

## Short Communication: Efficiency economic of whiteleg shrimp *Litopenaeus vannamei* (Boone 1931) cultivation with a household scale biofloc system

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**Abstract.** Bidayani E, Valen FS. 2023. Short Communication: Efficiency economic of whiteleg shrimp *Litopenaeus vannamei* (Boone 1931) cultivation with a household scale biofloc system. *Indo Pac J Ocean Life* 7: 156-160. Aquaculture is one of the necessary sectors for fisheries in Indonesia because it can contribute to national food security, income, employment development, and foreign exchange earnings. Shrimp is a non-oil and gas export commodity that plays a crucial role. Besides the high price, shrimp has a large market in various countries. Whiteleg shrimp *Litopenaeus vannamei* (Boone 1931) cultivation is synonymous with large capital. However, with innovation, people can cultivate whiteleg shrimp in their yards with small capital. This study aims to analyze the business efficiency of a household-scale shrimp farming business with a biofloc system. The research method is a case study in the Bio Ebi Micro Fish Cultivator Group, Air Mawar Village, Air Itam District, Pangkalpinang City, Bangka Belitung Islands Province, Indonesia. Collecting data is observation and interviews; the data analysis method is descriptive. The study's results show the acceptance of cultivators per cycle is 172,800,000 IDR with an average production yield of 1.8 tons/cycle with a selling price of 96,000 IDR/kg. The efficiency of household-scale shrimp farming with a biofloc system is 2.39. Based on these results, household-scale whiteleg shrimp cultivation is feasible to develop in coastal areas.

**Keywords:** Bangka, biofloc, cultivation, efficiency, household, whiteleg

### INTRODUCTION

Aquaculture can be implemented in freshwater, brackish water, and seawater using various facilities and production methods. Cultivation systems range from extensive to intensive, depending on stocking density, level of input, and management level. Brackish water cultivation is quite popular in Indonesia. One of them is shrimp farming. Shrimp farming contributes to the country's foreign exchange in Indonesia (Rajikkannu et al. 2020). Shrimp farming has increased rapidly in the last decade, and cultured shrimp continues to dominate the international seafood market (Iba et al. 2014). Some farmers suffered losses due to lack of technical knowledge in shrimp aquaculture, environmental carrying capacity, ecological and economic feasibility (Djumanto and Rustadi 2016).

In Indonesia, pond farmers have long practiced shrimp farming because shrimp is a prime aquaculture commodity in the fisheries sector that can increase foreign exchange through exports of fishery commodities. The high demand for shrimp at home and abroad makes Indonesia the fourth producer in the world because Indonesia has an extensive area and natural resources supporting shrimp farming development. Given the scope and potential for future expansion of this industry, the need for continuing regulation for safeguarding and improving shrimp aquaculture

Whiteleg shrimp *Litopenaeus vannamei* (Boone 1931) has officially been released as superior varieties and is

disease resistant and expected can increase the chances of doing aquaculture again. In addition, it also aims to enrich and add to the alternative types of cultivated shrimp that have the potential to be developed.

Bangka Island is a coastal area in the Province of the Bangka Belitung Islands which has a coastline of 1,200 km. The potential of fisheries and marine resources provides an opportunity to increase aquaculture production quite large (Mahmud et al. 2021; Setiyowati et al. 2022). Data from the Department of Marine Affairs and Fisheries of the Bangka Belitung Islands Province (2021), whiteleg shrimp production in this region in 2018-2020 increased by 1,931 tons to 11,333 tons or an increase of 318%. Household-scale shrimp farming is a small-scale business utilizing a narrow yard or land as a business location (Efani et al. 2020); the family can do this business as the executor (Sutaman 1993). Whiteleg shrimp have high productivity, shorter maintenance time, relatively fast growth, and are easy to cultivate (Amri 2013).

Semi-intensive shrimp ponds with a high abundance of plankton at the time of fry stocking had a better survival rate (Katmoko et al. 2021), which was 92.5% with a feed conversion value of 1.3. While the abundance of plankton is low, the survival rate is 40.13%, and feed conversion is 1.9 (Pratama et al. 2017). Factors influencing whiteleg shrimp culture's success include pH, salinity, DO content, ammonia, H<sub>2</sub>S, water brightness, and plankton content (Hudi and Shahab 2005). The shrimp growth rate is

influenced by feed supply, fertilization, aeration, and shrimp survival (Gunarto and Hendrajat 2008).

Shrimp cultivation with a biofloc system in the Micro Bio Ebi Fish Cultivator Group (Pokdakan) in Air Mawar Village, Air Itam District, Pangkalpinang City, Bangka Belitung Islands Province uses a round pond measuring 2 x 3 m. According to Gunarto et al. (2012), shrimp survival and growth in ponds grown with biofloc were better (Ogello et al. 2021; Nisar et al. 2022), and the feed conversion value was lower.

Biofloc is easily formed in ponds using high-density polyethylene (HDPE) plastic (Saenphon 2005). The shrimp will eat the biofloc formed in the pond (Manan et al. 2020; Mansour et al. 2022). According to Gunarto and Suryanto (2011), there are 15 types of amino acids found in biofloc. Biofloc also contains vitamins that can replace vitamins supplied through commercial feed (Tacon et al. 2002). Biofloc also contains enzymes that can help the digestive process of shrimp feed so that shrimp grow faster (Moss et al. 2001).

The main principle of bioflocs is to grow organisms, especially heterotrophic bacteria, in pond water to absorb ammonia pollutant components to be further converted into bacterial protein. It can be used as a feed substitution for farmed whiteleg shrimp (Gunarto et al. 2012). This biofloc technology can reduce the cost of shrimp feed (Schryver et al. 2008; Kumar et al. 2018). This study analyzes business efficiency in household-scale shrimp farming with a biofloc system.

## MATERIALS AND METHODS

This research was conducted from January to March 2022 at Pokdakan Mikro Bio Ebi, Air Mawar Village, Pangkalbalam Sub-district, Pangkalpinang City, Bangka Belitung Islands, Indonesia. Determination of the location purposively considering that Pokdakan Mikro Bio Ebi has successfully carried out household-scale shrimp *L. vannamei* farming with a biofloc system.

This study uses a survey method with a case study approach. Data collection methods are observation, interviews, and literature study. The quantitative descriptive data analysis method uses the following formula (Soekartawi 2003):

$$R/C = TR:TC$$

R/C: Business efficiency

TC: Total Cost

Business efficiency criteria:

R/C > 1 = Profitable business

R/C = 1 = Break-even work

R/C < 1 = Business loss

## RESULTS AND DISCUSSION

Cost components are grouped into two parts: Investment and operational costs. Investment costs must be incurred to obtain production factors used in the production process. Operational costs are the amount of funds spent for the production process.

### Investment cost

Investment costs are incurred once during the project's life to obtain benefits until it is economically no longer profitable. Investment costs for whiteleg shrimp farming include land, pond-making plots, guard houses, generators, windmills, pumps, scales, and water quality equipment. This investment value results from a reassessment of investments that were invested at the beginning of the business in 2018. The entire capital comes from their own capital. Details of investment components can be seen in Table 1.

Investment costs are the initial costs incurred when running a business, namely in the first year of business, where the amount is relatively large and may be exhausted. The investment costs incurred in the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi are 48,000,000 IDR. It can be seen that the largest percentage is windmills, HDPE plastics, and guardhouses from all investment costs. If you are allowed, these three higher costs due to the windmills, HDPE plastic, and guard houses greatly affect the smoothness of the production process and can be used for a long time. Investment costs are invested in a business to obtain profits in the future period, namely during the business's life or as long as the business is running.

### Production cost

Production costs are needed to process inputs to produce several outputs. The business costs incurred in whiteleg shrimp cultivation at Pokdakan Mikro Bio Ebi consist of fixed and variable costs.

#### Fixed cost

Fixed costs are costs that are fixed in number and do not depend on the volume of production. Fixed costs are costs incurred by a business; the size of the production of a business does not influence these costs. If you are allowed, the fixed-cost components required by the two Pokdakan Mikro Bio Ebi cultivators in rearing whiteleg shrimp could be depreciated for many years (depreciable costs). The following results of calculating the fixed costs of the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi are presented in Table 2.

Fixed costs for whiteleg shrimp farming include depreciation costs. The amount of fixed costs incurred for whiteleg shrimp ponds in Pokdakan Mikro Bio Ebi can be seen in Table 2, fixed costs based on the results obtained in Pokdakan Mikro Bio Ebi are 6,350,000 IDR. Fixed costs are usually the first costs cultivators incur to prepare for the cultivation process. Fixed costs are also types of costs that are always fixed in number or do not change even during a certain operating time range or the level of production capacity changes (Daulay et al. 2019).

### Variable cost

Variable costs are costs incurred by cultivators in their business activities; if you are allowed, these costs differ according to production variability, which is said to be variable costs. The variable costs of whiteleg shrimp farming can be seen in Table 3.

Table 3 shows the total variable costs incurred per cycle for the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi which are 66,000,000 IDR. Variable costs are costs that depend on the volume of production produced. Variable costs for whiteleg shrimp farming include feed, fry, probiotics, and others, and also the wages of on-call labor at harvest. The number of variable costs incurred for shrimp farming can be seen in Table 3.

Table 3 shows that the largest percentage is feed, which is 65.2% of all variable costs because feed is an important component in cultivation. This greatly affects the income of the cultivator's business because the feed cost incurred for this business is more than 60%. The feed cost is very large, and this is because the feed used by cultivators is not produced independently; the cultivators still have to buy feed whose price is relatively high, which makes variable costs high.

Therefore, feed is the biggest financing factor spent in rearing activities. The costs incurred for feed in the aquaculture business reach 60-70% of the total variable cost. The costs incurred for providing shrimp feed do not rule out the possibility that many cultivators still have to

spend quite a lot of money to construct the pond. According to Perius (2011), feed is a source of material and energy to support the survival and growth of fish, but on the other hand, feed is the largest component (50-70%) of production costs. The total operating costs are presented in Table 4.

**Revenue.** Revenue is the receipt of production from the sale of its output. Therefore, the results are multiplied by the output's selling price to calculate the total revenue obtained from the output or production. The feasibility study was conducted to determine how much yield was obtained in one cycle of whiteleg shrimp rearing in Pokdakan Mikro Bio Ebi, which could be accepted. The results of the feasibility study can be seen in Table 5.

Based on Table 5, it can be seen that the revenue per cycle cultivators is 172.8 million IDR. The average yield in this cultivation business reaches 1.8 tons/cycle with a selling price of 96,000 IDR/kg. This indicates that this business is feasible to develop because the business revenue exceeds the total costs incurred during the cultivation process. The revenue of a business will change according to the total production; the higher the total production, the more revenue will increase (Ahmad 2019). The acceptance of this cultivation business can be concluded that it is feasible to be developed because the cultivation business's total revenue is greater than the total cost incurred for the cultivation business.

**Table 1.** Components of investment in the whiteleg shrimp pond

Component Cost	Unit Amount	Quantity	Cost (IDR)	Percentage
Water wheel	Unit	3	15,000,000	31.25%
Guardhouse	Unit	1	10,000,000	20.83%
Gensets (gasoline generator)	Unit	1	2,000,000	4.17%
Plastic HDPE (Geomembran plastic Hdpe UV)	Roll	1	5,000,000	10.42%
Central pipe	Unit	2	2,000,000	4.17%
Water pumps	Unit	2	4,000,000	8.33%
Excavator rental fee	Unit	1	5,000,000	10.42%
Harvesting nets	Unit	1	500,000	1.04%
Resun Lp 100	Unit	2	3,000,000	6.25%
Round pool tarpaulin	Unit	1	500,000	1.04%
water tank	Unit	1	1,000,000	2.08%
Total			48,000,000	100%

**Table 2.** Fixed costs of whiteleg shrimp farming business per cycle

Description	Fixed Costs (IDR/cycle)
Ferris wheel	2,940,000
Gensets	360,000
Plastic Hdpe	500,000
Central pipe	370,000
Water pump	760,000
Harvest nets	100,000
Resun Lp 100	560,000
guardhouse	600,000
Water tendons	160,000
Total	6,350,000

**Table 3.** Variable costs of whiteleg shrimp ponds per cycle

Description	Total Cost (IDR/cycle)	Percentage (%)
Seed	6,000,000	9.10
Probiotics and drugs	8,000,000	11.7
Electricity	5,000,000	7.38
Feed	43,000,000	65.2
Employee salary wages	4,000,000	6.52
Total	66,000,000	100

**Advantage.** The profit of a business can be seen from the result of the difference between the total value of the revenue minus the total cost of expenditure. Profits from the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi can be seen in Table 6. Based on this table, the average profit of the whiteleg shrimp rearing business in Pokdakan Mikro Bio Ebi is 100,450,000 IDR/cycle. That stated the whiteleg shrimp expanding business at Pokdakan Mikro Bio Ebi was feasible to develop because the profits were quite large. In addition, the expanding of whiteleg shrimp in this cultivation business for 1 cycle takes 120 days to harvest. A business is said to be profitable and feasible to develop if the revenue obtained exceeds the total costs and implicit costs incurred (Sukirno and Sadono 2012). So it can be concluded that this cultivation business is feasible to be developed because the result of the difference between revenue and total costs and implicit costs shows a positive number.

**R/C Rasio.** Revenue Cost Ratio (R/C ratio) is a calculation to compares the total revenue with the total value of costs that have been incurred during the production process. Calculating the R/C ratio is also a way to determine whether a business action is feasible. The income from the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi can be seen in Table 7.

**Table 4.** The total cost of whiteleg shrimp rearing business per cycle

Type of Cost	Value (IDR/cycle)
Fixed fee	6,350,000
Variable cost	66,000,000
Total cost	72,350,000

**Table 5.** Revenue from whiteleg shrimp rearing business per cycle

Description	Production/cycle
Production (ton)	1.8
Price (IDR/kg)	96,000
Revenue (IDR/cycle)	172,800,000

**Table 6.** Profits from the whiteleg shrimp rearing business per cycle

Description	IDR/cycle
Revenue	172,800,000
Total cost	72,350,000
Profit	100,450,000
Total	100,450,000

**Table 7.** Results of the R/C ratio of whiteleg shrimp cultivation in Pokdakan Micro Bio Ebi per cycle

Description	Quantity/cycle (IDR)
Revenue	172,800,000
Total cost	72,350,000
R/C Ratio	2.39

From the calculation results above, the R/C ratio value is 2.39. Because the R/C value is > 1, it concluded that the whiteleg shrimp rearing business at Pokdakan Mikro Bio Ebi is profitable and feasible. In other words, the R/C Ratio value of 2.39 means that for every 100,000 IDR spent, the whiteleg shrimp rearing business in Pokdakan Mikro Bio Ebi gets a profit of 138,000 IDR. The value of the R/C ratio is 2.39, which means that if each expenditure is 100 IDR, then the cultivator will generate revenue of 2.39 IDR (with a profit of 138 IDR); the greater the R/C value, the greater the profit from the business. According to Vijayanti and Yasa (2016), entrepreneurs should improve entrepreneurial behavior by expanding insight and information to increase revenue and efficiency. According to Nugroho et al. (2021), some freshwater shrimp species in Indonesian waters are potentially cultivated. The types of shrimp cultivated widely in Indonesia are whiteleg shrimp. According to Renanda et al. (2019), whiteleg shrimp is a new variety with some advantages, including more resistance or resistance to disease and low environmental quality, high stocking density, and shorter rearing time, around 90-100 days per cycle.

**Discussion**

The efficiency economic of household-scale shrimp farming with a biofloc system is 2.39. Based on these results, household-scale whiteleg shrimp cultivation is feasible to develop in coastal areas. According to Crab et al. (2012), biofloc technology enhances water quality in aquaculture by balancing carbon and nitrogen in the system. The technology has recently gained attention as a sustainable method to control water quality, with the added value of producing proteinaceous feed in situ. Furthermore, Hidayat (2017) and Almuqaramah et al. (2018), the biofloc system has a higher whiteleg growth rate (9.85%) and feed efficiency (37.33%). In addition, Muhammad (2013), probiotics in the digestive tract secrete protease and amylase enzymes.

This research is in line with Simanjuntak and Sudaryono (2016) biofloc technology is one of the solutions to environmental problems and can increase aquaculture production. According to Supono et al. (2021), intensively cultivating *L. vannamei* with biofloc systems is one of the most efficient ways to reduce shrimp cost production. The biofloc can be used as feed substitution for *L. vannamei* cultured. Applying the biofloc system in commercial ponds is still experiencing many obstacles, so it is not optimal in supporting the success of cultivation. One factor that determines the success of shrimp farming with a biofloc system is the determination of the right organic carbon source.

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## REFERENCES

- Ahmad R. 2019. The effect of work motivation and job competition on work productivity through job satisfaction as an intervening variable for employees at the development Universitas Panca Budi Medan. *J of Manag Tools* 11 (1): 1-10. DOI: 10.21511/ppm.19(3).2021.14. [Indonesian]
- Almuqaramah TH, Setiawati M, Priyoutomo NB, Effendi I. 2018. *Litopenaeus vannamei* shrimp nursery with biofloc technology to increase growth and feed efficiency. *J Trop Mar Sci Technol* 10 (1): 143-152. DOI: 10.29244/jitkt.v10i1.21671. [Indonesian]
- Amri K. 2013. Vaname Shrimp Cultivation. Main Library Gramedia, Jakarta. [Indonesia]
- Crab R, Defoirdt T, Bossier P, Verstraete W. 2012. Biofloc technology in aquaculture: Beneficial effects and future challenges. *Aquaculture* 356: 351-356. DOI: 10.1016/j.aquaculture.2012.04.046.
- Daulay R, Kurnia E, Maulana I. 2019. Analysis of factors affecting employee performance at regional companies in Medan City. *Proceed Natl Sem Entrep* 1 (1): 209-218. [Indonesian]
- Department of Marine Affairs and Fisheries of the Bangka Belitung Islands Province. 2021. Prospects of Vaname Shrimp Cultivation in the Bangka Belitung Islands. PUPPBHP DKP Babel Sector, Department of Marine Affairs and Fisheries of the Bangka Belitung Islands Province. [Indonesian]
- Djumanto U, Rustadi TB. 2016. Feasibility study on the profitability of vannamei shrimp aquaculture on coastal area of Keberuhan Village, Purworejo Regency. *Aquacultura Indonesiana* 17 (1): 7-11. DOI: 10.21534/ai.v17i1.49. [Indonesian]
- Efani A, Harahab N, Primyastanto M, Susilo E, Handayani W. 2020. Shrimp pond business local market strengthening: An initiation. *Wacana* 23 (4): 222-226. [Indonesian]
- Gunarto, Hendrajat EA. 2008. Semi-intensive vaname shrimp cultivation with application of several types of probiotics. *J Riss Aquacult* 3 (3): 339-349. [Indonesian]
- Gunarto, Suryanto H. 2011. Produksi bioflok dan nilai nutrisinya dalam skala laboratorium. *Prosiding Forum Inovasi Teknologi Akuakultur 2011 jilid 2*. Pusat penelitian Perikanan budidaya. Badan Penelitian dan Pengembangan Kelautan dan Perikanan 2011: 1009-1017. [Indonesian]
- Gunarto, Suwoyo HS, Tampangallo BR. 2012. Intensive pattern vaname shrimp cultivation with biofloc system in ponds. *J Riss Aquacult* 7 (3): 393-405. DOI: 10.15578/jra.7.3.2012.393-405.
- Hidayat R. 2017. Efficiency of feed utilization and growth of tiger shrimp (*Penaeus monodon*) on biofloc media with different C/N ratios. *J Aquacult Technol Sci* 1 (1): 11-20.
- Hudi L, Shahab A. 2005. Productivity Optimization of Vannamei Shrimp Using Response Surface Methods and Non Linear Programming. Institut Teknologi Surabaya, Surabaya. [Indonesian]
- Iba WA, Rice MA, Wikfors GH. 2014. Microalgae in eastern pacific white shrimp, *Litopenaeus vannamei* (Boone 1931) hatcheries: A review on roles and culture environments. *Asian Fisher Sci* 27 (3): 212-233. DOI: 10.33997/j.afs.2014.27.3.005.
- Katmoko GMD, Risjani Y, Masithah ED. 2021. Analysis of phytoplankton structure community, water quality and cultivation performance in *Litopenaeus vannamei* intensive pond located in Tembokrejo Village, Muncar, Banyuwangi. *J Exp Life Sci* 11 (3): 68-76. DOI: 10.21776/ub.jels.2021.011.03.01. [Indonesian]
- Kumar VS, Pandey PK, Anand T, Bhuvaneswari GR, Dhinakaran A, Kumar S. 2018. Biofloc improves water, effluent quality and growth parameters of *Penaeus vannamei* in an intensive culture system. *J Environ Manag* 215: 206-215. DOI: 10.1016/j.jenvman.2018.03.015.
- Mahmud, Sinrang ADB, Massiseng ANP. 2021. Prospects of fisheries industry development in Indonesia through online publication media. *Intl J Appl Biol* 5 (2): 117-129.
- Manan H, Amin-Safwan A, Kasan NA, Ikhwanuddin M. 2020. Effects of biofloc application on survival rate, growth performance and specific growth rate of pacific whiteleg shrimp, *Penaeus vannamei* culture in closed hatchery system. *Pak J Biol Sci* 23 (12): 1563-1571. DOI: 10.3923/pjbs.2020.1563.1571.
- Mansour AT, Ashry OA, Ashour M, Alsaqufi AS, Ramadan KMA, Sharawy ZZ. 2022. The optimization of dietary protein level and carbon sources on biofloc nutritive values, bacterial abundance, and growth performances of whiteleg shrimp (*Litopenaeus vannamei*) juveniles. *Life (Basel)* 12 (6): 888. DOI: 10.3390/life12060888.
- Moss SM, Divakaran S, Kim BG. 2001. Stimulating effects of pond water on digestive enzyme activity in the Pacific white shrimp, *Litopenaeus vannamei* (Boone). *Aquacult Res* 32: 125-132. DOI: 10.1046/j.1365-2109.2001.00540.x.
- Muhammad A. 2013. Application of Probiotics with Different Doses for Prevention of IMNV in Vannamei Shrimp. [Essay]. Faculty of Fisheries and Marine Science, Institut Pertanian Bogor, Bogor. [Indonesian].
- Nisar U, Peng D, Mu Y, Sun Y. 2022. A solution for sustainable utilization of aquaculture waste: A comprehensive review of biofloc technology and aquamimicry. *Front Nutr* 8: 791738. DOI: 10.3389/fnut.2021.791738. [Indonesian]
- Nugroho A, Ramadhanti F, Kurniawan D, Iga M. 2021. The role of research and technology in post tsunami shrimp production in Aceh Province. *IOP Conf Ser: Earth Environ Sci* 667: 012094.
- Ogello EO, Outa NO, Obiero KO, Kyule DN, Munguti JM. 2021. The prospects of biofloc technology (BFT) for sustainable aquaculture development. *Sci Afr* 14: e01053. DOI: 10.1016/j.sciaf.2021.e01053.
- Perius Y. 2011. Introduction to Fish Nutrition.pdf. [Accessed April 28, 2011].
- Pratama A, Wardiyanto, Supono. 2017. Study on the performance of vannamei shrimp raised in a semi-intensive system in pond water conditions with different plankton abundance at the time of stocking. *J Aquat Eng Technol* 6: 643-652.
- Rajikkannu M, Krishnan S, Periyasamy S, Chetri Z, Nandakumar R. 2020. Immune response of shrimp *Penaeus monodon* against *Vibrio parahaemolyticus*. *World News Nat Sci* 30 (2): 150-168.
- Renanda A, Prasmatiwati FE, Nurmayasari I. 2019. The profit and risk on cultivating vaname shrimp in Rawajitu Timur District, Tulang Bawang Regency. *JIIA* 7: 466-473. [Indonesian]
- Schryver PD, Crab R, Devoldt T, Boon N, Verstraete W. 2008. The basics of bio-flocs technology: The added value for aquaculture. *Aquaculture* 277 (2008): 125-137. DOI: 10.1016/j.aquaculture.2008.02.019.
- Setiyowati H, Nugroho M, Halik A. 2022. Developing a blue economy in Depok West Java, Indonesia: Opportunities and challenges of neon tetra fish cultivation. *Sustainability* 14: 13028. DOI: 10.3390/su142013028.
- Simanjuntak ICBH, Sudaryono A. 2016. The effect of the concentration of probiotic bacteria associated in the intestine as biofloc on the efficiency of feed utilization, growth and survival of African catfish (*Clarias gariepinus*). *J Aquacult Manag Technol* 5 (2): 1-8. [Indonesian]
- Soekartawi. 2003. The Role of Research and Education in Creating a Sustainable Agriculture Development and Agricultural System for Developing Countries. *Proceeding International*. Universitas Gadjah Mada, Yogyakarta. [Indonesian]
- Sukirno, Sadono. 2012. Introduction to Macroeconomic Theory Third Edition. Rajawali Press, Jakarta. [Indonesian]
- Supono S, Harpeni E, Pinem R. 2021. Performance of vaname shrimp *Litopenaeus vannamei* (Boone 1931) raised in biofloc systems with different carbon sources. *Maritime J: Indones J Mar Sci Technol* 14 (2): 192-202. DOI: 10.21107/jk.v14i2.9191. [Indonesian]
- Sutaman. 1993. Practical Guidelines for Household Scale Windu Shrimp Hatchery. Canisius, Yogyakarta. [Indonesian]
- Tacon AGJ, Cody JJ, Conquest LD, Divakaran S, Forster IP, Decamp OE. 2002. Effect of culture system on the nutrition and growth performance of Pacific white shrimp *Litopenaeus vannamei* (Boone) fed different diets. *Aquacult Nutr* 8: 121-139. DOI: 10.1046/j.1365-2095.2002.00199.x.
- Vijayanti MD, Yasa IGWM. 2016. The effect of length of business and capital on the income and business efficiency of groceries traders at the Kumbasari Market. *E-J Dev Econ Udayana Univers* 5 (12): 165-217. [Indonesian]