Potency and Strategy of Aquaculture Development in Rokan Hilir Regency, Province of Riau, Indonesia

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Abstract. Rokan Hilir Regency is situated east coast of Sumatera in Riau Province. Fish production of the area dominated by capture fisheries (80.67%) compared to aquaculture production (19.33%), however, there is a demand for strengthening the role of aquaculture. This study aimed to analyze the prospects and strategies for developing aquaculture in this area. Primary data was obtained by measuring of water quality, observations of aquaculture objects and other supporting facilities. Interviews and discussion were conducted with fish farmers, community leaders, the fishing industry, local government officials and other stakeholders. Secondary data were obtained from government and private institutions. This area has the potential for freshwater aquaculture of 102.80 ha, brackishwater aquaculture of 3,049.25 ha, and marine aquaculture of 118.330 ha. In 2019, aquaculture only utilized an area of around 2,879,107 ha, including 47,107 ha of freshwater (ponds), 10 ha of brackish, and 2,822 ha of shellfish ponds. Aquaculture production in 2019 was 15,006.34 tons consisting of fish production from ponds (blood clams and shrimp) 9,009.34 tons which was the main production, followed by fish production from ponds of 5,997 tons. In coastal waters, it is recommended to cultivate blood cockles and Pacific white shrimp (Litopenaeus vannamei). While in inland waters, the recommended fish culture included tilapia (Oreochromis niloticus), striped catfish (Pangasianodon sp), kissing gouramy (Osphronemus sp), and African catfish (Clarias gariepinus), both in ponds and floating net cages. The recommended development strategies include; training on aquaculture human resources, training on making their own feed, building seed and brood centers, and providing business stimulants in the form of seeds, making ponds and floating net cages as well as sustainable guidance from the fisheries industry and the government.

1. Introduction
Economic development is a process of increasing total income and per capita income by taking into account population growth and accompanied by fundamental changes in the economic structure and income distribution for the population of a country. Fishery development is basically a process of human efforts to utilize fishery and aquatic resources through fishing and fish maintenance activities as well as aquatic and coastal environmental services [1] [2] [3]. The development of the fisheries sector is also related to increasing the country's foreign exchange while maintaining the preservation
of biological and environmental resources so that the potential can be managed sustainably in the future [4].

The development of the marine and fisheries sector is not just a way to eliminate poverty and unemployment. However, more than that, the marine and fisheries sector is the basis of the national economy, so it is only natural that this sector is developed into a leading sector on an international scale [5]. Thus, industrial sector support for development in the fisheries and marine sector is a must. Therefore, fisheries and marine and industrial development are not the chosen alternative, but are complementary and mutually supportive for both inputs and outputs [6] [7].

Fishery production in this area consists of capture fisheries and aquaculture production, both derived from cultivated fish and captured fish from the sea and inland public waters. Fishery production figures increase from year to year and are dominated by fish caught from the sea (80.67%) compared to aquaculture production (19.33%). It was reported [8] that fish production in 2019 was recorded at 67,914.08 tons, an increase compared to production in 2016 (62,843.35 tons), 2017 (60,315.80) and 2018 (67,113.60 tons).

The aquaculture development program is implemented in order to support the efforts to increase the quantitative, quality and continuity of aquaculture business by improving facilities and infrastructure and facilitating access to technology [9]. Aquaculture production in 2019 was 15,006.34 tons consisting of fish production from ponds (blood clams and shrimp) 9,009.34 tons which was the main production, followed by fish production from ponds of 5,997 tons. The cockles were cultivated in ponds, especially in the Pasir Limau Kapas district, Sinaboi, Bangko and Kubu Babussalam. This study aims to determine the state of production and potential of aquaculture in Rokan Hilir Regency. Then proceed with analyzing and formulating a strategy for developing this fishery sub-sector.

2. Methodology
2.1 Time and place
This research was conducted from July to December 2020. Data collection was carried out in all districts that have aquaculture activities and other districts that are expected to affect aquaculture in Rokan Hilir Regency, Riau Province, Indonesia.

2.2 Research methods
The method used in this study is a survey method, namely data collection directly in the field. Primary data is obtained from the measurement of water quality parameters, field observations of aquaculture objects and supporting facilities that are expected to affect. Interviews were also conducted with fish farmers, community leaders, the fishing industry, local government and other stakeholders. Meanwhile, secondary data were obtained from government-owned and private institutions.

2.3 Data analysis
The data obtained in this study were tabulated and analyzed descriptively by logically reviewing and comparing them with theories, opinions and previous research results. Includes SWOT analysis, and situation, participatory, analysis, objective, and development analysis.

3. Results
3.1 General Condition of Rokan Hilir Regency
Rokan Hilir Regency, Riau Province has an area of 8,881.59 Km² or 888.159 Ha, located at coordinates 1º14’ - 2º45’ North Latitude a & 100º17 to 101º21 East Longitude. This district has its capital in Bagansiapiapi, consisting of 18 districts. Some districts are located along the Straits of Melaka and border neighboring Malaysia. In detail, the names of the districts in Rokan Hilir Regency are shown in Table 1.

Based on data from the Central Bureau of Statistics of Rokan Hilir Regency in 2021, the total population of Rokan Hilir Regency in 2020 is 637,161 people consisting of 327,243 men and 309,918
women. This population is spread across 18 districts with 192 Kelurahan and Kepenghuluan (villages). When viewed by district, the most populous district is Bangko District with 78,742 inhabitants and the least populated is Rantau Kopar district with 6,592 inhabitants. More detail is presented in Table 1.

Rokan Hilir Regency has a tropical climate and is influenced by two seasons, namely the dry season and the rainy season with air temperatures ranging from 24-32 oC. The dry season generally occurs from March to August while the rainy season occurs from September to February. The amount of rainfall ranges from 1,173.00-3,609.00 mm/year with the number of rainy days ranging from 12-126 days.

The area of Rokan Hilir Regency has a relatively flat topography and is generally lowland. When viewed from sea level, Pasir Limau Kapas District is the lowest area at 1.5 meters above sea level, while Bagan Sinembah is the highest area at 50 meters above sea level. Pasir Limau Kapas and Bagansiapiapi which have a low altitude above sea level have a risk of flooding both from the influence of tides and from the flow of rainwater.

### Table 1. Names and capitals of districts and population of Rokan Hilir Regency in 2020.

| No. | Districts         | Capitals       | Population |
|-----|-------------------|----------------|------------|
| 1   | Tanah Putih       | Sedinginan     | 69,150     |
| 2   | Pujud             | Pujud          | 33,954     |
| 3   | Tanah Putih Tj Melawan | Melayu Besar | 14,628     |
| 4   | Rantau Kopar      | Sungai Rangau  | 6,592      |
| 5   | Tanjung Medan     | Tanjung Medan  | 36,282     |
| 6   | Bagan Sinembah    | Bagan Batu     | 69,825     |
| 7   | Simpang Kanan     | Simpang Kanan  | 24,821     |
| 8   | Bagan Sinembah Raya | Bagan Sinembah | 20,150     |
| 9   | Balai Jaya        | Balai Jaya     | 53,404     |
| 10  | Kubu              | Teluk Merbau   | 25,616     |
| 11  | Pasir Limau Kapas | Panipahan      | 37,258     |
| 12  | Kubu Babusalam    | Rantau Panjang | 23,836     |
| 13  | Bangko            | Bagansiapiapi  | 78,742     |
| 14  | Sinaboi           | Sinaboi        | 18,373     |
| 15  | Batu Hampar       | Batu Hampar    | 9,448      |
| 16  | Pekaitan          | Pekaitan       | 15,858     |
| 17  | Rimba Melintang   | Rimba Melintang| 37,624     |
| 18  | Bangko Pusako     | Bangko Bhakti  | 61,600     |
|     | **Total**         |                | **637,161**|

Source: [10].

Rokan Hilir Regency is fed by several rivers, one of the most important rivers is the Rokan River. The Rokan River is a means of communication, especially for residents who live along the river. With a length of 350 km, apart from being a means of transportation, it is also a place of livelihood for the population, namely as fishermen. There are still other small rivers. These rivers are like the Rokan River, in addition to functioning as a means of transportation, they also function as a source of livelihood, especially for fishermen who live in villages located along the river.

### 3.2 Fisheries Policy Strategy and Direction

The strategy and policy directions for fisheries and marine development in Rokan Hilir Regency are as follows:
1. Increasing fishery development within the framework of export, development of processing industry, and efficient and effective use of resources as well as increasing fishermen's income;
2. Develop great potential for aquaculture, both ponds and cages;
3. Develop a fishery business that aims to meet the animal protein needs of the community and improve the welfare of fishermen and fish cultivators;
4. Increasing product diversification and processing of fishery products, both through large-scale industry and home industry scale.

3.3 Aquaculture household
Aquaculture household (AH) in Rokan Hilir Regency until the end of 2019 amounted to 2531, included cultivation in ponds, cages and coastal ponds. The largest number of AHs is in Rimba Melintang District with the number of 365 AH, while the smallest number is in Rantau Kopar District with the number of 22 AH (Table 2).

| No. | Districts                      | Total of aquaculture household (AH) |
|-----|--------------------------------|-------------------------------------|
| 1.  | Kubu                           | 115 115 115 115 115                 |
| 2.  | Bangko                         | 232 220 298 298 298                 |
| 3.  | Tanah Putih                    | 120 121 121 121 121                 |
| 4.  | Rimba Melintang                | 360 365 365 365 365                 |
| 5.  | Bagan Sinembah                 | 405 200 200 200 200                 |
| 6.  | Pasir Limau Kapas              | 50 238 238 238 238                  |
| 7.  | Sinaboi                        | 65 70 103 103 103                   |
| 8.  | Pujud                          | 180 120 120 120 120                 |
| 9.  | Tanah Putih Tj Melawan         | 60 63 63 63 63                      |
| 10. | Bangko Pusako                  | 205 205 205 205 205                 |
| 11. | Simpang Kanan                  | 163 165 165 165 165                 |
| 12. | Batu Hampar                    | 151 155 155 155 155                 |
| 13. | Rantau Kopar                   | 20 22 22 22 22                      |
| 14. | Pekaitan                       | 70 75 75 75 75                      |
| 15. | Kubu Babussalam                | 51 51 51 51 51                      |
| 16. | Tanjung Medan                  | - 65 65 65 65                       |
| 17. | Bagan Sinembah Raya            | - 80 80 80 80                       |
| 18. | Balai Jaya                     | - 90 90 90 90                       |
|     | Total                           | 2247 2420 2531 2531 2531            |

Source: [11].

3.4 Aquaculture Production
The aquaculture development program is implemented in order to support the efforts to increase the quantity, quality and continuity of aquaculture by improving facilities and infrastructure and facilitating access to technology. The cultivated fish so far are fresh water tambaqui (*Colossoma macropomum*), kissing gouramy (*Osphronemus gouramy*), cockles (*Anadara granosa*), silais (*Kryptoterus micronema*), African catfish (*Clarias gariepinus*), tilapia (*Oreochromis niloticus*), pangas catfish (*Pangasius pangasius*), jambal catfish (*Pangasius djambal*). The aquaculture sector has 102.80 ha of fresh water potential, 3,049.25 ha of brackish water, and 118.330 ha of marine waters. The aquaculture sub-sector utilizes an area of around 2,879,107 ha, covering 47,107 ha of freshwater, 10 ha of brackish, 2,822 ha of shellfish ponds. Aquaculture has the potential with 102.80 ha of fresh water, 3,049.25 ha of brackish, and 118.330 ha of sea. In 2019, aquaculture only utilized an area of around 2,879,107 ha, including 47,107 ha of freshwater (ponds), 10 ha of brackish, 2,822 ha of shellfish ponds. The production of aquaculture in 2019 was 15,006.34 tons consisting of fish production from ponds (cockles and shrimp) 9,009.34 tons which was the main production, followed by fish production from ponds of 5,997 tons.
Earth ponds. The total aquaculture production in Rokan Hilir Regency until the end of 2017 was 12,226.02 tons, of which 2,875.15 tons were pond production. Pond production in 2017 was 2,875.17 tons. Compared to the total production in 2018, pond production increased by 3981.03 tons, increasing to 3,897 tons in 2019. Bagan Sinembah District is the highest producer, at 812 tons, while the lowest producer is Tanah Putih Tanjung Melawan District (20 tons). Pond production data in Rokan Hilir Regency in 2015-2019 is shown in Table 3.

Table 3. Pond production (tonnes) in Rokan Hilir Regency in 2015-2019.

| No. | District                      | 2015 | 2016 | 2017  | 2018 | 2019 |
|----|-------------------------------|------|------|-------|------|------|
| 1  | Kubu                          | 29.21| 20.11| 23.14 | 48.13| 49   |
| 2  | Bangko                        | 86.26| 96.05| 99.17 | 166.29| 166.5|
| 3  | Tanah Putih                   | 35.78| 40.01| 152.16| 316.51| 316  |
| 4  | Rimba Melintang               | 269.96| 257.57| 367.05| 656.51| 657  |
| 5  | Bagan Sinembah                | 287.08| 110.15| 719.71| 809   | 812  |
| 6  | Pasir Limau Kapas             | 407.53| 359.45| 257   | 300   | 300  |
| 7  | Sinaboi                       | 34.35| 41.32| 53.64 | 111.58| 112  |
| 8  | Pujud                         | 124.60| 80.15| 96.83 | 99.42 | 99.5 |
| 9  | Tanah Putih Tj Melawan        | 10.59| 15.09| 10.09 | 20.99 | 20   |
| 10 | Bangko Pusako                 | 155.82| 98.34| 14.99 | 30.18 | 32   |
| 11 | Simpang Kanan                 | 5.30 | 16.73| 209.58| 210.95| 210  |
| 12 | Batu Hampar                   | 14.36| 20.18| 32.51 | 67.62 | 68   |
| 13 | Rantau Kopar                  | 4.81 | 9.50 | 53    | 60.87 | 61   |
| 14 | Pekaitan                      | 47.67| 45.68| 155.01| 189.44| 192  |
| 15 | Kubu Babussalam               | -    | 11.03| 16.19 | 13.68 | 10   |
| 16 | Tanjung Medan                 | -    | 45.80| 79.01 | 85.35 | 86   |
| 17 | Bagan Sinembah Raya           | -    | 95.03| 321.76| 549.3 | 550  |
| 18 | Balai Jaya                    | -    | 63.15| 214.03| 245.21| 246  |
|    | Total                         | 1,513.32| 1,425| 2875.17| 3981.03| 3987 |

Source: [11].

Floating cages. The production of cages in Rokan Hilir Regency in 2019 was 74.18 tons. Compared to the total production in 2018, cage production increased by 0.76% or increased by 0.56 tons. The increase occurred in Pujud District, which was 1.32 tons or 4.13%. The production of cage cultivation in Rokan Hilir Regency in 2015 - 2019 is shown in Table 4.

Table 4. Cage Production (tonnes) in Rokan Hilir Regency in 2015-2019.

| No. | Districts                      | 2015 | 2016 | 2017  | 2018 | 2019 |
|----|--------------------------------|------|------|-------|------|------|
| 1  | Tanah Putih                    | 8.30 | 7.80 | 8.20  | 11.22| 10.11|
| 2  | Pujud                          | 16.80| 18.13| 23.34 | 31.95| 33.27|
| 3  | Tanah Putih Tj Melawan         | 10.60| 12.30| 14.55 | 19.91| 20.04|
| 4  | Bangko Pusako                  | 5.40 | 7.30 | 7.70  | 10.54| 10.76|
|    | Total                          | 41.10| 45.53| 53.79 | 73.62| 74.18|

Source: [11].

The production of fish from coastal earth pond cultivation in Rokan Hilir Regency in 2019 amounted to 9,009.34 tons. Compared to the total production in 2018, the production of aquaculture decreased by 0.09% or 8.21 Tons, namely in Kubu District by 5.3% or 26.28 Tons. Fish production in 2015 - 2019 is shown in Table 5.
Table 5. Total production of coastal earth ponds in Rokan Hilir Regency in 2015-2019.

| No. | Districts          | 2015     | 2016     | 2017     | 2018     | 2019     |
|-----|--------------------|----------|----------|----------|----------|----------|
| 1.  | Kubu               | -        | -        | 1,784,72 | 525,41   | 524,00   |
| 2.  | Bangko             | 7,20     | -        | 1,166,84 | 2,086,71 | 103,09   |
| 3.  | Pasir Limau Kapas  | -        | 18,13    | 5,627,40 | 5,415,11 | 5,411,76 |
| 4.  | Sinabo i           | -        | 12,30    | 437,65   | 495,10   | 497,10   |
| 5.  | Batu Hampar        | -        | -        | -        | 0,12     | 4,57     |
| 6.  | Kubu Babussalam    | -        | 15,15    | 274,45   | 495,10   | 468,82   |
|     | Total              | 7,20     | 45,8     | 9,291,06 | 9,017,55 | 9,009,34 |

Source: [11].

3.5 Hatchery

Until the end of 2019, there were only 2 hatcheries, namely the Tanah Putih Hatchery and the Rantau Kopar Hatchery. The hatchery is owned by the local government. In addition, there were also a number of community fish hatchery units (CFHU). The number of hatchery fish seed production in Rokan Hilir Regency in 2017 - 2019 is shown in Table 6.

Table 6. The hatchery fish seed production in Rokan Hilir Regency in 2017 - 2019.

| No | Hatchery and CFHU     | 2017     | 2018     | 2019     |
|----|-----------------------|----------|----------|----------|
| 1  | Tanah Putih Hatchery  | 299,580  | 265,292  | 200,890  |
| 2  | Rantau Kopar Hatchery | -        | 32,423   | 240,130  |
| 3  | CFHU                  | -        | -        | 47,980   |
|    | Total                 | 299,580  | 297,715  | 489,00   |

Source: [11].

Community fish hatchery units (CFHU)

There were 10 CFHU units until the end of 2019 in Rokan Hilir Regency and the data for 2017 - 2019 are shown in Table 7.

Table 7. Community fish hatchery units (CFHU) Rokan Hilir Regency 2017 – 2019.

| No | District                     | 2017 | 2018 | 2019 |
|----|-------------------------------|------|------|------|
| 1  | Tanah Putih                  | 2    | 2    | 2    |
| 2  | Rimba Melintang              | 3    | 3    | 3    |
| 3  | Rantau Kopar                 | 1    | 1    | 1    |
| 4  | Bagan Sinembah               | -    | -    | 1    |
| 5  | Bagan Sinembah Raya          | 2    | 2    | 2    |
| 6  | Balai Jaya                   | 1    | 1    | 1    |
| 7  | Total                        | 9    | 9    | 10   |

Source: [11].

4. Discussion

4.1 Aquaculture Production

Bagan Siapiapi as the capital city of Rokan Hilir Regency is actually very well known as a fish-producing area. This area was once known as the most fertile seawaters in the world. But over time this achievement continues to fade and fish production continues to decline. Several factors causing the decline in catch production include; intensification of fishing in marine waters, population growth, modernization of fishing gear and fleets and decreasing water quality. Clearing of forests along the
Rokan River watershed and rivers that are tributaries of the Rokan River has increased the rate of erosion, silting of waters, especially in river mouth areas, increased water turbidity, reduced nutrients in the water and so on [12] [13]. Even so, until now the fishery production of Rokan Hilir Regency is still dominated by fish caught from the sea, which is around 93.74%, general water catches are 3.69% and the rest (2.57%) is the production of aquaculture. The production of aquaculture in 2019 was 15,006.34 tons consisting of fish production from ponds (cockles and shrimp) 9,009.34 tons which was the main production, followed by fish production from ponds of 5,997 tons (Tables 3, 4, and 5).

The development towards aquaculture business has begun to be seen. This is due to general government policy factors in this area, appropriate climatic conditions, supportive topography, demographics and other relatively supportive social conditions [14]. The number of aquaculture households continues to grow, the types and volume of aquaculture businesses (ponds, ponds, cages and floating nets) continue to grow, and other socio-economic factors are increasingly supporting the development of aquaculture businesses. Presumably this is also the cause of the local government to formulate strategies and policy directions for marine fisheries development in such a way that it spurs the pace of the aquaculture industry in general.

4.2 Coastal aquaculture prospects

The government of Rokan Hilir Regency has accelerated a shellfish cultivation program in coastal areas, including Bangko District, Pasir Limau Kapas District, Kubu District, and Sinaboi District. From the results of research carried out in 2019 it was explained that shellfish in the area had very low metal content and was safe for consumption [15]. The technology for cultivating shellfish itself is currently still using the traditional method by utilizing the ebb and flow of sea water, and collecting shellfish seeds by dredging the waters as deep as 3 to 5 cm using baskets. The Rokan Hilir Regency Government through the Fisheries Service is currently conducting the coaching phase for shellfish farmers by conducting socialization and training [8].

From the data on water quality and soil types as well as the conditions of access to transportation, several places along the coast in four districts are considered feasible to be developed as vanamei shrimp cultivation areas. Until now, this effort has not been carried out in this area [11], but the results of the study show that some of these places are very suitable to be used as vanamey shrimp ponds. Some researchers [16] stated that based on the analysis of water quality, soil conditions and security and ease of access, several districts in this area have the potential to be developed as vanamei shrimp cultivation areas. Types of marine biota cultivation that have the potential to be developed include the cultivation of blood clams and the cultivation of vanamey shrimp on the beach.

4.3 Inland aquaculture prospects

The development of freshwater aquaculture is increasingly visible today. Starting from the growth in the number of aquaculture households, the increase in the number of cage units, the increase in the area of the pond, the increase in the number of production, and up to the increase in community hatchery units. The data above shows that in all districts have started to develop freshwater fish farming (Table 3, 4, 5, 6 and Table 7). This means that people are starting to realize that freshwater aquaculture is one of the economic opportunities that can be developed [17].

Based on considerations of water quality, soil type, transportation access, other socio-economic factors, this study recommends fish farming activities that have the potential to be developed, including the cultivation of tilapia, catfish, pomfret, gourami, and African catfish, both in ponds and in floating net cages. Some places are relatively free from flood reach, relatively easy to access and local people can accept the presence of this business activity. Another reason is that these types of fish have been kept in several places in this area, the business infrastructure (seedlings, feed, market and guides) is already relatively there. In addition, local people are used to consuming this type of fish [18] [19].
4.4 Aquaculture development strategy

The development strategy of a development sector should be based on a comprehensive analysis. Includes SWOT analysis, situation analysis, participatory analysis, problem analysis, objective analysis, project alternative analysis, and development analysis. The principles, mindset and approach to planning and strategy formulation used in this study include; a) environmentally friendly planning, b) integrated development planning, d). holistic development planning, and e) community base approach planning. Covers technical aspects, business aspects, security aspects and other socio-economic aspects.

The human resource factor is the main key that must be prepared [20]. This preparation includes generating public interest, establishing business organizations, technical training and aquaculture business and business development assistance. In addition, the preparation and channeling of business infrastructure is no less important. For example, the availability of seeds, the availability of feed, the availability of medicines as well as the availability of markets and business capital [21]. From this series of analyzes, the writer recommends a good strategy to be taken, including; a) aquaculture human resource training, independent feed making training, b) development of seed and parent centers, and c) provision of business stimulants in the form of seeds, making ponds and cages as well as d) sustainable guidance from the fisheries industry and the government.

5. Conclusions

In Rokan Hilir Regency the potential area for freshwater aquaculture is around 102.80 Ha, brackish water 3,049.25 Ha, and marine water 118,330 Ha. Potential marine biota to cultivate are blood cockles and vannamey shrimp in ponds on the coast. While in inland fisheries, the potential animals include; tilapia, catfish, pomfret, gourami, and African catfish, both in ponds and in floating net cages. The recommended development strategies include; a) training on aquaculture human resources, , construction of seed and brood centers, and provision of business stimulants in the form of seeds, making ponds and floating net cages as well as sustainable guidance.

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