Economic analysis of vannamei shrimp aquaculture in Aceh Besar Regency based on different land areas

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Abstract. Aceh Besar District, Aceh Province, is known as one of the producers of shrimp commodities in Indonesia. The shrimp commodities that cultivated is vannamei shrimp (Litopenaeus vannamei). This study aims to conduct an economic analysis of vannamei shrimp farming in Aceh Besar Regency based on various land sizes, namely less than 1 Ha and more than 1 Ha. The research was conducted in 2019 using a survey method. Data collection using interview techniques to 40 shrimp farmers. Descriptive statistical methods and economic analysis were used in this study. The results of the analysis show that most of the respondents have a cultivated land area of less than 1 Ha with a number of plots of 1 to 3 plots. Aquaculture investment is positively related to the land used. The land shrimp pond is the largest asset cost compared to other assets. The biggest operational costs are feed and shrimp seeds. Regarding business revenue, R/C ratio and payback period, vannamei shrimp farming with land less than 1 Ha is relatively better than land more than 1 Ha.

1. Introduction
Aquaculture contributes to national food security, income and employment generation, foreign exchange earnings and played as alternative income for coastal communities as well [1]. Shrimp commodity, can come from aquaculture and capture, which is the proportion from aquaculture is greater than capture. However, shrimp production between 2011 to 2018 [2], particularly aquaculture has growth by 12% (Table 1). This growth was greater than growth in the 1993 to 2003 period [3]. Positive development of vannamei farming because it has the advantages namely high growth rate, short cultivation time, high stock density, tolerance to good salinity, low protein requirements, responsiveness to feed, and easy to culture [4, 5]. In the global level, vannamei production was also the aquaculture species for which production has increased the fastest over the last five years [6].

Table 1. Shrimp production in Indonesia based on type of fisheries between 2011 - 2018 (Ton)*

| Type of Fisheries | Year  | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Share 2018 (%) | Growth 2011 - 2018 |
|------------------|------|------|------|------|------|------|------|------|------|----------------|-------------------|
| Aquaculture      |      | 384  | 387  | 618  | 603  | 580  | 667  | 920  | 933  | 80             | 12                |
| Capture          |      | 261  | 263  | 251  | 273  | 275  | 292  | 400  | 232  | 20             | -1                |
| Total            |      | 645  | 650  | 869  | 876  | 855  | 960  | 1320 | 1164 | 100            | 8                 |
Shrimp farming in Indonesia are spread over almost all coastal areas. Aceh Province is one of the national shrimp producers. In 2018, the shrimp production in Aceh province was 43,951 tons [2], which is in the 8th rank of national production, in this case ranking 3rd in the Sumatra region after Lampung and South Sumatra Province (Figure 1). Aceh Besar Regency, Aceh Province is known as one of the producers of vannamei shrimp, located at 5.2º - 5.8º Longitude and 95.0º - 95.8º East Longitude. Most of the area is on land and a small part is in the islands. The fisheries sector is one of the leading sectors in Aceh Besar Regency. In 2015, the fisheries sector in Aceh Besar Regency became a development priority through the minapolitan program [7].

![Vannamei commodity production in Indonesia, year of 2018](image)

Figure 1. Shrimp aquaculture production in Indonesia, year of 2018

Vannamie commodity (*Litopenaeus vannamei*) is one of the aquaculture commodities as an export product which is widely culture in Aceh Besar Regency. The demand for vannamei shrimp products is quite large from local and international markets, because shrimp is known to have high nutritional. The high development of vannamei shrimp farming is also due to high economic value of shrimp [8]. The high demand is one of the opportunities for vannamei shrimp farmers in Aceh Regency to increase their business. Therefore, information related to investment, operational costs and production of vannamei farming in Aceh Besar Regency is important to analyze.

Comparative analysis on vannamei shrimp farming based on differences in technology systems, differences in commodities, differences in maintenance systems has been carried out. Production costs and income received by farmers of intensive systems are greater than extensive systems. Business income from vannamei shrimp is relatively higher than that of tiger prawns [9, 10, 11, 12, 13]. However, comparative analysis of vannamei shrimp farming based on land area has rarely been studied. This research attempts to answer, is there a positive correlation between land area and investment, operating costs and business revenue? Therefore, this study aims to analyze the economic analysis of vannamei shrimp farming in Aceh Besar Regency based on land area.

2. Material and Methods

2.1. Time and Site

The study was conducted in October 2019 at Aceh Besar Regency, Aceh Province. Aceh Besar Regency is one of the producers of shrimp aquaculture in Aceh Province. Aceh Besar Regency consists of 23
Districts, 9 of them have a shrimp aquaculture activity. The study locations are in five Districts, namely Masjid Raya, Peukan Bada, Lhoknga, Lhoong and Baitussalam Districts as known as shrimp production centers in Aceh Besar Regency.

### 2.2. Collecting data method

Primary data were collected using a survey method. Interviews with the shrimp farmer using structured questionnaires. This study focused on the vannamei shrimp farmers because shrimp aquaculture on the location of study dominated by vannamei commodity. In five research locations, the number of cultivators was 396 people. To meet the statistical rules of 10% of the population, this study involved 40 respondents shrimp farmer using purposive sampling method. Selected respondents with status as land owner and directly involved in the shrimp culture. Based on land area, respondents are divided into two categories which is the farmers with land less and more than 1 Ha.

The questions addressed were related to the basic characteristic of respondent and shrimp aquaculture activities, which consists of investment costs, operational costs, and production. Secondary data were also collected in this study, including statistical data from government agencies and previous studies that are used as research references.

### 2.3. Data analysis method

Primary data that has been collected is processed and analyzed using descriptive analysis and economic analysis method. Descriptive analysis was used to describe basic information of respondent and shrimp aquaculture business. Economic analysis uses three indicators, namely profit ($\pi$), revenue cost ratio (R/C ratio) and payback period. Profit is the total revenue (TR) from the sale of products less total costs (TC). The profit formula used is as follows.

The revenue cost ratio (R/C ratio) is an economic analysis used to determine the results obtained from business activities during a period have a certain benefit [14]. The R/C ratio is ratio between total revenue and total cost. R/C ratio as an indicator, have three criteria, as follows:

- If R/C more than one : the business is profitable so that the business is feasible to continue
- If R/C equal to one : the business activity is neither profitable nor loss
- If R/C less then one : the business loss or not feasible to continue

Payback period is the period required to cover investment expenses using cash flow. Payback period (PP) can also be interpreted as the ratio between initial cash investment value and cash inflow or revenue. The faster the payback period is compared to the maximum business time period, the more feasible the business.

### 3. Result and Discussion

#### 3.1. General condition shrimp farming in Aceh Besar Regency

Vannamei shrimp is one of the leading commodities in Aceh Besar Regency, besides tiger prawns, tilapia, snapper, grouper etc. Based on the assessment of its business sustainability, vannamei prawns get the first priority with a value of 21.5% [6]. In 2019, brackish water pond area in Aceh Besar Regency has 2.198 Ha, which is 34% of area utilized. The high level of unutilized pond land due to the tsunami disaster that occurred in 2014 [15]. Masjid Raya District is center of shrimp production in Aceh Besar Regency with tilled pond area and production respectively of 242 Ha and 313 ton. Based on the aspect of productivity estimation, Lhoknga, Leupung and Lhong Districts are Districts with productivity above 2 tonnes per ha.

Currently, the number of shrimp farmers in Aceh Besar Regency is 624 people, with the largest number of farmers in the Masjid Raya Districts is 123 people [16]. Based on table 2, the greatest productivity from shrimp farmers in Lhoknga, Mesjid Raya and Lhoong District.

#### 3.2. Socio-economic condition of shrimp farmers respondents
Characteristic of respondents can be seen from five aspects, namely age, education, income, land ownership and number of ponds. Based on age aspect, average of age shrimp farmer is included in category of 35 – 45 years which is the productive age. Based on education aspect, average of education shrimp farmer is included in category senior high school.

Based on income aspect, average monthly income for both type of land is in the range IDR2.7 – 3 million. This value is still smaller than the regional minimum wage issued by the regional government in 2019, which is equal to IDR3.16 million [17]. Based on ownership of area pond, the shrimp farmer less than 1 Ha and more than 1 Ha respectively has an area pond of 0.7 Ha and 2.1 Ha. Based on number of ponds, the shrimp farmer less than 1 Ha and more than 1 Ha respectively has an number of pond of 2.5 unit and 4.8 unit.

### Table 2. General condition of brackish water pond in Aceh Besar Regency by District

| District          | Brackish water pond area (Ha) | Production (Ton) | Productivity estimation by land (Ton/Ha)¹ | Number of shrimp farmer (people) | Productivity estimation by farmers (Ton/people)² |
|-------------------|-------------------------------|-----------------|----------------------------------------|----------------------------------|-----------------------------------------------|
|                   | Untilled shrimp pond          | Tilled shrimp pond | Tilled pond to total (%) |                                 |                                               |
| 1. Lhoong         | 136                           | 93              | 41                       | 226                              | 2.4                                          | 93                                            | 2.4                                          |
| 2. Lhoknga        | 35                            | 8               | 19                       | 75                               | 9.0                                          | 24                                            | 3.1                                          |
| 3. Leupung        | 36                            | 17              | 32                       | 105                              | 6.2                                          | 95                                            | 1.1                                          |
| 4. Seulimeum      | 133                           | 131             | 50                       | 97                               | 0.7                                          | 98                                            | 1.0                                          |
| 5. Mesjid Raya    | 448                           | 242             | 35                       | 313                              | 1.3                                          | 123                                           | 2.5                                          |
| 6. Baitussalam    | 316                           | 139             | 31                       | 89                               | 0.6                                          | 78                                            | 1.1                                          |
| 7. Krueng Barona Jaya | 17                        | 14              | 46                       | 8                                | 0.6                                          | 18                                            | 0.4                                          |
| 8. Peukan Bada    | 312                           | 97              | 24                       | 45                               | 0.5                                          | 78                                            | 0.6                                          |
| 9. Pulo Aceh      | 16                            | 7               | 31                       | 5                                | 0.8                                          | 17                                            | 0.3                                          |
| Total             | 1,448                         | 749             | 34                       | 963                              | 624                                          |                                               |                                               |

¹ Data processed, production divided by tilled shrimp pond
² Data processed, production divided by number of shrimp farmer

### Table 3. Characteristics of respondent vannamei shrimp farming in Aceh Besar Regency based on land area

| Information                  | Unit   | Less than 1 Ha (n = 27 respondent) | More than 1 Ha (n = 13 respondents) |
|------------------------------|--------|-------------------------------------|--------------------------------------|
| Age of shrimp farmer         | Category | Min | Max | Average | Min | Max | Average |
| Education of shrimp farmer   | Category | 1.0 | 5.0 | 3.6     | 2.0 | 5.0 | 3.6     |
| Income of shrimp farmer      | IDR/month | 1.500.000 | 5.000.000 | 2.740.741 | 1.000.000 | 6.000.000 | 3.038.000 |
| Ownership of area ponds      | Ha      | 0.2 | 1.0 | 0.7     | 1.3 | 3.5 | 2.1     |
| Number of ponds              | Unit    | 1   | 10  | 2.5     | 2   | 20  | 4.8     |

### 3.3. Economic analysis of vannamei shrimp farming based on land

Shrimp farming in Aceh Besar Regency, requires both investment and business operations. Investment costs are costs incurred until the business is ready to operate [18]. The most important investment requirement in vannamei shrimp farming is shrimp pond land. There are two types of shrimp pond land, namely inheritance land and lease land. Most of the respondents belong to the first type. In the context of economic analysis, inherited land is given a value of IDR150 million per Ha based on price information from community in the location of study. Total investment with shrimp pond land less than and more than 1 Ha is IDR175 million and IDR257 million, respectively.

The types of aquaculture technology that are commonly used in research locations are traditional and semi-intensive. In detail, some of the investments needed include a pond house, a water pump, prawn basket, weighing scale, fishing net to feed the shrimp, a gates for ponds, water hoses, pipes, plastic mats and a waterwheel. Plastic is the dominant percentage of economic value compared to the total investment.
without land, namely plastic mats, waterwheels and guard houses. Infrastructure, asset ownership and investment are variables that sensitive to the sustainability of vannamei shrimp business [19].

### Table 4. Characteristics of shrimp farming investment in Aceh Besar Regency based on land area

| Type of investment            | Less than 1 Ha | More than 1 Ha |
|------------------------------|----------------|----------------|
| Unit                         | Vol | Price (Rp) | % | Vol | Price (Rp) | % |
| 1. Shrimp pond land          | Ha  | 1.0  | 150.000.000 | 150.000.000 | 1.5 | 150.000.000 | 225.000.000 |
| 2. Pond house                | Unit | 1    | 5.000.000 | 5.000.000 | 20 | 1 | 5.000.000 | 5.000.000 | 15 |
| 3. Water pump                | Unit | 1    | 3.000.000 | 3.000.000 | 12 | 2 | 3.000.000 | 6.000.000 | 18 |
| 4. Prawn bucket              | Unit | 1    | 600.000 | 600.000 | 2 | 1 | 600.000 | 600.000 | 2 |
| 5. Shrimp weighing scale     | Unit | 1    | 750.000 | 750.000 | 3 | 2 | 750.000 | 1.500.000 | 5 |
| 6. Fishing tank net          | Unit | 2    | 160.000 | 320.000 | 12 | 2 | 160.000 | 320.000 | 1 |
| 7. Pond sluice gates         | Unit | 1    | 3.200.000 | 3.200.000 | 13 | 1 | 3.200.000 | 3.200.000 | 10 |
| 8. Water hose                | Meter | 20   | 25.000 | 500.000 | 2 | 20 | 25.000 | 500.000 | 2 |
| 9. Pipe                      | Unit | 5    | 150.000 | 750.000 | 3 | 7 | 150.000 | 1.050.000 | 3 |
| 10. Plastic pond liner       | m²   | 269   | 24.000 | 6.456.000 | 25 | 367 | 24.000 | 8.808.000 | 27 |
| 11. Pond waterwheel          | Unit | 10   | 500.000 | 5.000.000 | 20 | 12 | 500.000 | 6.000.000 | 18 |
| Total investment (landless)  |     |      |         |         |     |     |         |         |     |
| Value (Rp)                  | 25.576.000 | 100 | 32.978.000 | 100 |
| Total investment (with land) |     |      |         |         |     |     |         |         |     |
| Value (Rp)                  | 175.576.000 | 257.978.000 | 257.978.000 | 100 |

Generally, vannamei shrimp farming is divided into three activities, namely preparation, maintenance and harvesting. Shrimp pond preparation is crucial for production. Preparation activities include pond draining, pond cleaning, pond fertilizing, saponin to control pests shrimp and filling brackish water into the pond. Preventing diseases is major concern for shrimp pond preparation. Also, to make sure that the water is sufficient and have a good condition. Maintenance activities include feeding shrimp, giving antibiotics, controlling salinity levels, and so on. Harvesting activity is harvesting and selling shrimp to collectors. All the process, can not be done by the shrimp farmer alone. Shrimp farmer need worker, where the bigger the land, the more worker are needed.

The vannamei shrimp culture cycle is 3 times per year. In one cycle, the total operational costs required for cultivated land less and more than 1 Ha are IDR18 million and IDR31 million, respectively. The largest operational cost is shrimp feed with a share of 44% on land less than 1 Ha and 53% on land more than 1 Ha. Feed is an important factor in vannamei shrimp cultivation. Beside feed, shrimp seeds are one of the biggest operational costs with a share of 16% and 18%. The average density of the vannamei shrimp seeds is less than 30 individuals per m². This density is in the low category, where the density that is common in other areas is 80-100 individuals per m². Low stocking density is one of the farmers reason to prevent disease (white spot syndrome virus). In addition, low stocking density also correlates with an increase in shrimp weight [20]. Several things that are needed for successful shrimp farming include selecting the origin and quality of seeds, water quality, feed, season factor and controlling pests and diseases [21, 22].

The average vannamei shrimp production in one cycle on land less than and more than 1 Ha is 487 Kg and 664 Kg, respectively. The price of vannamei shrimp is IDR60.000 per kg, so that the farmers' income in one cycle is IDR29 million and IDR 39 million. The profit in one cycle is IDR10 million and IDR8 million. If there are 3 cycles in one year, then the revenue obtained by the farmers with land less than and more than 1 Ha is IDR32 million and IDR24 million, respectively.

Based on the information on investment value, operational and production costs, economic indicator of R / C ratio and payback period of vannamei shrimp farming in Aceh Besar Regency can be known. The R / C ratio values on land less than and more than 1 Ha are 1.6 and 1.3, respectively. This value indicates that the cultivation business on the two lands is feasible. Regarding payback period indicator, value on land less and more than 1 Ha is 5.4 years and 10.7 years, respectively, by calculating the cost of land for investment.

Calculation of the two indicators show that vannamei shrimp farming with a land less than 1 hectare is relatively more profitable compared to land more than 1 hectare. This condition shows that the larger
of the land, is not correlated to business enhancement. Some of the reasons for this phenomenon are (1) operational costs on land less than 1 ha are relatively lower than on land more than 1 ha. (2) Shrimp production in 2019 is not as expected by farmers. One of them is due to the death of shrimp due to disease, which is one of the biggest risks in vannamei shrimp farming [23, 24]. Health as a constraint to aquaculture, disease is now a primary constraint to the culture of many aquatic species, including shrimp [25]. Shrimp mortality due to disease can come from many factors namely, low quality of vannamei seeds, feed that has accumulated at the pond, and contaminated water sources. Good water quality have a positive correlation to the efficiency of production and reduction in disease. Therefore, the incentive for farmers to maintain water quality is important [26].

| Table 5. Operational cost, production and economic analysis of vannamei shrimp farming per production cycle based on land difference in Aceh Besar Regency¹ |
|-----------------------------------------------|
| Type                                      | Unit | Less than 1 Ha | More than 1 Ha |
| OPERATIONAL COST                          |      | Vol  | Price (Rp) | Value (Rp) | %   | Vol  | Price (Rp) | Value (Rp) | %   |
| 1. Urea fertilizer                        | Kg   | 190  | 3,500     | 665,000    | 4   | 301  | 3,500     | 1,053,500  | 3   |
| 2. TSP fertilizer                         | Kg   | 167  | 4,000     | 668,000    | 4   | 244  | 4,000     | 976,000    | 3   |
| 3. Pest control (saponin)                 | Unit | 56   | 10,000    | 560,000    | 3   | 73   | 10,000    | 730,000    | 2   |
| 4. Antibiotik, vitamin, etc               | Unit | 1    | 1,200,000 | 1,200,000  | 7   | 1    | 1,200,000 | 1,200,000  | 4   |
| 5. Lime powder                           | Kg   | 593  | 1,100     | 652,300    | 4   | 824  | 1,100     | 926,200    | 3   |
| 6. Vannamei shrimp seeds                  | Pcs  | 75,963| 43        | 3,266,409  | 18  | 117,308| 43        | 5,044,244  | 16  |
| 7. Gasoline                              | Litr | 86   | 7,500     | 645,000    | 4   | 220  | 7,500     | 1,650,000  | 5   |
| 8. Shrimp feed                           | Kg   | 508  | 16,000    | 8,128,000  | 44  | 1,047 | 16,000    | 16,752,000 | 53  |
| 9. Land preparation wages                | Rp/Man | 3 | 300,000 | 900,000    | 5   | 3    | 300,000  | 900,000    | 3   |
| 10. Land maintenance wages               | Rp/Man | 2 | 500,000 | 1,000,000  | 5   | 4    | 500,000  | 2,000,000  | 6   |
| 11. Harvest wages                        | Rp/Man | 3 | 200,000 | 600,000    | 3   | 3    | 200,000  | 600,000    | 2   |
| Operational Cost Total                   |      | 18,284,709 | 100      | 31,831,944 | 100 |

PRODUCTION

| Type          | Unit | Less than 1 Ha | More than 1 Ha |
|---------------|------|---------------|----------------|
| Vannamei Production | Kg   | 487 | 60,000 | 29,220,000 | 664 | 60,000 | 39,840,000 |
| Profit per cycle  |      | 10,935,291 | 8,008,056 |
| Profit per year   |      | 32,805,873 | 24,024,168 |
| R/C Ratio        |      | 1.6  | 1.3   |
| Payback Period (with land) |      | 5.4  | 10.7  |

¹ note: primary data processed

4. Conclusion

The vannamei shrimp farming business has become one of the main livelihoods of coastal communities in Aceh Besar Regency. The results of the study can be concluded that the cultivation of vannamei shrimp with land less than 1 hectare is relatively better than land with more than 1 hectare, seen from two economic indicators, namely R / C ratio and payback period.

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References

[1] Nurdjana M L 2006 Indonesian Aquaculture Development proceedings of the international workshop on Innovative Technologies for Eco-friendly Fish Farm Management and Production of Safe Aquaculture Foods pp 56 – 70
[2] MMAF 2018 Statistical of Indonesia Fisheries Online: https://statistik.kkp.go.id
[3] Budhiman A A, Paryanti T S, and Sunaryanto A 2005 *Regional Technical Consultation on the Aquaculture of P. vannamei and Other Exotic Shrimps in Southeast Asia* Manila Philippines (Tigbauan: SEAFDEC Aquaculture Department) pp 42 – 49

[4] Purnamasari I, Purnama D, and Utami M A F 2017 *Jurnal Enggano* 2 pp 58 - 67

[5] Amri K and Kanna I 2008 *Budidaya Udang Vaname Secara Intensif, Semi Intensif dan Tradisional* (Jakarta: PT Gramedia Pustaka Utama) p 163

[6] FAO 2019 *Fishery and Aquaculture Statistics* (Rome: FAO Fisheries and Aquaculture Department)

[7] Dinas Kelautan dan Perikanan Kabupaten Aceh Besar 2015 *Masterplan pengembangan kawasan minapolitan Kabupaten Aceh Besar* (Banda Aceh: PT Dua Mitra Koalisi) p 226

[8] Isamu I, Salam I, dan Yunus L 2018 *Jurnal Sosio Agribisnis* 3 (1) pp 41 – 48

[9] Utami R, Supriana T and Ginting R 2014 *Journal of Agriculture and Agribusiness Socioeconomics* 3 (2)

[10] Al-Furqan 2017 Analisis Komparatif Pendapatan Usahatani Udang Putih (*Litopenaeus vannamei*) Udang Windu (Penaeus Monodon) di Kecamatan Dewantara Kabupaten Aceh Utara *ETD Unsyiah Online Theses & Dissertation Universitas Syiah Kuala*

[11] Andika 2017 *Jurnal Sains Pertanian* 1 (8) p 7

[12] Arsad S, Afandy A, Purwadhi A P, Maya B V, Saputra D K, and Buwono N R 2017 *Jurnal Ilmiah Perikanan dan Kelautan* 9 pp 1 - 14

[13] Sitti M B A, Irfan Z, and Aus N 2019 *Jurnal Ilmiah Mahasiswa Pertanian* 4 (4) pp 283 - 292

[14] Umar H 2003 *Studi Kelayakan Bisnis* (Jakarta: PT Gramedia Pustaka)

[15] Thursina C U 2018 Analisis Keberdayaan Petani Tambak Pasca Tsunami di Kabupaten Aceh Besar *ETD Unsyiah Online Theses & Dissertation Universitas Syiah Kuala*

[16] BPS 2019 *Statistical of Aceh Besar Regency Statistic* Online: https://acehbesarkab.bps.go.id/

[17] Pemerintah Provinsi Nangroe Aceh Darussalam 2019 *Keputusan Gubernur Aceh Nomor 560/1774/2019* (Banda Aceh: Pemerintah Provinsi Nangroe Aceh Darussalam)

[18] Choliq A R, Wirasmita, and Sofwan O 1999 *Evaluasi Proyek (Suatu Pengantar)* (Bandung: Pionir Jaya)

[19] Hadie W and Hadie L E 2017 *Jurnal Kebijakan Perikanan Indonesia* 9 pp 51 - 60

[20] Gunarto and Mansyur A 2007 *Jurnal Riset Akuakultur* 2 pp 167 - 176

[21] Halim R W and Adjijaya D 2005 *Udang vannamei, pembudidayaan dan prospek pasar udang putih yang tahan penyakit* (Jakarta: Penebar Swadaya) p 75

[22] Hartoyo K L and Fariyanti A 2018 J. Sosek KP 13 (1) pp 109 - 110

[23] Nurlaila, Irma D, and Silvi W 2016 *Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah* I (3) pp 388 - 396

[24] Nasution N A A 2020 Pengukuran risiko finansial budidaya udang vannamei studi kasus budidaya udang intensif di Desa Lam Pageu Kecamatan Peukan Bada Kabupaten Aceh Besar *ETD Unsyiah Online Theses and Dissertation Syiah Kuala University*

[25] Bondad-Reantaso M G, Subasinghe R P, Arthur J R, Ogawa K, Chinabut S, Adlard R, Tan Z and Shariff M 2005 *Veterinary Parasitology* 132 pp 249 - 272

[26] Hukom V, Nielsen R, Asmild M and Nielsen M 2020 Do aquaculture farmers have an incentive to maintain good water quality? The case of small-scale shrimp farming in Indonesia *Ecological economics* 176 article in issue