

PAPER • OPEN ACCESS

## The inovation of eco-friendly aquaculture system in enhancing *clarias gariepinus* growth performance in Serut village, Panti sub-distrit, Jember regency of East Java

To cite this article: S Wathon and M Su'udi 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **243** 012158

View the [article online](#) for updates and enhancements.

### You may also like

- [Utilization of \*Mycelium steriliun\* KT31 metabolites with diet for controlling \*Aeromonas hydrophila\* infection on catfish \*Clarias gariepinus\*](#)  
D Wahjuningrum, K Tarman, N Faradisa et al.
- [Effect of Maggot-Based Feed on Carbohydrate and Protein Content of Catfish Processed Products](#)  
M Sulistyoningsih, R Rakhmawati, E I Retnowati et al.
- [Growth Performance of Catfish \(\*Clarias Gariepinus\* Burchell, 1822\) Cultured in High Density on the Biofloc System](#)  
Fajar Basuki, Tristiana Yuniarti, Dicky Harwanto et al.



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# The inovation of eco-friendly aquaculture system in enhancing *clarias gariepinus* growth performance in Serut village, Panti sub-distrit, Jember regency of East Java

S Wathon\* and M Su'udi

Department of Biology, University of Jember

\*syubbanulwathon@unej.ac.id

**Abstract.** *Clarias gariepinus* is a special catfish and highly favorable by the people. It occurs because the cultivation doesn't need specific terrain, big budget, high water supply, easy to be maintained and fast growth. The tasty and mouthwatering meat are the reasons why this cultivation business is promising huge profit. The aquaculture of *Clarias gariepinus* is well known and being business opportunity in many region, including Serut village in Panti sub-district. As the time goes, the problem occurs among the catfish farmers begin with over feeding, pricey feed, the disease attack and prevalent growth among the fish. This problem needs solution with a knowledge and applying simple technology to enhance the aquaculture performance. Through approaching the youth organization and farmer group by using communication, discussion and joint working, the team finally summed up the output as follows: pond construction and its instrument, workshop and training, manufacturing the alternative feed and the manual of feeding, the issue of developing catfish aquaculture services, partnership or any other related program, long term-achievement simulation for catfish aquaculture in Serut village of Panti sub-district, Jember regency. Through this program, the catfish performance is enhancing therefore it increase the farmers' income and develop the scale of cultivation as business opportunity for the community. Last but not least, the achievement of catfish aquaculture development makes the Serut village become the model of developing catfish aquaculture in other region.

Keywords: aquaculture, catfish, *Clarias gariepinus*, partnership, performance.

## 1. Introduction

Fisheries is one of supporting sector for maritime nation economic such as Indonesia. Fisheries system which potentially develop is capture fisheries and aquaculture [1]. The technique of aquaculture or fish farming are flow through system, pond system and cage system [2]. Catfish cultivation is one of the inland aquaculture which become superior commodity in community [3]. The development of catfish aquaculture is increasing annually [4]. These condition also increase the catfish production [5]. Therefore, it will be needed innovation in order to optimize the production to meet the consumer demand.

*Clarias gariepinus* also known as African catfish has many specialty and mass-cultivated by the community. The aquaculture of *Clarias gariepinus* has a bright future. It happened because the cultivation doesn't need specific terrain, low budget, high water supply, easy to be maintained and fast growing [6]. The tasty and mouthwatering meat makes these business promising high profit [7]. The high development of catfish aquaculture will create more jobs, increase the income, high frequency of market demand, development business skill and meet the community fisheries nutrient needs [8].

Jember regency area has high potential in growing many kind of fresh water fish species. Serut village which located in Panti sub-district has high potential as the new place to develop catfish aquaculture. It supported by the amount of farm and plantation area which suitable for catfish aquaculture. There are plenty area which not optimally used so far, especially plantation area of bushes.



The environmental situation which is not too hot and dry are possible to be the place of catfish aquaculture. On the other hand, the spring is highly sufficient in meeting the needs of water for catfish aquaculture.

A few of local groups which gathered in “Bolo Dewo” youth organization, “Sejahtera Bersama” farm group, “Pos Daya Semarak 11” farm group has initiated catfish aquaculture in Serut village. This business has been running for 2 years. As the time goes by, the problems occurs among of them. Begin with overfeeding, pricey feed, disease strikes (red fin which caused by virus and smallpox which caused by fungi) and prevalent growth among the fish. This problem needs solution with a knowledge and applying simple technology to enhance the aquaculture performance.

This situation draw the attention of lecturer team from biology department of Math and Science faculty, Jember university through the program of “Program Pengabdian Kemitraan Masyarakat” (PPK) to be involved in the community in solving the catfish farmers problems. This program is the manifestation of high education institution tri dharma in giving services to the community. The eco-friendly innovation in enhancing the performance of catfish aquaculture hopefully will increase the income, the scale of aquaculture and become the business opportunity for the residence in Serut village, Panti sub-district of Jember regency. Last but not least, the achievement of catfish aquaculture development makes the Serut village become the model of developing catfish aquaculture in other region.

The local groups which gathered in “Bolo Dewo” youth organization, “Sejahtera Bersama” farm group, “Pos Daya Semarak 11” farm group while running the business of catfish aquaculture also do social work by helping orphan house in Serut village. Half of their income will be donated to the orphan house. This social work also shows that the business of catfish aquaculture is helping the community especially the orphan house in Serut village. In conclusion, the PPK program not only help to increase the income, develop the scale, and enhancing the catfish aquaculture performance but also help the community in creating business opportunity, and giving social effect by helping orphan house in Serut village, Panti sub-district, Jember regency.

## **2. Methods**

In solving the problem, the method are as follows:

### *2.1. Education*

Education conducted in order to deliver the aim of the activities from the proposer into the partner. PPK proposer team will explain the background of PPK program and design the equipment and the type of training and assistance in order to reach the output target. As the feedback, partner will provide a place for educating and training, invite the similar business associate and suggest the interviewee for the training program. This series of event will be held along with partner in the form of their participation.

### *2.2 Providing Business Asset*

The fund will be provided in the form of suitable equipment for solving the problem. The proposer team will design tarpaulin pond or wall with bio filter device for the catfish cultivation place and add simple aerator with draining system. The proposer team design these equipment after considering the partner suggestion.

### *2.3 Training*

The training is held to increase the partner understanding on the use of tarpaulin pond or wall with bio filter device and simple aerator with draining system. The manual use of equipment will be explain clearly in order the partner understand and able to use it manually. The enhancement of understanding in feeding, sorting technique for infected catfish, sorting catfish based on the age and size is held by inviting an expert of fisheries and animal husbandry from the university or research institution. In other hand, there is also training for simple marketing management (post-harvesting) through inviting expert in fisheries and agribusiness.

### 2.4 Enhancing Knowledge

Enhancing knowledge conducted by giving prior knowledge, understanding and applying the theory. The theory given through discussion, lecturing and practice with the assistance of viewer, visual aid, and some examples. After that, enhancing knowledge and skill through measuring partner understanding by using pre-test and post-test.

### 2.5 Assisting

The proposer team assist the partner in using tarpaulin pond or aerator wall with bio filter device for catfish cultivation with the draining system, application the result of counseling and guiding in feeding the catfish with natural feed, sorting technique for infected catfish, sorting the catfish based on the age and size, and application of marketing management. The assisting held until the partner can conduct it manually. The assisting conducted by supervising the skill application on theory to make sure that the skill is applied.

The effect of this activities economically can enhance the performance of catfish aquaculture which will giving impact on increasing the farmers' income. In other hand, it also giving social impact by the donation for orphan house from the result of catfish aquaculture. On the science and technology, there will be knowledge transfers between the private sectors and the community.

## 3. Results and Discussion

Community service program of innovation eco-friendly aquaculture system in enhancing *Clarias gariepinus* growth performance in Serut village, Panti sub-distrit, Jember regency of East Java presenting several result. Pond construction and its equipment, workshop and training, innovation on feed formula and how to feeding, and the issue of developing catfish aquaculture on the service program, partnership or other related program and the catfish aquaculture long-term achievement simulation in Serut village, Panti sub-distrit, Jember regency.

### 3.1. Workshop

Workshop conducted as one of the activities from the community services team purposing to sharing, transferring knowledge, and debriefing the partner in keeping their commitment in the program of innovation eco-friendly aquaculture system in enhancing *Clarias gariepinus* growth. Every workshop participant will receive a module which contain the information of the innovation on the catfish aquaculture system which equipped with the illustration to make it easily understandable. Workshop conducted in one of the partner post, Bolo Dewo youth organization, Karanganom county of Serut village – Panti, Jember.

Workshop participant can understand the eco-friendly innovation technique in catfish aquaculture begin with the sorting technique and pond construction, selecting the catfish seeds, sorting technique, arranging and controlling the water, food innovation with natural ingredients, and the post-harvesting simulation. At the end of workshop, there will be discussion session to enhance the participant understanding about the programs that will be held. The participant have to giving their opinion, suggestion and critique both written and spoken after the workshop. In the workshop activities, the participant seem so enthusiast, cooperative and show the commitment to collaborate with the community service team. The partners also demanding the workshop schedule should be well-arranged and continuously. Another participant expecting the assistance in and after the workshop. After the workshop activities, the partner can apply the knowledge and technology as the module and explanation.

### 3.2. Walled-Pond Construction

Tarpaulin pond and walled-pond (cement/concrete) is 2 kind of ponds which commonly used as the media in catfish aquaculture intensively [9]. Tarpaulin pond is a pond which the wall and base made of tarpaulin and constructed by wood, bamboo or steel construction. Tarpaulin pond was chosen because it is low budget and fit with narrow spaces, practical and more economical in construction [10]. But this

pond has many disadvantages: 1) tarpaulin is potentially torn apart and leak, 2) Tarpaulin pond is semi-permanent and will be damaged faster under sun exposure, 3) It takes extra feed because tarpaulin doesn't have nutrient, 4) the water is smelly faster, 5) it takes draining much often to keep the water quality, because the dirt is potentially sediment in the bottom of the pond especially in the shelf, 6) tarpaulin pond will face quality degradation as the time of use and frequency, therefore the farmers need to buy the new one.

After reviewing several pond for catfish aquaculture, therefore in this program the phase of growing the catfish until reach consumption size conducted in walled pond. Despite the budget is higher than tarpaulin pond, but it has more advantages. Among of them are: 1) more durable and no leak, 2) more resistant against the pond pressure, 3) permanent structure, unbreakable, and weatherproof, 4) the feeding can be conducted efficiently because the catfish will get natural food from the pond, 5) water management is much more easier and controlled, 6) the excretion of catfish metabolism is easily conducted through central drainage system, 7) perfect maintaining will led to continuously use without thinking the damage that exist in tarpaulin pond.

The aquaculture in walled pond is very precisely with long term target. As this program explained, half of the catfish aquaculture outcome will be given to the orphan house. Walled pond will be useful for the catfish farmer continuously and indirectly giving positive effect and continuously on social work program.

Walled pond constructed to enhance catfish aquaculture performance which meet the amount of partner 3 ponds with each size are 3 x 2 meters and height 1-1.2 meters (picture 1). Each partners ("Bolo Dewo" youth organization, "Sejahtera Bersama" husbandry group, "Pos Daya Semarak" husbandry group) will receive a single pond with central drainage system and standard equipment for catfish aquaculture such as aerator and sesh.

### *3.3. Pond Preparation and Water Quality Control*

Walled pond preparation before using are including drying, mud and dirt cleaning, liming, fertilizing and filling the water. Drying the pond can be done by sunbathing the pond for 2-3 days until the base and the wall dry. The next step is cleaning the mud and dirt which stick to the pond's wall by flushing with the water. Then liming and fertilizing the pond. The liming is conducted by liming the wall and base with the lime mixture. The lime which commonly used is dolomite with the dose of 60 - 200 g/m<sup>2</sup>. Meanwhile, the fertilizing process using manure with the dose 200 - 500 g/m<sup>2</sup> [11].

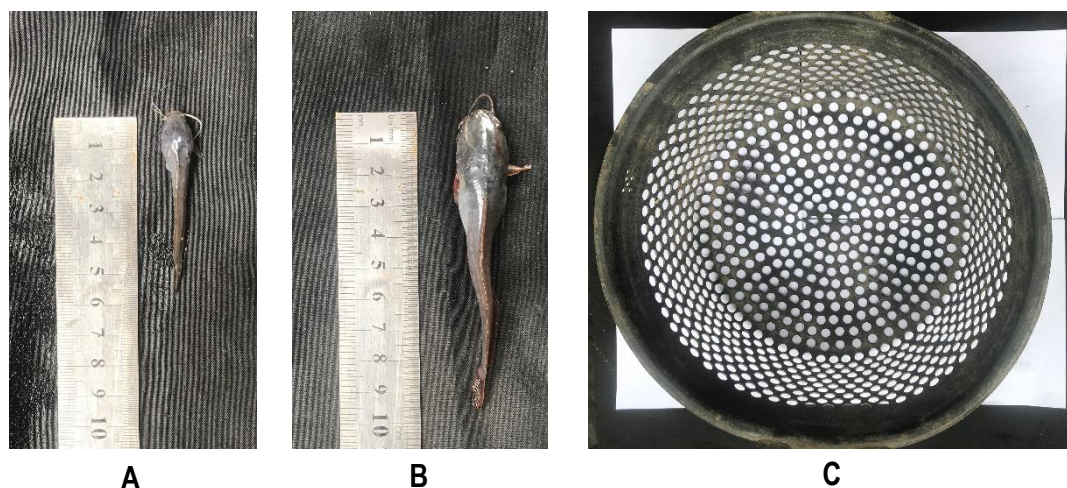
The next step is filling the pond with the fresh water with the volume of 40 – 50 cm. The spread density of catfish seed in the pond's wall is between 150-400 species/m<sup>3</sup>, depend on the growing system. Water is the media of fish cultivation. The accomplishment of fish cultivation determine by the water quantity and quality [12]. Water quantity is the amount of available water from the source such as river, irrigation channel and well. The advantages of catfish aquaculture that it doesn't need much water supply, unlike goldfish and silver barb. It occurs because catfish has extra respiration instrument therefore it can takes oxygen freely from the air [13]. The water quality include the physics, chemical and biology nature of water. The physics nature include the temperature, brightness, turbidity and color. The chemical nature include the pH level, soluble oxygen, carbon dioxide, ammonia and alkalinity, while the biology nature include plankton, benthos and water plantation. These variable will affect the management, living performance, fish growth and development [9; 14]. Water condition as the media require the temperature 22 – 27°C, dissolve oxygen level 5 - 6 mg/L, pH level 6 – 7 and ammonia level 0,1 ppm. Water quality based on the literature require the temperature 27 – 30°C, dissolve oxygen level >5 mg/L, pH level 6,5 – 8,5, and ammonia level < 0,2 ppm [15;16].

### *3.4. Catfish Seed Growing and Sorting Technique*

500 *Clarias gariepinus* with the head size 9-10 mm the length of the body 5-6 cm (picture 2a) spread out in the seed growing pond with the size of 2 x 2 M and the height 1 meter. The growing pond contain the volume of water 50 cm from the base. The spreading of the seeds should not be so crowded to avoid

the disease. Every square meter of the pond will accommodate 100 *Clarias gariepinus* seeds. The catfish seed aged 2 weeks (head size 16 – 18 mm and the body length 8 – 10 cm) will be move to growing pond.

Before the seed move to the growing pond, there will be seed sorting using sorting device (Picture 2c). sorting conducted purposing the seed will have the same size when it move to the growing pond [6]. Imbalance spread of catfish will lead to varying development on the catfish. The big-sized catfish often eat the smaller one is the mortality-caused factor and varying development. Catfish is one of aquaculture fish who has cannibalism behavior [17]. The higher interaction of varying size of catfish then the higher cannibalism behavior.



**Picture 1.** (a) African catfish seed on the first spread; (b) African catfish aged 15 days on the growing pond; (c) catfish sorting device.

### 3.5. The Innovation of Food Producing

Beside water quality control, food is one of important thing in intensive catfish growing and contribute 60-70% on production cost [18; 19; 20]. Generally, their food divided into natural feed, commercial feed and alternative feed. Natural feed is naturally available on the pond. The feeding technique is commonly applied in the traditional pond which clay-constructed. The natural feed are plankton, worm, and another creature or vegetation which naturally on the pond or accidentally brought by the water [21; 22; 23; 24; 25; 26]. On the contrary, the natural catfish aquaculture is rarely find because when it comes to harvest period the amount of catfish is decreasing comparing to the amount of the seed, means that catfish need a lot of food and the natural food doesn't accommodate their needs. Therefore the cannibalism behavior occurs and eat the smaller and weak catfish [17]. Growing natural food is very difficult because the limited spaces or media and depending on environmental factors such as, temperature, light intensity, pest, disease and poison.

Commercial feed is fabric-made food which commonly in the form of pellet or concentrate feed and design to meet the catfish nutrient needs. Pellet available in many kind and size which can be suit to the fish age. Commercial food has complete nutrient such as protein, fat, carbohydrate, vitamin and mineral. Protein which contain in commercial food is 30-40% and it suit to the catfish nutrient needs [27]. The intensive catfish aquaculture using commercial feed unfortunately will lead to pollution and disease [28]. In other hand, the price of pellet which increasing often being the problem for the catfish aquaculture. Therefore on the field, it's rarely find aquaculture using 100% pellet all the time. This situation also occurs in Karanganom county, Serut village-Panti, Jember. The best solution for this problem is creating food based on eco-friendly and natural ingredients.

Producing the food manually will minimize the cost. The food will consist of formulated natural ingredients so the shape will be different with the ingredients. High quality food should consist nutrients such as protein, fat, carbohydrate, vitamin and mineral. The carbohydrate and fat will be the main source



of energy while the protein will help the development process. These component have to in equal amount and meet the catfish nutrient needs. The ingredient will be natural object which easily found in surrounding area of aquaculture such as soy bean grain, bran, tofu pulp, coconut pulp and molasses. Soy bean grain, fish flour, corn bran, tofu pulp, coconut pulp, and molasses are organic material which has big amount and if it's not well utilized will turn into waste and creating disease. One of the requirement for natural material is the continuously available, means that the component can easily obtained in surrounding [29]. It needed because if the food keep changing will caused stress for the catfish. Besides, the availability of material will decrease the transportation cost. Therefore, in this activities will recycle the material into eco-friendly natural-made food which can enhance the performance of catfish aquaculture. As the additive material, consortium EM<sub>4</sub> bacteria added. The formula composition can be seen on table 1.

The whole ingredient will be mashed up using flour machine (picture 3). Fish flour, soy bean flour, and coconut pulp mixed up into one dough. Then the dough will be added the molasses, EM<sub>4</sub> bacteria and water. Then, the mixture will be fermented for 5-7 days. After that, the fermented mixture added with fish oil, coconut oil, and tapioca flour solution. The food dough then mixture evenly and shaped with extruder machine (picture 3). The synthetic food then dried until the surface shiny. The natural mixture formulation then suit with the need of catfish nutrient which can be predicted through the ingredient presentation. Based on the composition, the protein contain in the mixture is  $\pm 32\%$ . The feed which formulated from many ingredient valued is better than the commercial food which formulated from one kind of ingredient with the same nutrient contain.

Fish flour, soybean flour, corn barn, barn, tofu pulp, coconut pulp, and molasses is the food component which contain carbohydrate, fat and protein [24; 29; 30; 31; 32]. Besides, the catfish food should contain amino acid. The 20 essential and non-essential amino acid needed for the catfish growth and development [33]. Feather flour not only contain protein but also make the food float on the surface and easily eat by the fish [34]. The fish oil contain fat acid (EPA and DHA) which important for the fish growth and development [35]. Fish oil also the attractant component which give the smell and stimulate catfish appetite [36]. Tapioca flour solution used as the adhesive of pellet so that the food doesn't destruct easily in the water [37]. The consortium EM<sub>4</sub> bacteria help the fermentation and also the probiotic which able to degrade the fish organic waste and sediment it and also increase the micro flora inside the water which can be the additional food for the African catfish [14]. The fabricated food then shaped and dried in order to avoid the bacteria and fungus strike so that the food will be resistant for long-time storage.

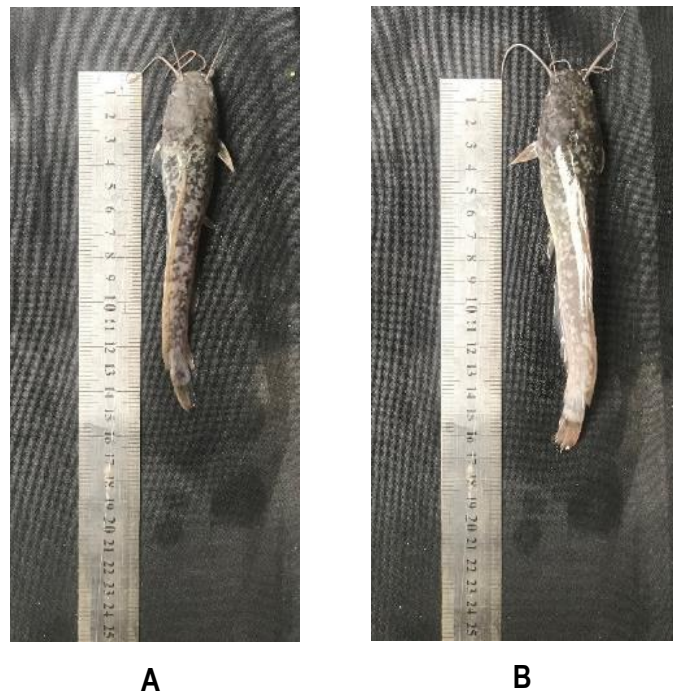
**Table 1.** The ingredient composition for natural fabricated food

No.	The Ingredient	Percentages
1.	Fish Meal	30%
2.	Soy Bean Flour	10%
3.	Feather Flour	10%
4.	Corn ran	28%
5.	Bran	10%
6.	Tofu pulp	7%
7.	Coconut pulp	5%
8.	Sugarcane	0,5 L
9.	EM <sub>4</sub>	0,5 L
10.	Fish oil	15 mL
11.	0,04% Tapioca	1 L

### 3.6. Total Achievement

Generally, the achievement of eco-friendly innovation to enhance the *Clarias gariepinus* performance which conducted in Karanganom county, Serut village of Panti sub-district, Jember regency were fit to

the planned program. The achievement include pond construction and the equipment, workshop and training, and the innovation on the natural-fabricated food. Despite there is some problem in the beginning of this program such as: rain disturbed the pond construction, which led to slower harvested, generally in growing the African catfish and water control show performance enhancement. The performance include: water quality control easily, the number of fish stroked by disease low, the fish growth and development run well and fast (picture 4) and also the natural-fabricated food manually which able to decrease the food cost in the process until reach permanent stage.



**Picture 2.** African catfish aged 40 days after: (a) aquaculture using commercial food; (b) aquaculture using innovation natural ingredient formula food.

#### 4. Conclusions

Based on the result of this community service program partnership, we conclude that this community service program will increase people knowledge about catfish aquaculture start with selecting the pond type, selecting and sorting catfish seed, the innovation of natural ingredient formula food and feeding technique, catfish growing technique until it's correctly permanent. Besides, this program has provided walled pond and food processing machine which can be utilize by the partner for catfish aquaculture continually and increase the residences' income and also supporting the donation program for the orphan house. Makin natural food can be the solution for eco-friendly catfish aquaculture and also anticipate the expensive price of commercial food. Integrating supporting factors of aquaculture such as walled pond, catfish sorting technique, food processing machine and the concept of natural ingredient formula food innovation is the strategy in African catfish aquaculture strategy which support the development of catfish aqua culture business in Karanganom county, Serut village of Panti sub-district, Jember regency.

#### References

- [1] Negara I K W, Marsoedi and Susilo E 2015 *Jurnal Manusia dan Lingkungan* **22(3)** 365 – 371
- [2] Syamsunanrno M B and Sunanrno M T D 2016 *Seminar Nasional Perikanan dan Kelautan* 1 – 15



- [3] Muhammad W N and Andriyanto S 2013 *Media Akuakultur* **8(1)** 63 – 71
- [4] Negara I K W and Pebriani D A A 2017 *Jurnal Ilmu Perikanan* **8(1)** 38 – 43
- [5] Sitio M H F S, Jubaedah D and Syaifudin M 2017 *Jurnal Akuakultur Indonesia* **5(1)** 83 – 96
- [6] Situmorang B 2016 *Jurnal Ilmu Sosial dan Humaniora* **5(2)** 1 – 11
- [7] Sudana S N, Arga I W and Suparta N 2013 *Jurnal Management Agribisnis* **1(1)** 1 - 18
- [8] Khairuman 2002 *Budidaya Lele Dumbo Secara Intensif* (Jakarta: Argo Media Pustaka)
- [9] Mardinawati, Serdiati and Yoel N 2011 *Media Litbang Sulteng* **(2)** 83 – 87
- [10] Kordi M G H K 2010 *Budidaya Ikan Lele di Kolam Terpal* (Yogyakarta: Lily Publisher)
- [11] Dwiyantri B S and Jemadi 2014 *Jurnal Maksipreneur* **4(1)** 4 - 21
- [12] Mustafa A and Erna 2013 *Jurnal Riset Akuakultur* **8(2)** 325 - 338
- [13] Suyanto S R 2011 *Budidaya Ikan Lele* (Jakarta: Penebar Swadaya)
- [14] Elpawati, Pratiwi D R and Radiastuti N 2015 *Jurnal Biologi* **8(1)** 6 – 14
- [15] SNI 01-6483.4-2000 *Tentang Budidaya Ikan Lele* Accessed 01 December 2018
- [16] Boyd CE 1990 *Water Quality Management in Aquaculture and Fisheries Science* (Amsterdam: Elsevier Scientific Publishing Company) p 3125
- [17] Muarif and Rosmawati 2011 *Jurnal Pertanian* **2(1)** 36 – 47
- [18] Emma Z 2006 *Jurnal Sains Kimia* **10** 40 - 45
- [19] Suprayudi M A, Edriani G and Ekasari J 2012 *Jurnal Akuakultur Indonesia* **11** 1 – 10
- [20] Arief M, Fitriani N and Subekti S 2014 *J. Ilmiah Perikanan dan Kelautan* **6(1)** 49 - 53
- [21] Susanto H 1988. *Budidaya Ikan Lele* (Yogyakarta: Kanisius). p 71
- [22] Muchlisin Z A, Damhoeri A, Fauziah R, Muhammadar and Musman, M 2003 *Biologi* **3(2)** 105 – 113
- [23] Mufidah N B W, Rahardja B S and Satyantini W H 2009 *Jurnal Ilmiah Perikanan dan Kelautan* **1(1)** 59 – 65
- [24] Utomo N B P, Susan and Setiawati M 2013 *Jurnal Akuakultur Indonesia* **12(2)** 158 – 168
- [25] Chilmawati D, Suminto and Herawati V E 2014 *Prosiding Seminar Nasional Tahunan Ke-IV Hasil-Hasil Penelitian dan Kelautan* 204 - 217
- [26] Zulhelmi, Fitri C A and Yaman M A 2016 *Jurnal Ilmiah Mahasiswa Pertanian Unsyiah* **1(1)** 746 – 757
- [27] Hastuti S and Subandiyono 2014 *Journal of Fisheries Science and Technology* **10(1)** 37 – 42
- [28] De Schryver P, Crab R, Defoirdt T, Boon N and Verstraete W 2008 *Aquaculture* **277(3-4)** 125 – 137
- [29] Falahudin I, Syarifah and Rahmalia M 2016 *Jurnal Bioilmi* **2(1)** 1 – 9
- [30] Sukarman 2011 *Media Akuakultur* **6(1)** 36 – 42
- [31] Anggraeni D N and Rahmiati 2016 *Biogenesis* **4(1)** 53 – 57
- [32] Yuhanna W L and Yulistiana Y G 2017 *Agrokreatif* **3(2)** 108 – 114
- [33] Schmittou H R, Chremer M C and Zhang J 1997 *Principle and Practice of High Density Fish Culture in Low Volume Cages* (Copyright 2004 American Soybean Meal Assosiation) p 87
- [34] Muttaqin R S M and Murwono D 2012 *Jurnal Teknologi Kimia dan Industri* **1(1)** 444 - 449
- [35] Perdana A A, Suminto and Chilmawati D 2016 *Journal of Aquaculture Management and Technology* **5(1)** 26 – 34
- [36] Yudiarto S, Arief M, Agustono 2012 *Jurnal Ilmu Perikanan dan Kelautan* **4(2)** 135 – 140
- [37] Mujiman A 2004 *Makanan Ikan* (Penebar Swadaya: Jakarta)