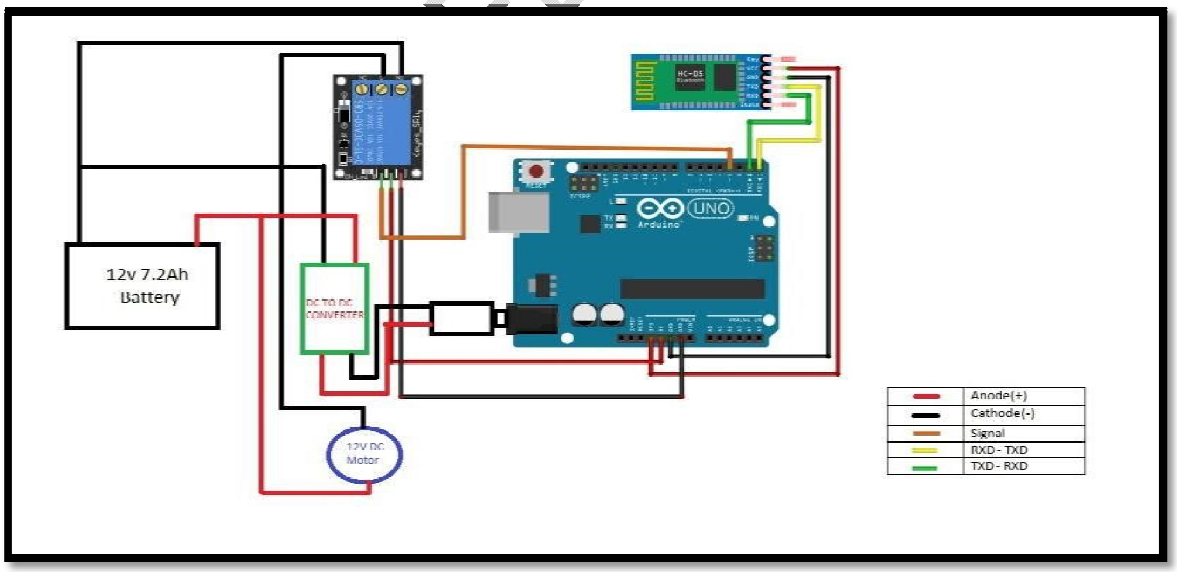

Figure 3: Schematic diagram of connection setup of Bluetooth operated fish feeder

2.7. Operating the machine

The hopper contains the feed which comes out through the discharge outlet. In Bluetooth farm automation app click “ON” button, then the platform rotates around its axis, then the feed comes out from the discharge outlet. The desired amount of the feed would be

dispensed into the pond and this completes an operation for 1 m. After the operation is completed, click on the “OFF” button.

2.8. Performance Evaluation of Machine

The performance evaluation of the device was conducted using integrated floating cage aquageoponics system (IFCAS) placed in the farm pond at College of Agricultural Engineering, Madakasira, Ananthapur (Dist), Andhra Pradesh, India. The experiments were conducted in IFCAS cage structure having 9.45 m^3 (2.70 m×2.50 m×1.4 m) volume, with 300 numbers of Tilapia fish

3. RESULTS AND DISCUSSION

3.1. Performance and evaluation of automatic fish feeder

The aqua-feeder shown in Figure 2a., having the capacity of 2kg, filled with rice husk and allowed to discharge the feed whenever we need to supply the feed to fishes. Total amount of feed filled was delivered rightly with accurate time. The feeding efficiency was found to have improved significantly when compared to manual feeding. The price of the machine is affordable and operation is simple, it can be operated by young and old who had the android mobile. Its feeding time is flexible.

3.1.1. Height vs. Spreading distance

The automatic fish feeder was designed and evaluated for its performance on spreading distance of fish feed (rice husk) at different heights i.e., 0.2 m, 0.4 m, 0.6 m, 0.8 m and 1.0 m above the ground surface. The maximum (2.1 m) and minimum (1.2 m) spreading was obtained at 1 m and 0.2 m height. From Figure 4, the results indicated that with increase in height of the machine from ground surface, the spreading distance of the fish feed from the feeding machine was also increased. Based on the rotation of the motor shaft, the spreading distance was decided.The obtained results were similar to wei et al., (2010) who observed that position of the hopper vs spreading distance. When the hopper was raised, the spreading distance of the small and large pellets being dispensed will also increase.

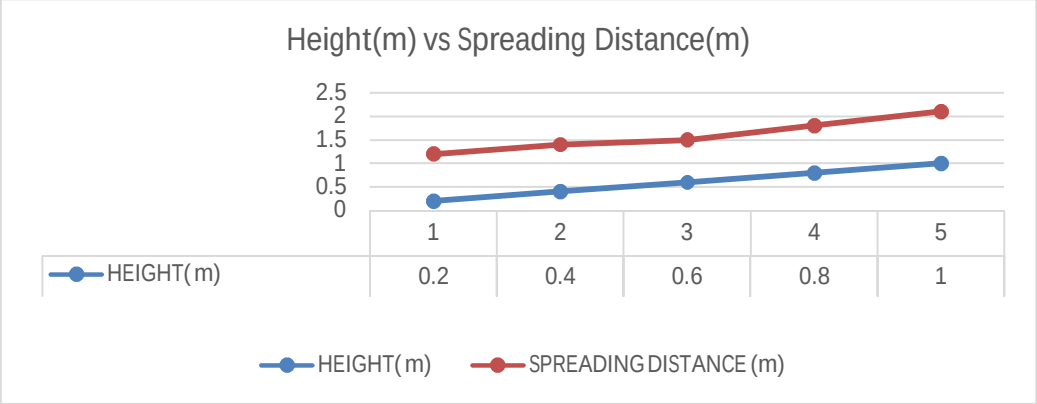

Figure 4: Height of the feeder (m) vs. Spreading Distance of the feeder (m)

3.1.2. Height vs Amount of feed spread

The performance of amount of feed spread vs height was determined. The different heights were 0.2 m, 0.4 m, 0.6 m, 0.8 m and 1.0 m selected. From Figure 5, the amount of feed spread was maximum (140 g m^{-1}) and minimum (101 g m^{-1}) at 0.2 m and 1.0 m height, respectively. This clearly shows that the fish feeder has to be kept at maximum height so that it covers maximum spreading distance with minimum loss of fish feed by drift. The obtained results were supported with Osueke et al., (2018), who observed the closest results in Height vs amount of spread evaluation.

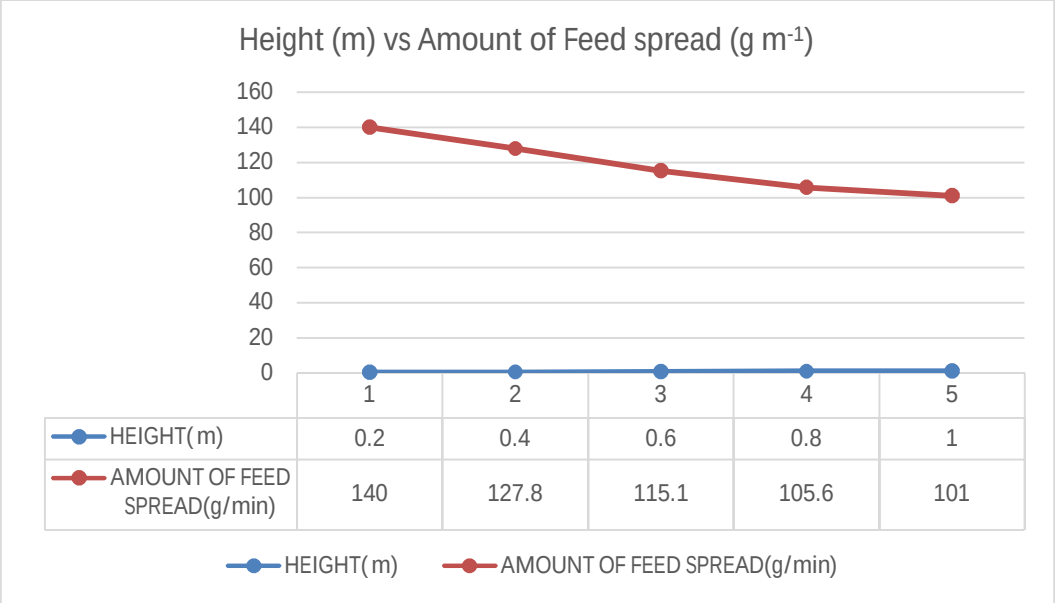

Figure 5: Height of the feeder(g) vs. amount of feed spread (g m^{-1})

3.1.3 Opening angle vs Spreading distance

The spreading distance and opening angles of aqua-feeder were evaluated. Based on the previous research studies, opening angles were 0^0, 15^0, 30^0, 45^0, 60^0 selected for evaluation. From Figure 6. it was noted the opening angle upto 60^0 increased, spreading distance also increased upto 2.5 m. The minimum spreading distance of 0.5m obtained at opening angle 0^0.If the opening angle was optimum, feeder will work effectively and discharge the correct amount of feed and spread to its maximum distance.Yeoh et al., (2010) obtained the similar results, as the opening angle is increased from 0° to 30°, the dispensing width also increases at an average of only 20%, but the increment is more significant when the opening is at 60°, where the husks are dispensed up to 80% further.

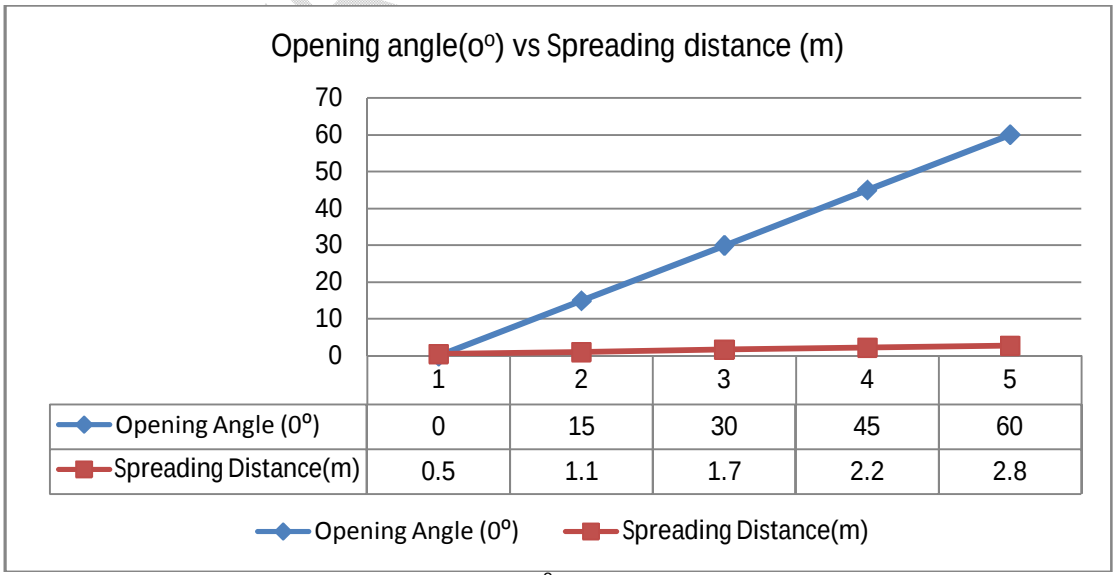

Figure 6 : Opening angle(o°) vs Spreading distance (m)

4. CONCLUSION

With increased height of feeder from ground surface, spreading distance of feed increased. The fish feeder has to be kept at maximum height so that it covers maximum spreading distance with minimum loss of fish feed by drift. By using automatic fish feeder CAS, fish feed can be supplied in time with increased precision in feed quantity; reduced drudgery of entering into farm ponds for feed application, thereby reducing the cost of labour besides higher income.

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