Evaluation of freshwater fish farming to support food security

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Abstract. Food security is defined as a condition of fulfilling the nutritional needs of the community through the availability of sufficient food, both in quantity and quality, evenly distributed and affordable by everyone. The research was conducted in Pandeglang Regency, Banten Province using survey method and literature study. Respondents were selected using purposive sampling technique. Data were analyzed qualitatively, descriptively, and quantitatively. The results showed that the main production of freshwater aquaculture in Banten Province in 2019 was catfish (17.8 million tons), followed by tilapia (5.44 million tons), carp (5.40 million tons), tilapia (3.2 million tons), and tawes (540 thousand tons). Meanwhile, fish farming production in Pandeglang reached 5.176 million tons in 2019, dominated by catfish, carp, and tilapia. Catfish farming that has the prospect to be developed, as one of the elements of household food security in Pandeglang Regency is fish farming with a bucket system or known as "budikdamber". Based on a brief study in the field, both technically and economically feasible, catfish cultivation in buckets is more potential. If used for household protein supply needs that contribute to food security, and as a support/additional source of family economy.

1 Introduction

Food security has a very broad range of meanings and involves various aspects that are very complex [11, 3]. In Indonesia, food security is defined as the condition of food fulfillment for the community through the availability of sufficient food, both in quantity and quality as well as equitable and affordable by all parties (Law No. 7/1996). Four components are required to achieve food security, namely: a) sufficient food availability; b) stable food availability from season to season or from year to year; c) accessibility and affordability of food; and d) quality of food safety [4].

Initially, the concept of food security was focused on agriculture. In the 1970s, more attention was paid to food availability at the global and national levels. Then in the 1980s, food security began to pay attention to food cases at the household and individual levels. And finally, the broad definition of food security is the assurance of access to food for all households and individuals at all times so that they can work and live healthy lives [3, 13, 14]. Furthermore, it is explained that food security also includes aspects of food availability,

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employment and income [15]. All three affect access to food and nutrition for each family member. Similarly, it is stated that food prices in the market are highly dependent on the availability of the food [16]. An increase in food prices can pose a threat to the nutritional fulfillment of family members who do not work or work at a level that is not sufficient for a decent life.

Fisheries have a considerable contribution in creating food security through the fulfillment of protein needs. More than one billion people around the world rely on fish as their main source of animal protein. Worldwide, the estimated average annual fish consumption is 19.6 kg per capita in 2021, while in Indonesia the national average consumption level in 2020 was 56.39 kg/capita/year (bisnis.com/view/20210227/1361672). In the last 30 years, per capita animal protein consumption in developing countries has more than doubled, as a direct result of technological advances in aquaculture. Indirectly, commercial aquaculture leads to improved food security by providing employment opportunities and increased income for local communities. More than 500 million people in developing countries are reported to depend on fisheries and aquaculture for their livelihoods [4]. Most aquaculture production occurs in developing countries, increased income leads to increased food purchasing power and, more importantly, diversification of non-staple food consumption, including fish and vegetables, has a positive correlation with income growth, supporting food security and greater nutrient content in the diet.

Pandeglang Regency is one of the regencies in Banten province which is located at the coordinates 06° 21'00" - 07° 10'00" LS 105° 25'00" - 106° 30'00" East with altitude ranging from 0.0 - 1,778 m above sea level (DPL). The geographical boundaries of Pandeglang Regency are Serang Regency to the north, Indian Ocean to the south. To the east is Lebak Regency, and to the west is the Sunda Strait. The total area of Pandeglang Regency is 4,448.89 km² consisting of 2,746.89 km² of land area and 1,702 km² of ocean area, with a recorded coastal length of 307 km.

The total population in 2018 was 1,205,203 people with a density of 439 people/km² [5]. The problem faced in the last decade is that there are around 8,000 people who are stunted. The level of Regional Minimum Wage (UMR) is the second lowest in Banten Province. The minimum wage in Pandeglang Regency is Rp.2,800,000/month. Similarly, the level of fish consumption per capita recorded in 2018 was 27.8 kg/year or 2.3 kg/month and ranked 4th out of 6 districts in Banten Province. Given this condition, a breakthrough activity is needed that can support food security in Pandeglang Regency, especially from the field of freshwater fisheries. Therefore, this research was conducted with the aim of looking at the potential of freshwater fisheries that can be used as a basis or policy material for food security programs in Pandeglang Regency.

2 Materials and methods of research

This research is a study that can be categorized in substantive policies, namely regarding government efforts to prepare food security programs through the sustainable use of fisheries resources [1]. The data used are primary and secondary data derived from various sources or literature. The data were analyzed in depth using a rational model, namely logical and step-by-step analysis [10].

The activities of this study include site surveys, FGDs and determination of survey groups in coordination with the local government. The method to be used is a rapid survey using questionnaires and interviews with direct and indirect stakeholders. Community response is conducted through PRA (Participatory Rapid Appraisal) and RRA (Rural Rapid Appraisal) methods, which are methods for analyzing the conditions and life of an area, planning an action from, with and by rural communities to empower local communities.
3 Results

Comprehensively, food security is defined as the availability of food in sufficient quantity and quality, distributed at affordable prices and safe for consumption for every citizen to sustain their daily activities at all times. Thus, food security covers both the household level and the national level [2]. Referring to the understanding in agriculture, in the field of fisheries, several things that can be used as initial information to support food security programs include the condition of fisheries and their supporters, cultivation systems that can be used as a source of income equivalent to the district level minimum wage and cultivation for household scale through the provision of family protein sources.

3.1 Fisheries condition and its supporters

The main production of freshwater aquaculture in Banten Province in 2019 was catfish (17.8 million tons), followed by tilapia (5.44 million tons), carp (5.40 million tons), tilapia (3.2 million tons) and tawes 540 thousand tons. Meanwhile, fish farming production in Pandeglang reached 5.176 million tons in 2019 with the dominance of catfish, carp and tilapia. This level of production is still insufficient to meet the needs of fish in Pandeglang. The fulfillment of consumption fish and aquaculture fish needs still rely on supplies from surrounding areas, especially Bogor district. Increasing freshwater aquaculture production can be done through the provision of superior seeds, functional feed and adequate water quality [6]. Optimizing the Fish Seed Center is one alternative that can be done in ensuring the supply of quality seeds. Innovative feed and water quality technologies are also needed in Pandeglang. These efforts will also support the stability of production costs in aquaculture so that the relatively high price level for catfish and tilapia in producers, namely 18-20 thousand/kg (catfish) and 25-28 thousand/kg (tilapia) can be utilized as well as possible to obtain business margins.

Adopting and modifying the scale of food security in agriculture which is divided into two, namely national and family food security [2]. The mission of this research activity is targeted at two targets, namely food security at the district level and food security at the household scale. The results of discussions with stakeholders and secondary data available, there are two main freshwater fish commodities in Pandeglang that have the potential to contribute to food security, namely tilapia and catfish. At the national level, tilapia and catfish commodities were ranked first and second in production in 2017 with production volumes of 1.28 million and 1.13 million [5].

Fish farmers in Pandeglang Regency are dominated by the age group of 25-35 years old, which is included in the productive labor category. Generally, fish farming is one of the livelihoods in addition to other jobs undertaken by farmers. Approximately 20% of human resources involved in freshwater aquaculture are earning all their income from fisheries. There are about 20 groups of freshwater fish farmers (pokdakan) registered with the Office of Maritime Affairs and Fisheries of Pandeglang Regency and spread across 11 sub-districts. Meanwhile, the unregistered groups are almost equal to the registered groups, generally they are doing business independently.

Table 1. Respondent data, segmentation and cultivation commodities of Pandeglang Regency.

<table>
<thead>
<tr>
<th>No</th>
<th>Respondent</th>
<th>Address</th>
<th>Segmentation</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nila Maju, Huda Farm</td>
<td>Kaddumadang Village, Cimanuk Sub-District</td>
<td>Hatchery, Enlargement</td>
<td>Tilapia (enlargement), Catfish (hatchery)</td>
</tr>
<tr>
<td>2</td>
<td>Mitra Maju</td>
<td>Mayasari Sub-District</td>
<td>Enlargement</td>
<td>Tilapia</td>
</tr>
</tbody>
</table>
The education level of human resources involved in freshwater aquaculture is dominated by SLA graduates, followed by graduates of < SLA and S1 or equivalent education level. Around 75% of the human resources working in freshwater aquaculture are married with between 3-4 family members. Only about 5% of the cultivators are women. The income earned from freshwater fish farming varies greatly, ranging from IDR 2 million per month to IDR 4 million per month. Meanwhile, the minimum wage in Pandeglang is Rp 2,800,000 per month for a family with 1 child.

The above condition is a manifestation of the amount of effort that must be done to increase the role of freshwater aquaculture in supporting food security programs in Pandeglang Regency. Income and food price directly affect food security index in a region [12]. With the value of net income above the minimum wage and the existence of non-fisheries livelihoods, it can be estimated that the value of food security supported by the fisheries sector has an index above 1, which means that the conditions are quite good for the creation of food security.

Furthermore, the quality of human resources with a relatively good level of education is an added value that can be best utilized as a trigger in the development of technological innovation in freshwater fisheries. Along with a relatively better income level compared to the minimum wage value in the area, it is expected to make aquaculture businesses have a fairly high bargaining value among millennials. This is indicated by the considerable enthusiasm in adopting new knowledge or technology from productive-age farmers.

The targets of this study are:

a. **Food security at district level:**

The Pandeglang District Government through the Food Security Office has had programs related to, among other things:

i. Preparation of the Distribution Map of Food Insecure Vulnerable Areas (PSPA). There are 12 villages in 4 sub-districts that fall under the criteria of food insecurity with an indicator of animal protein deficiency;

ii. Food and nutrition security system (SPG);

iii. Establishment of food self-sufficient villages, for example in Ketapang village which utilizes the yard as a source of vegetables and livestock including fish, one of which is through the application of red tilapia biofloc technology.
The high enthusiasm of farmers in applying biofloc technology in the cultivation of red tilapia, the concept of forming a village of tilapia biofloc system which includes support from upstream to downstream with good technical and economic conditions, is quite feasible as one of the options for developing fish farming in its contribution to the food security program [7]. The on-the-spot locations are Jaya Lancar 1 and Mina Berkah farms in Sukamanah village, Kaduhejo sub-district, Hudafarm farm in Batubantar village, and a farm in Kadumadang village, Cimanuk sub-district. Technically, the technology of red tilapia cultivation with the biofloc system has been going quite well since it began around 2019. The productivity value is still at a decent level but can still be optimized to be equivalent to 20-25 kg/m$^3$ and FCR value < 1.1. Improvements can be made through increased density, feed and oxygen supply [8].

Economically, by considering the price of pellets and the price of consumer red tilapia prevailing at harvest time, the operational cost per unit of red tilapia biofloc pond can be estimated as follows = (5000x1000) + (15x50x1.1x11,000) = Rp 14,075,000. - If the price of electricity for 1 period is 1 million, the cost of production per kg of biofloc red tilapia is Rp 15,075,000/750 = Rp 20,100. Meanwhile, the BC ratio value is 28,000/20,100 = 1.39. Considering this information, it is necessary to increase efficiency so that biofloc tilapia farming can be used as a source of income [8].

Based on the technical and economic conditions, the cultivation of red tilapia in a biofloc system can be used as an aspect of food security, through its function as a source of family economy so as to facilitate access to food sources. Sumarwan & Sukandar. Food security also includes aspects of food availability, employment and income. Some improvements that can be made in increasing the success of this system are by applying efficient biofloc technology including the use of superior seeds in Pandeglang Regency so that it can be utilized by the community as much as possible through mentoring programs so as to improve the level of productivity [6].

b. Household-scale food security:

Cultivation that has the prospect to be developed as an element of household scale food security in Pandeglang District is a fish farming system in a bucket or known as budikdamber. The status of fish farming in buckets with catfish as the main commodity is still in the trial stage. One of the locations on the spot is Pokdakan Suka Makmur in Sampang Bitung village, Jiyuh sub-district. The group has successfully harvested fish once with a maintenance period of 3 months and 3 times harvested kale.

Bucket fish farming is relatively easy to run for all levels of society. The main equipment that needs to be prepared is a source of water supply, considering that about 70% of the water volume must be replaced, equivalent to 56 liters per bucket/week. The estimated FCR from available information is 8000/(6000-250) = 1.39. The survival rate was estimated to be between ((6000/(10000:7))/50) x 100% = 84.0%. The measured uniformity rate of the fish from the 30 buckets harvested of which 15 buckets were reused is about 15/30 = 50%.

Looking at this technical information, there is still a need to increase understanding and improve the technology for fish farming in buckets in order to achieve the maximum FCR target of 1.1 and a survival rate of > 90% and uniformity above 80%.

Considering the price of pellets and the price of consumer fish prevailing at the time of harvest, the following information is obtained: Operating cost per one bucket = (50x440) + (8 x 11,000) = IDR 90,200. COGS per kg of fish is IDR 90,000/6 = IDR 15,033. Revenue per bucket is Rp 19,000 x 6 = Rp 114,000. Gross margin per bucket = Rp 114,000-90,200 = Rp 23,800 or Gross margin per kg of fish is Rp 19,000-Rp 15,033 = Rp 3,96 with BC ratio value < 1.26. Additional income is from the sale of kale amounting to 3 x14 x Rp.500 = Rp.21,000 so that the BC ratio becomes 1.49. Considering this information, it is necessary to increase efficiency so that catfish farming in buckets can also be used as a source of income,
in addition to a source of family protein.

Based on a quick field study of both technical and economic feasibility, catfish farming in buckets has more potential if used for household-scale protein supply purposes that contribute to food security, and as a support/addition to family economic resources. Some improvements that can be made in increasing the productivity of this system are:

- Distribution of superior seeds of Mutiara catfish needs to be done in Pandeglang Regency so that the community as much as possible can utilize it so that the uniformity of harvest size is more evenly distributed.
- The application of recirculation technology and the principle of "yumina bumina" is an alternative solution so that the problem of limited water supply can be minimized.

Based on the level of fish consumption per capita in Pandeglang Regency which reaches 28 kg/capita/year then for one household with 2 children requires a fish supply of 112 kg/year or 9.3 kg per month. If 50% of the fish consumption is sourced from bucket fish farming then things that can be done in the development of bucket fish farming to contribute to food security are:

- Massive planning of fish farming in buckets, especially for areas that are far from the supply of capture fish for each household as much as = (9.3/6 x 3) = 4.6 or 5-6 buckets, with a target harvest of 2 buckets every month. The need for seeds is 50x6 = 300 fish and feed is 6x8 kg = 48 kg. If 1 village with 100 households and 10% participation, the need for seeds and feed during the 3-month rearing period is 3000 seeds and 480 kg. This value is equivalent to Rp. 6,600,000.
- Planning for sustainable self-production with a BC ratio of 1.49, the capital required is 1.51 x Rp 6,600,000 = Rp 9,966,000 for one village.

Fig 1. Budikdamber

4 Conclusions

The catfish culture technology model can meet the needs of fish consumption levels of 1.6 kg/person/month or around 69.56% of the per capita fish consumption level in 2019. Red tilapia biofloc technology can be used as one of the options for food security activities at the
district level with an economic feasibility value equivalent to or exceeding the Regional Minimum Wage in Pandeglang District.

Thanks.

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References


