A study on the economic potential of blood cockles (*Anadara granosa*) in Rokan Hilir, Riau Province, Indonesia

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Abstract. This research was conducted from January to July 2019 in Rokan Hilir Regency, Riau Province for the purpose of investigating the prospects and economic potentials of blood cockle (*Anadara granosa*) cultivation in the regency. The methods used included a survey, direct observation and an in-depth interview with 65 marine cockle cultivators and related stakeholders in the three production centers of marine fisheries, namely Panipahan, Bagansiapiapi and Sinaboi. The data obtained were analyzed descriptively and its business feasibility analyzed. The results showed that the blood cockle cultivation business of Rokan Hilir is very profitable (BCR 1.88 and PPC 1.92). In addition, the prospects of developing cockle cultivation is also good because of the wide (124,000,000 m2) land potential available, the low demand for high skills, and the accessibility for export of products to the Malaysian market.
Key Words: *Anadara granosa*, economic potential, cultivation, Rokan Hilir.

Introduction. Indonesia is the largest maritime and island nation in the world. The country has 17,504 large and small islands and almost 75% of the territory consists of oceans (5.9 million km^2). The length of the coastline reaches 95,161 km and is the second longest after Canada (Ninef et al 2019). Indonesia has become one of the biggest marine fish producing countries in the world with a potential of about 6.4 million metric tonnes per year (Lasabuda 2013). Indonesia has also developed its marine culture, one of which is the blood cockle (*Anadara granosa*). According to Daris et al (2019, 2020) coastal resources must be managed properly because it can lead to conflict. Blood cockles have a soft flat-shaped body with two hard shells that serve as a body armor. These shells are connected by an elastic hinge that moves the body muscles allowing it to open and close, crawl and dig mud or sand. They breathe with two gills and a mantle section, produce a lot of hemoglobin in the blood fluid and live in intertidal areas with sloping and muddy beaches (Harith et al 2016) (Figure 1).

Figure 1. Blood cockle (*Anadara granosa*) and habitat (field) in Rokan Hilir, Indonesia.

There are 8,000 blood cockle species in the world, and some live in fresh water. Its population spreads along the Indo Pacific region from the East African coast to the Polynesian region. Blood cockles are consumed raw, boiled, steamed, fried, baked, or as a snack by people of East Asia and Southeast Asia (Yurimoto et al 2014).

Blood cockles have a high nutritional value as it is a complete source of protein and contains high levels of essential amino acids (85-95%). It is a source of vitamins A, B, D, E, K, and unsaturated fats (omega 3) and also contains minerals, especially calcium, phosphorus, iron, iodine and zinc (Hossen et al 2014). The calcium in these cockles can prevent bone fragility (osteoporosis), the zinc can increase male libido, while the high protein and low calorie content not only makes one feel full but can prevent weight loss (Mirsadeghi et al 2011, 2013). According to Prasojo et al (2012) that organic matter dissolved in waters is the main source of nutrition for benthos animals, so the minimum or maximum organic matter in waters is one of the factors that greatly influences the growth and presence of benthos animals, including those from the bivalvia group. Further stated that the factors that influence the growth of shellfish are season, temperature, food, salinity and other water chemical factors that vary in each region. As blood cockles have many advantages, it is quite an expensive item in the market. Many people are therefore motivated to cultivate it (Mirsadeghi et al 2011, 2013). According to Shumway et al (2003), as many as 76 countries in the world are into shellfish cultivation accumulating a total production of 15.2 million metric tons a year. Some countries that have successfully cultivated blood cockles include China (278,058 metric tons), Thailand (71,450 metric tons), and Republic of Korea (2,232 metric tons per year).

Research in Thailand shows that blood cockle cultivation does not require a high cost because building a suitable breeding pond does not need special requirements. Thailand's blood cockle production is valued at 180 million baht per year (McCoy 2016). As for Indonesia, Rokan Hilir in the Riau Province is one of the areas that have developed the cultivation of blood cockles. Geographically, the region lies between $1^{o}14'$-$2^{o}45'$N and $100^{o}17'$-$101^{o}21'$E, on the east coast of Sumatra and is directly adjacent to the Straits of Malaka.

According to Saja (2012), this regency is the largest marine fish production center in the Riau Province. The reason for this is that the coastal and marine waters of Rokan Hilir are quite fertile as it is influenced by water masses which are rich in nutrients coming from the Atlantic Ocean and South China Sea, as well as mass water supplies from some major river estuaries. In addition, fish marketing from Rokan Hilir is very prospective, as it is close to neighboring Malaysia (Nurjanah et al 2005). Its marine fish production has reached 58,377 tons per year or 56.65% of the total production of Riau's marine fish (Dinas Perikanan dan Kelautan Kabupaten Rokan Hilir 2016). About 50% of Rokan Hilir's fish production is exported to Malaysia at an export value of Rp 1,000,000,000 per year. This production can still be enhanced through marine cultivation, especially which of blood cockles by taking advantage of the region's wide coastal waters, relatively sloping muddy beach, and waters which are strongly influenced by tides.

The cultivation of blood cockles in Rokan Hilir started in 2010. Of the approximate land area potential of 124 km^2 available for its cultivation, only 0.15% of the total area is currently used for shellfish cultivation. In addition, the potential impact of this business on the local community's economy and on the development of Rokan Hilir Regency has not been studied. For this reason, a deeper assessment of this business needs to be done (Dinas Perikanan dan Kelautan Kabupaten Rokan Hilir 2016).

The main objective of this research is to explore the prospects and economic potential of blood cockle cultivation in Rokan Hilir. It aims: (1) to determine the current status of blood cockle cultivation in Rokan Hilir, and (2) to conduct an economic analysis of blood cockle cultivation in Rokan Hilir.

Material and Method

Description of the study sites. The study was conducted between January to July 2019 in Panipahan, Bagansiapiapi and Sinaboi, Rokan Hilir Regency, Riau Province, Indonesia.

Data and method. Data collection methods are techniques or methods used to obtain data for further processing and obtaining new information (Nazir 2004; Yusuf & Daris 2018). Data were collected from three marine production centers, namely Panipahan, Bagansiapiapi and Sinaboi. A survey method was used, while the primary data were obtained through direct observation and in-depth interview with stakeholders. The total population of blood cockle cultivators in this regency amounted to 188 people. Cultivate respondents (65) were randomly sampled by using the Slovin formula (Sevilla 2007), namely:

$$n = \frac{N}{1 + N(e)^2}$$

where: n = number of samples;
N = total population (188 cultivators);
e = error rate (10%).

The purposive sampling method was employed to determine the five stakeholder respondents: a merchant collector, an exporter, a fishery supervisor, an officer of Marine Affairs and Fishery, and a government official of the Rokan Hilir Regency. In addition, secondary data were obtained through literature search of various reports and research studies. The data obtained were then analyzed by a business feasibility analysis (Soekartawi 1993), as follows:

$$\pi = TR\text{-}TC$$

where: π = net income (IDR per harvest period);
TR = total revenue (IDR per harvest period);
TC = total cost (IDR per harvest period).

$$TC = FC + VC$$

where: TC = total cost (IDR per harvest period);
FC = fixed cost (IDR per harvest period);
VC = variable cost (IDR per harvest period).

$$TR = Y \times Py$$

where: TR = total revenue (IDR per harvest period);
Y = total production (kg per harvest period);
Py = Y price (IDR per harvest period).

$$I = Mt + Mtt$$

where: I = investment;
Mt = fixed capital;
Mtt = not fixed capital.

Results. The results of the investigation show that although Rokan Hilir has 12 districts, only three (3) areas namely Panipahan, Bagansiapiapi and Sinaboi are currently involved in the cultivation of blood cockles. There are 188 blood cockle cultivators, 138 from Panipahan, 25 from Bagansiapiapi and 25 from Sinaboi. The total land area used for the cultivation is 267,900 m^2. The land is a sloping and muddy coastline around the township of the inhabitants. According to the cultivators, the blood cockle seeds which were obtained from six locations in the regency, namely Sungai Baun, Sungai Sanda, Pasir

Limau Kapas, Sungai Tengah, Teluk Palas, and Teluk Pulai were bought from the fishermen at a price of IDR 3,000 - IDR 6,000 per kg.

Each cultivated area (pond) is fenced with a net to prevent security disturbances, both from humans and ocean currents. The net price of 100 m^2 is IDR 350,000. Operational costs incurred included the cost of shellfish pond maintenance at IDR 1,500,000 per month, and the cost of harvesting at IDR 1,500 per kg.

The blood cockle cultivation period varies between three and seven months, depending on the size of the seed. Seeds of 2 mm can be harvested after seven months of the cultivation period, while seeds of 6 mm are harvested after three months. Harvesting is done using scoop net (tangguk) and tongkah. Tongkah is a piece of board that serves as a foothold for the cultivators when harvesting is done above the mud. The tongkah can slide along the mud with the help of the cultivator's legs and as the vessel slides, the cultivator collects the blood cockles which are scattered on the mud surface by operating the tangguk by hand. The tangguk is made of a nylon net equipped with a metal frame in its mouth. The iron frame can be moved to open and close (Figure 2). The catch from the insert is then put into a small collection boat.

Figure 2. Scoop net (left) and operation method (right).

Blood cockles are sold to exporters through collecting traders. There are six exporters of blood cockles in Rokan Hilir: four (4) in Panipahan, one (1) in Bagansiapiapi and one (1) in Sinaboi. These blood cockle products are then exported to Port Klang, Malaysia via a cruise vessel from Panipahan to Port Klang that takes only eight hours.

The results of the business analysis and the economic potential of marine shellfish culture indicate that the business is beneficial to the cultivators. Details are described in Table 1.

Table 1 shows that the land used for cultivation is between 100 and 5,600 m^2, where the average is 1,425 m^2. The average investment amount is IDR 39,261,544. This investment included the purchase of nets, wood, barrels, cows, ropes, buckets, canoes and seeds. Blood cockle seeds required by cultivators averaging 3.2 kg per $meter^2$ were bought at a price of IDR 3,000 per kg, so the total cost for each cultivator amounted to IDR 13,680,000.

The cultivation period of blood cockles is on average seven months, with one harvest. The total cost incurred during the cultivation period amounted to IDR 75,960,261, which consisted of seed purchases, security fees, depreciation and harvesting costs. The average production of blood cockles per cultivation period is 27,360 kg, while the average selling price is IDR 8,000 per kg. Therefore, the gross revenue received per cultivator per period is IDR 218,880. Based on these calculations, the average net income obtained is IDR 142,919,739 per period (IDR 20,417,105 per month).

The result of the business feasibility analysis shows that the value of Benefit Cost of Ratio (BCR) is 1.88. This means that for every one dollar incurred a profit of IDR 1.88 is generated. Furthermore, the Payback Period of Capital (PPC) for this business amounted to 1.92. This means the payback of business capital can be achieved in 1.92 months on average.

Table 1

Financial analysis and economic potential of marine shellfish culture in Rokan Hilir regency, Riau Province, Indonesia

No	*Description*	*Value*	*Unit*	*Details*
1	Average area used for cultivation	1,425	meters^2	per person
2	Value of investment	39,261,544	IDR	per person
	Fixed capital	25,581,544	IDR	per person
	Variable capital	13,680,000	IDR	per person
3	Clam cultivation period	7	months	
4	Total cost	75,960,261	IDR	per cultivation period
	Security	10,500,000		
	Depreciation (10% x investment)	3,900,261		
	Harvest	47,880,000		
	Purchase of seeds	13,680,000		
5	Total production per period	27,360	kilogram	per person
6	Price of marine clam	8,000	IDR	per kilogram
7	Total sales of marine clam (5 x 6)	218,880,000	IDR	per cultivation period
8	Profit per period (7-4)	142,919,739	IDR	
9	Profit per month (8:3)	20,417,105	IDR	
10	Benefit of cost ratio (8:4)	1.88		
11	Payback period cost (2:9)	1.92	months	
12	The area of potential cultivation	124,000,000	meter^2	
13	Potential of culture capacity (12:1)	87,017	orang	
14	Economic potential (14x10)	524,421,990,237	IDR	per month

Discussion. The results showed that the cultivation of blood cockle in the Rokan Hilir Regency was concentrated in 3 regions with the largest percentage being in Panipaha (73.40%) and the rest were in Bagansiapiapi and Sinobi. The land used for cultivation is a coastal area with a muddy texture. As stated by Suryono et al (2015), the location of the growth of blood cockle culture is in the sloping coastal areas and clay-sand substrate. Coastal areas or tidal areas are areas with great potential for the development of aquaculture of blood cockle and other types of shellfish (Chalermwat et al 2003). In Indonesia, shellfish farming activities are: green mussels, blood clams, ark shell, and others are carried out in coastal and tidal areas, such as in Jakarta Bay (Arifin 2008). The tidal area with clay-sand substrate is an area suitable for the development of blood cockle cultivation (Suwartimah et al 2017). Blood cockle are bivalve that live at the bottom waters by immersing themselves in the soil.

From the economic analysis, the results show that cultivation business of Rokan Hilir is a very prospective venture. This is consistent with that blood cockle cultivation cost is not expensive and yet provide a high returns as cited in many studies (i.e. Nurdin et al (2006), Suwarjarat et al (2009), Yang et al (2016), to name a few). Findings from the business feasibility analysis reveals that the blood cockle cultivation business of Rokan Hilir is a very prospective venture for three reasons. Firstly, the potential land available for future cultivation of blood cockles is 124,000,000 m^2, a land area which is wide enough to accommodate as many as 87,017 blood cockle cultivators. This presents a good opportunity for traditional fishermen in Rokan Hilir to increase their income, which has been dependent on the season. Secondly, blood cockle cultivation does not require high skills as confirmed by many survey respondents who consider the cultivation process as fairly simple. This means that much more fishermen and coastal communities can be easily involved in looking for suitable land to be filled and sprinkled with blood cockles. Furthermore, it seems that this type of cultivation does not require any special treatment apart from ensuring that the land is secure from theft. Finally, the marketing of blood cockle products from Rokan Hilir to Malaysia has already been set up with four experienced exporters, namely Aliong, Ancu, Kampung and Akiong. Despite considerable domestic demand, this product is also exported easily to Malaysia via Port Klang, which is only 8 hours by boat from Panipahan. The obstacles faced by blood cockle cultivators are limited capital and the black mud disaster. The initial investment required for this business is IDR 39,291,544, which is considered as quite high.

Conclusions. This study concludes that the blood cockle cultivation business of Rokan Hilir is very profitable (BCR 1.88 and PPC 1.92). It has high development prospects due to the availability of wide cultivation land, the fact that it does not require high skills, and its accessibility to marketing and export. This study also would like to suggest that relevant authorities such as Bappenas and Bappeda could look into these three centers to redesign the landscape for a sloppy land and also in trapping a muddy water in order to encourage more cultivation coastal areas.

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