Management strategy for sustainable eel farming

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Abstract. The types of eel being farmed by the community are Anguilla bicolor and A. marmorata. A. bicolor eel farming has been developed in several areas in Java, such as Sukabumi, Cilacap, Kebumen and Banyuwangi Districts. The important issues of developing eel farming are high feed costs and water quality which is less favourable to the growth of eel. Therefore, it is necessary to have an economical but effective technology benefitting the eel farmers. The study was conducted through surveys in Cilacap from April - December 2018 and by using primary and secondary data. The respondents were selected using purposive sampling method. The method used was the combination of descriptive research and direct survey. The collected data were analyzed by applying an exponential comparison method. The results of the study showed that the eel feed combined with probiotics produced positive results favouring eel production. The subsidy program to provide probiotics and economical but effective eel feed should be proposed by the local Fisheries Agency in order to reduce the costs of eel production.

Keywords: farming, eel, policy, probiotics, strategy

1. Introduction
The farming of Anguilla bicolor eel has been sufficiently developed in Banyuwangi and Situbondo, East Java, especially in ponds with a total area of about 50 hectares. The farming business in the areas involves the local community with the guidance of a consultant from Japan. Products produced are exported in the form of processed kabayaki [1]. Another area that is still developing eel farming is Cilacap, Central Java. However, most of the farming is still conducted in tarpaulin ponds and concrete tanks. The life span of tarpaulin ponds is relatively short, but more economically feasible. Concrete tanks are quite long, but the construction cost is more expensive. Kaliwungu Village in Kedungreja District is an eel farming centre that has been rapidly developing. Production of farmed eels from Cilacap Regency in 2017 reached 15-20 tons [1]. Policy strategy is one of the important factors to be designed accurately, so that the intended targets can be optimally achieved. There is an urgency to develop eel farming due to unbalanced gap between supply and demand for eel. The existing stock could not meet the high demand in both domestic and international market. The gap between supply and demand for eel requires an accurate policy strategy to achieve the targeted stock of farmed eel. An important issue in eel farming is high feed costs and water quality that is less favourable to the growth
of eel. Therefore, it is necessary to have an economical but effective technology benefitting eel farmers. Eel farming business that has been developing in the community uses a variety of technologies, such as the use of a recirculation system in the tub or of aeration to add dissolved oxygen in the farming media.

Another factor influencing the development of eel farming is slow growth of eel, so it requires high protein intake in its feed [2]. This obviously resulted in high production cost, because protein sources require expensive basic ingredients. A study by Cheng et.al [3] showed that the protein requirement of Anguilla marmorata with the size of around 2.29 g is 50%. Efforts to deal with the feed costs are, among others, increasing the digestibility of eel through the use of probiotics. Probiotic bacteria are live microbial agents that can provide benefits for the host by modifying the microbial community or associating with the host, improving nutritional value and feed utilization, increasing the host's response to disease and improving environmental quality [4]. The provision of probiotics in feed affects the digestive tract. It greatly helps the process of absorption of feed nutrients. The work mechanism of probiotics bacteria is to produce enzymes that can break down complex compounds into simple ones, so that they are ready for use by fish. Enzymes contained in probiotics include amylase, protease, lipase and cellulase [5].

The study of eel farming is intended to obtain effective and efficient farming development strategies to produce competitive fishery products to help policy makers in making practical arrangement to increase eel production in their area.

2. Materials and Methods

The study was conducted through surveys in the Cilacap regency from April – December 2018. The study used primary and secondary data. The respondents were taken using purposive sampling method. This method was chosen so that the selected respondents can be right on target and the target data objectives can be met for 30 person. The method used was the combination of descriptive research and direct survey. The collected data were analyzed applying an exponential comparison method which involved several stages. The steps taken are arranged according to the alternative decisions to be chosen, which include determining criteria, determining the importance of each criterion, scoring each criterion, calculating scores and then determining the priority order. The formulation of the score calculation for each alternative in the exponential comparison method was as follows [6]:

\[
\text{Total score (TNi)} = \sum_{j=1}^{m} (RK_{ij})^{TKK_j}
\]

Details :
\begin{align*}
\text{TNi} & = \text{total score of alternative } i \\
\text{RK}_{ij} & = \text{relative importance degree of the criterion } j \text{ in selected decision } i \\
\text{TKK}_j & = \text{importance degree of the criteria of decision } j; \text{TKK}_j > 0 \\
\text{m} & = \text{total criteria of decision}
\end{align*}

The level of importance of the criteria was determined by interviews with experts and eel farming practitioners in Cilacap Regency, as well as by brainstorming agreement with local policy makers of 10 person. An alternative score for each criterion was made by giving a score based on the score of the criterion [6].

A qualitative descriptive supply chain analysis was conducted to deal with the supply of eel in Cilacap Regency. The analysis was carried out to identify the merchandiser involved directly in the eel supply chain [7;8].

3. Results and Discussion

The scoring was carried out on three alternative feed in eel farming (fish feed plus probiotics, eel feed plus probiotics, and eel feed without probiotics as a control) which were obtained from interviews with experts and references from various sources. There are six considered criteria, namely farming
technique, operational costs per cycle, market prospect, farmer competency, impact on the environment, and export policy. Type of feed potential to be used is the type of feed that has a high score for each criterion. The alternative scoring of each criterion uses a scale of 1 - 9, as listed in (Table 1). Determination of alternative score on certain criteria was done by giving each alternative a value based on criterion value. The greater the alternative value, thus the greater the value of the criteria. The smallest alternative value starts from 1 to 9 for high value. Total score of each alternative decision will be relatively different because of the exponential function.

### Table 1. Scoring of potential feed alternative for eel farming based on alternative value.

| Criteria                  | Quantity | Commodity | alternative score |
|---------------------------|----------|-----------|-------------------|
|                           |          | Fish feed plus probiotic | Eel feed plus probiotic | Controlled feed |
| Farming technique         | 3        | 4         | 4                 | 3                |
| Operational costs per cycle | 5      | 5         | 3                 | 4                |
| Market prospect           | 5        | 4         | 5                 | 3                |
| Farmer competence         | 4        | 3         | 3                 | 2                |
| Impact on the environment | 3        | 2         | 2                 | 3                |
| Export policy             | 5        | 4         | 5                 | 2                |

The results of the scoring of all the predetermined criteria can be seen in (Table 2).

### Table 2. Results of scoring of potential feed alternative for eel farming.

| Criteria                  | Commodity | alternative score |
|---------------------------|-----------|-------------------|
|                           |           | Fish feed plus probiotics | Eel feed plus probiotics | Controlled feed |
| Farming technique         | 64        | 64                 | 27                |
| Operational costs per cycle | 3125   | 243                | 1024              |
| Market prospect           | 1024      | 3125               | 243               |
| Farmer competence         | 81        | 81                 | 16                |
| Impact on the environment | 8         | 8                  | 27                |
| Export policy             | 1024      | 3125               | 32                |
| Total number              | 5326      | 6646               | 1369              |

After estimating using exponential comparison method technique, the priority of the type of feed to be used in eel farming was determined as illustrated in (table 3).

### Table 3. Results of calculation with exponential comparison method in feed alternative for eel farming.

| Priority    | Selected alternative | Score estimate |
|-------------|----------------------|----------------|
| Feed type 1 | Eel feed plus probiotic | 6646          |
| Feed type 2 | Fish feed plus probiotic | 5326          |
| Feed type 3 | Controlled feed        | 1369          |

The type of potential feed for developing eel farming is a combination of eel feed plus probiotics showed in (table 3). Fish feed plus probiotics is the second priority and eel feed without probiotics is the third alternative. The results obtained in this study were in line with [9] where the use of probiotics
in feed provides positive results in favouring eel growth, due to important roles of probiotics in controlling pests and diseases that can attack fish [10]. The work mechanism of probiotics is their ability to influence the food absorption process. Probiotics bacteria produce enzymes that can break down complex compounds into simpler compounds, making it easier for fish to absorb nutrients in feed [11,12].

The eel supply chains in Cilacap Regency has not yet fulfilled the market demand. The current eel supply chains pattern can be seen in the following scheme (figure 1).

The results of the study showed that the most effective eel supply chain is the first channel (local consumer) because the farmer gains a high enough profit. However, this channel is inefficient because of the limited number of consumers. The supply chain to the exporter is quite large in production volume, but due to limited production of eel at the level of farmer, the channel was not effective.

Government policy from the local government in Cilacap Regency has declared that eel is a superior fish species that has priority to be farmed [12]. In recent years, eel farming business in Cilacap Regency has well-developed and spread in several districts. The scale of the business varies, including large-scale and household scale. The eel farming center is located in Kaliwungu Village in Kedungreja District. Production of farmed eel from Cilacap Regency in 2017 reached 15-20 tons [13].

The national policy related to the utilization of eel resources is under the jurisdiction of Minister of Maritime Affairs and Fisheries (Ministerial Regulation) No. 19 of 2012. The Ministerial Regulations regulates the ban on the export of eel seed size of less than 150 grams. At regional level, registration and obligation to restock the eel brood stock for business people were regulated as mentioned in the Circular Letter of Sukabumi Regent and the Regulations of Sukabumi Regent No. 25 of 2018.

Technical support from national research institute need to be further improved to facilitate eel farmers. Productivity of aquaculture business is more optimal by effectively technic of eel farming. Technical assistance by fisheries instructors on a regular basis needs to be more intensive, especially in the use of safety, economical and efficient probiotics.

The cooperation program between the IFISH-FAO Project and the Directorate General of Marine Space Management is expected to increase improvements in the status of protection for eel, especially Anguilla bicolor type and to support the lives of fishermen on the coastal areas [14].

Several efforts to increase eel production have been carried out through improved feed [15,16], improved farming [17], seed maintenance [18], and Wolffia arrhiza in feed [19].

4. Conclusions
This study showed that the use of eel feed combined with probiotics gave positive results in supporting the eel productivity. The economical but effective subsidy program that provide probiotics and eel feed should be proposed by the local Fisheries Agency, which is the centre of eel farming, in order to
reduce the costs of eel production. However, policies at the national level require structured and systematic synergy among the central government, regional government, business people and non-governmental organizations such as WWF-Indonesia in the management of eel farming.

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