Analysis of Production Factors of Small-Scale Fisheries using Arad Nets in Tegal City, Indonesia

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Abstract

Production factors are an important issue in fishing operations. The success of a fishing operation is determined by the role of each production factor. This study aims to examine the factors that influence the production of small-scale fisheries using Arad nets in Tegal. This research carried out in the Muarareja Village, a small-scale fishing village in Tegal. The study was conducted between July 2013 and March 2014. The production factors analyzed were the size of fishing gear, the fishing season, the availability of fuel, ice blocks, fresh water, crew, and cost supplies using Arad nets. Data were analyzed using the multiple regression analysis. The results showed there were a very strong relationship between the production factors with a R^2 value of 82.30% and a probability significance value of <0.05. Factors that influence the production of fishing operations using Arad nets are the fishing season, the use of fuel, the use of ice, and cost supplies.

Keywords: small-scale fishermen, production factors, small-scale fisheries, Arad nets, Tegal

1. Introduction

Fishing operations carried out by fishermen, especially by small-scale fishermen, are particularly vulnerable to the influence of many factors. Salas and Charles (2007) stated that fishing practices are related not only to biological, technological, environmental factors but also to behavioral practices of the fishers. Thus, human element is an important component in addition to components of fish resources and fisheries management in the system. Salas & Gaertner (2004) stated fishing activities undertaken by small-scale fishermen are characterized by various limitations including the limitations of time, types of vessels, fishing gear used by fishermen, and individual performance. Individual performance will determine trends in distribution of the catch among those fishermen who share the same resources.

Given the variability in fisheries, fishermen will undertake various activities by optimizing of their knowledge and ability on seasonal changes in resources and the environment. Combination of knowledge about seasonal changes and environmental resources as well as an adaptive response that belongs to the small-scale fishermen make them very flexible in terms of fishing operations where the ultimate goal is to get the catch as the source of their income (Salas and Charles 2007). In other words, as stated by Salas and Gaertner (2004), fishermen will give a response in accordance with the changes going on around them, and will adapt to adjust for these changes as much as they can do. A wide variety of skills such as operating fishing gear, vessel operations, knowledge of the fishing location (Forman 1967 as cited by Salas and Charles 2007), knowledge of environmental conditions (the weather, sea currents), operating fishing equipment are needed in their daily work as a fisherman, as it would relate to production of their catchment. The fishermen also respond by making alterations to production factors by adding, enlarging, reducing, or replacing the production factors and thus improving the success of fishing activities.

Factors of production are crucial issues in fishing operations. Preparation of the factors of production is very important to do by fishermen related to the type of fishing activity and socio-economic conditions of fishermen. Factors that influence the production factors are the preparation of diesel fuel and material supplies (Purba 2008), revenues and operating expenses (Prabowo 2012). For small-scale fishermen, coastal fishing activities cannot also be separated from the provision of production factors such as fuel oil, ice blocks, fresh water, fishing gear equipment, and supplies. The issue of price hike of fuel oil and the lifting of fuel subsidies is much hit small-scale fishermen. Fuel oil is indispensable for the operation of fishing activities. If fuel scarce and expensive, the fishermen not to fish, and this means that the fishermen do not have the income from the sale of fish.

Coastal fisheries activities generally require relatively small operating costs than offshore fishing activities. However, most of the small fishermen in general have limited economically, especially in terms of capital. They still rely on capital obtained from previous catches. Socio-economic conditions of small-scale fishermen will also affect the fulfillment of production factors. Income derived from the sale of fish typically used to meet the basic needs of their everyday lives (food, clothing, housing), but it is also used to meet the

operational costs allocated to fishing activities (Sudarmo *et al.*, 2015, in press).

The small-scale fisheries have existed for a long time in coastal waters of Tegal City. In its development, fishing activities, especially fishing for demersal fish, the operation of Arad nets in Tegal and Pekalongan have shown symptoms of overfishing (Suseno 2004). This is because the number of fishermen who use fishing gear is relatively dominant and the there is a high level of fishing efforts. Fauzi and Anna (2010) in their study stated that fish production has decreased since the late 1980s in the northern coastal areas of Java because of the very strong pressure in terms of fishing and other reasons, such as environmental degradation and changes in the environment. Stagnant water in coastal areas are now more common and mangrove forests are significantly reduced in this area. All these factors have contributed to the decline in fish production and the economic uncertainty in the fishermen's households.

The supply of production factors related to the income possibly earned by fishermen tends to be negative when fishing activities around the coast are dense, the aquatic environment is of poor quality, and fish resources that can be captured are limited. The coastal waters of Tegal have limited fishing grounds and its location is close to the port area of Tegal which will at least affect the small-scale fishermen's supply of production factors. This study aims to identify the production factors that influence the activities of small-scale fisheries using Arad nets in Tegal.

2. Methodology

The study was conducted in the village Muarareja, a typical fishing village located on the seashore of the town of Tegal, Central Java, Indonesia. The respondents in this research was selected purposively. The sample criteria in this study is the small-scale fishermen who operate the gear around the territorial waters of Tegal or close to shoreline, have one day fishing trips, boat size less than 5 GT. The number of samples is 45 fishermen using Arad nets. Data are collected directly by survey and field observation. Each respondent was asked to answer the questions with open answers. The questions related to variables such as the amount of fish catch per trip, the size of fishing gear, fishing season, fulfillment of fuel, availability of ice blocks, the availability of fresh water, number of crew, and fulfillment the supplies.

Types of data collected are Y (the catch), X1 (the size of fishing gear), X2 (fishing season), X3 (fulfillment fuel), X4 (availability of ice blocks), X5 (the availability of fresh water), X6 (number of crews), and X7 (fulfillment the supplies).

Secondary data were obtained from the relevant agencies including the Department of Agriculture and Marine Tegal, Muarareja village office, and the office of Muarareja fish market. Data were analyzed using multiple regression analysis. Data first tested with the assumption prior to data analysis is to test for normality, heteroscedasticity test, autocorrelation test. The accuracy of the model was analyzed using ANOVA models with linearity test, measurement analysis of the coefficient of determination (R^2), and the significance of each variable.

In general, factors that support the development of nets Arad operating performance, especially the factors of production by using Arad nets can be done by modifying the size of the fishing gear, the fishing season, the availability of fuel, ice blocks, fresh water, crew, and the supplies. Factors that support can be formulated by

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7$$

Remarks:
Y = catch / fish production Arad (kg)
a = constant
X1 = the size of the fishing gear
X2 = fishing season
X3 = the availability of fuel oil
X4 = the availability of ice blocks
X5 = availability of freshwaters
X6 = availability of crew
X7 = the supplies
Variable X which has a value of significance probability <0.05, means it has a real effect or significant in affecting the supporting factors that influence the performance of fisheries using Arad nets in Tegal.

3. Results and Discussion
3.1 Profile of respondents
Profiles of the respondents in this study were 45 small-scale fishermen who were all male. The average age of respondents was 47.64 years, with a standard deviation of 1.23, with a lifespan of 28 years is the youngest and

the oldest was 65 years old. These data also indicate that the age of fishermen in this study, the age of about 40s was a productive working age. The productive age is in the age range between 40-49 years as many as 19 people (42.22%) of fishermen. This situation is similar to the average age of fishermen on research conducted by Sinh and Long (2011) in the range 42-43 years and the research conducted by Cinner and Pollnac (2004) that the average age was 45 years.

Respondents' in this study have been working in the fisheries sector average of nearly 24 years (Table 1). This situation illustrates that the fishermen are almost half of his life was working the fisheries sector and they start at a young age. The results are consistent with research that has been done by Yuerlita and Perret (2010) which shows that the fishermen on the lake Singkarak has done the work to catch fish on average almost 25 years with a lifespan of 41-50 years.

Table 1. Profile socioeconomic fishermen who use Arad netss in the Muarareja village, Tegal

Average years of work as a fisherman (standard deviation)	24.34	2.24
The average number of family members (standard deviation)	4.56	0.42

The average number of family members of fishermen is 4.56 people. This situation is similar to the Central Bureau of Statistics Tegal (BPS Kota Tegal, 2013) indicated the average number of family members in the Muarareja village is 4.26 people per household (HH). The level of education of all respondents (45 fishermen) is the primary school. This indicates that the level of education that can be achieved by fishermen still low. Like most fishing circumstances portraits in various places, most of the fishermen in this study had only a primary school education as much as 100%. This situation is a portrait of the level of education that exist among fishermen in general (Pana & Sia Su 2012, Yuerlita & Perret 2010). Education for the majority of Indonesian people who live far from the capital of the province or district / city or central government are generally excluded from the reach of government intervention. There is an assumption in most Indonesian people, that education is something that is considered to be expensive expenses. UNDP (2013) put Indonesia in ranked 121 of 186 countries in the world in the Human Development Index (HDI). This index shows the access to education in Indonesia is still far from expectations. Indonesia is in the category of Medium Human Development group with rank 121.

Muarareja village is directly adjacent to the coast, so most of the people who live there are vast majority working in the fisheries sector. The number of people working as a fisherman is relatively large compared to most other workers. The proportion of the main labor force in the villages Muarareja based on BPS Kota Tegal (2013) can be seen in Table 2.

Table 2. The proportion of the main employment in the Muarareja village in 2012 (BPS Kota Tegal, 2013)

Types of jobs	Total	Percentage
Farmers	315	9.9
Farm workers	42	1.32
Fishermen	1975	62.07
Businessman	67	2.11
Industrial workers	68	2.14
Construction workers	72	2.26
Merchant	404	12.7
Transporters	30	0.94
Civil Servants / Armed Forces	70	2.2
Retired	11	0.35
Others	128	4.02
	3182	100.00

3.2 Condition of fish resources and fishing characteristics
The potential of fish resources at the sites generally come from the waters of the Java Sea. The development of marine fish production in the town of Tegal from 2008 to 2012 fluctuated, but tended to increase (Table 3). Value of marine fish production from 2008 up to 2012 experienced a significant upward trend. This indicates that the type of fish caught has a high economic value in addition to the selling price of the fish continues to increase.

Table 3. The growth of production and the value of marine fish production in Tegal from the year2008-2012
(BPS Kota Tegal 2013)

	2008	2009	2010	2011	2012
Marine fish production(kg)	19.539.491	25.285.303	20.323.865	29.516.013	27.178.122
The values of marine fish production (in thousand Rupiah)	124.899.612	147.611.365	135.616.286	198.911.948	206.770.092

Types of fish that can be caught with Arad nets are demersal fish species such as shrimp or squid. In general, demersal fish life is in an environment such as mud, sand or rocks. Demersal fish species found in the waters Tegal include shrimp and squid (Loligo pealei). Arad net type is appropriate with the basic conditions of the waters of North Java Sea is sandy and muddy. Suseno (2004) in his research stating that the Arad nets is the dominant gear, and is common to catch demersal fish in waters north coast of the Java island. Suseno (2004) states the condition of the actual production of fish resources in the waters of Tegal likely to lead to overfishing. This situation is due to the competition between fishing gears that operate there. Imron (2008) also states the type of fishing gear Arad is a modification of the type of trawl gear. Arad fishing gear most widely operated by fishermen in the waters around Tegal is because the gear is most effective and economical way to catch shrimp and various fish species. In terms of selectivity, the gear is low selectivity due to the diversity of the catch in terms of both size and number so that the operation of this gear makes the demersal fish resources is reduced.

3.3 Analysis of Production Factors

Production factors which support the development of coastal fisheries using Arad nets can be done partly by modifying the size of the fishing gear, carry out fishing activities that depend on the fishing season, the availability of fuel, ice blocks, water, crew, and supplies. Factors of production used by small-scale fishermen in Tegal such as fishing gear size (X1), fishing seasons (X2), the availability of fuel (X3), ice block (X4), freshwater (X5), number crew (X6), and supplies (X7) overall has a very strong correlation shown by R of 0.907 in the performance of fish production using Arad nets in Tegal (Table 4).

Table 4. Results of multiple regression analysis in the form of Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.907[a]	.823	.790	55.7686

a. Predictors: (Constant), Supplies (X7)_Rp/trip, Fishing Gear Size (X1)_m, Fuel (X3)_liter/trip, Fresh Water (X5)_liter/trip, Crew (X6)_person/trip, Fishing season (X2)_month, Ice (X4)_blocks/trip

From Table 4 it can be seen the value of R^2 , or in other words, the relationship model has a coefficient of determination (R^2) of 0.823. This shows that the influence of the factors of production all together such as the size of fishing gear (X1), fishing seasons (X2), the availability of fuel (X3), ice block (X4), freshwater (X5), crew (X6), and supplies (X7) can be explained by 82.3% the ups and downs the production of fish with Arad nets around the coastal city of Tegal, while the rest is influenced by other factors not examined in this research. Referring to the ANOVA analysis, the results of multiple regression analysis on the effect of fish with Arad nets production with production factors such as the size of the fishing gear (X1, fishing season (X2), the availability of fuel (X3), ice block (X4), freshwater (X5), crew (X6), and supplies (X7) can be trusted, because it has a significance value (Sig.) probability <0.05, namely 0.000.

The model of the relationship between production factors such as the size of the fishing gear (X1), fishing seasons (X2), the use of fuel (X3), ice (X4), freshwater (X5), crew (X6), and supplies (X7) to the development of coastal fisheries, represented by the amount of production of fish with Arad nets (Y) can be formulated in the following equation:

$$Y = 136.425 - 0.175 X_1 - 12.436 X_2 + 0.577 X_3 + 10.791 X_4 - 0.174 X_5 - 5.114 X_6 - 0.00003989 X_7$$

This model can be trusted because the results of ANOVA analysis showed significance probability value <0.05, namely 0.000. And the model can explain the very strong relationship between the factors of production in relation to the development of coastal fisheries in Tegal with its R Square value (R^2) of 82.3%.

Referring to the value of the significance of each factor of production to the production of fish using Arad nets in Tegal, then only the fishing season (X2), the use of fuel (X3), ice (X4), and supplies (X7) significantly affected the development of small-scale coastal fisheries in Tegal as indicated by the significant value <0.005. Significance values for each of the factors of production such as the fishing season (X2), the use of fuel (X3), the availability of ice (X4), and supplies (X7) are respectively 0.003, 0.023, 0.005, and 0.005, where each the value of significant value <0.05. While other production factors such as the size of the fishing gear (X1), the use of fresh water (X5), and the crew (X6) did not significantly affect the development of small-scale fisheries. From the above results it can be shown that only the fishing season (X2), the use of fuel (X3), ice (X4),

and supplies (X7) which may affect the performance of fishing operations using Arad nets. Three other production factors do not affect the production of fish using Arad nets.

In this research showed that for small-scale fishermen, seasonal factors greatly affect their fishing activities. This was due to the small-scale fishing boats, in general, made of wooden materials and had a small size (less than 5 GT). In addition, the availability of fuel must be provided to run their motor boat. The relationship between seasonal factors, the availability of fuel oil, provision of ice blocks, operational costs for fishing will affect the number of catches. With the size of their boat under 5 GT, the fishing location also could not be much farther between 4 miles up to 12 miles. If the weather is good they can sail a bit far from the the coast. Factors such as the availbility of fuel, ice blocks, and supplies are required even their fishing grounds still close to the shoreline.

Fishermen fishing in the waters of Tegal have been going on ever since of their ancestors from generation to generation and their familiarity with the area of their fishing operations so that they already know all too well the presence of estimating a set of schools of fish and shrimp. Fishermen also use natural signs to determine the existence of a set of fish and shrimp as the wind direction, the level of water turbidity (cloudiness of water), water depth and current direction of seawater. Efforts to catch distribution are also determined by the size of the vessels used, besides control of fishing areas. Vessels used by fishermen is wooden boats sized under 5 GT, so the coverage fish and shrimp fishing areas are in the vicinity of the coast with a depth of less than 5 meters.

Ecological issues, social, and economic currently being faced by small-scale fishermen in sustain their livelihoods. On the other hand, the livelihoods of fishermen catching fish in the sea provide direct income for fishermen and their families, besides an important economic resource for the community in the coastal region. Small-scale fisheries contribute to employ more than 90 percent of the world's capture fishermen, and their presence is important for food security, nutrition, poverty alleviation, sustainable livelihoods and security in poverty prevention (Gardiner *et al.* 2004, FAO 2012).

The existence of small-scale fishermen in terms of both number and activity that is dominated almost fisheries activities in Indonesia. This situation is quite reasonable considering the approximately 95% of fishermen in Indonesia is the traditional small-scale fishermen who operate gear with fishing ground not far from the beach (Murdiyanto 2011). Pollnac (1988) in Satria *et al.* (2002) and Satria (2009) states that the characteristics of small-scale fishermen are having a limited area of fishing operations, close to the beach, and labor intensive. Nababan *et al.* (2008) cites Herwaman (2006) states that the existence of fisheries in Indonesia is still dominated by small-scale fishery business is about 85%, and only about 15% done by large-scale fishing effort.

Jones *et al.* (2010) cited the source of FAO (2005) states that the introduction of trawler boats around 1960s led to the fishing industry is growing rapidly and this has negative effects with symptoms of overfishing. Excessive depletion and reduction potential of fisheries resources is a real threat to many coastal communities that rely on small-scale fisheries. Fishing activities carried out by fishermen with Arad fishing gear in Tegal also showed symptoms of overfishing (Suseno 2004, Imron 2008). This is because the number of fishermen who use gear relatively significant and a high level of fishing effort. Fishery management should be implemented with adequate controls in achieving sustainable fisheries management.

5. Conclusion

Factors of production used by small-scale fishermen in Tegal such as the size of fishing gear, fishing season, the availability of fuel, ice cubes, fresh water, crew, and supplies as a whole has a very strong correlation in fisheries nets arad in Tegal. Of the seven factors of production are studied, four (4) factors of production such as the fishing season, the use of fuel, availability of ice, and supplies which significantly affect the development of fishing operations using nets arad in Tegal. While other production factors such as the size of the fishing gear, the use of fresh water, and the crew did not significantly affect the development of nets arad in Tegal.

Suggested future works include regulating the use of the location of fishing ground is needed in the coastal town of Tegal, in order to avoid congestion fishing operations. Due to the location of fishing grounds are not too extensive. Small-scale fishermen as the main actors in fishing activities also need to obtain the information or education of the local Marine Department of the production factors that influence the amount of output of the fish catch. These factors directly affect the revenue to be gained by fishermen from catching fish in the sea.

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