"How do fisheries technologies affect production?"
(Case study: North Gorontalo Regency)

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Abstract. Prohibition of several fishing gears has been started since 2015 by issuing MMAF Ministry regulation no. 2 of 2015. The regulation prohibits several fishing gears; one of them is seine nets. MMAF Ministry regulation no. 71 of 2016 details the size of seine nets, including Purse Seine, which are not allowed. Fishers still believe that fishing using the purse seine with a large fleet gives more production than the hand line fishing gear with a small fleet. The purpose of this study is to see whether the hand line fishing gear has smaller production or productivity per GT than others. The data used for this study were obtained from the Letters of Evidence Report for Fishing Ship Arrival (STBLK) and from National Fishing Ports (PPN) Kwandang in the North Gorontalo Regency from March to November 2018 to be analyzed.

The results show that hand line fishing gear with small fleet gets average productivity for about 9.195 Kg/GT/year compared to large vessels with purse seine fishing gear, which gets average productivity for about 1.985 Kg/GT/year.

1. Introduction

Technology related to marine and fisheries consists of hard technology and soft technology to make the capture optimum [1–3]. Technologies in the marine and fisheries sector include ship technology, fishing gear, remote sensing, radar, monitoring, communication, fish detection, aquaculture, and salt production technology. This paper emphasizes fishing technology, especially the size of the boat and its fishing gear. Boat size technology is used to carry fisher, to fish gear and equipment as well as to carry fish with a storage system. Fishing gear technology is a technology used to catch fish efficiently and effectively [4]. The size of the boat and fishing gear is the primary technology as a reference for fishers to catch fish. However, this capture technology, if it is not appropriately used and wisely, will deplete the natural resources [5–10].

Prohibition of several fishing gears has started since 2015 by issuing Ministry for Marine Affairs and Fisheries (MMAF) Ministry regulation no. 2 of 2015 [11]. The regulation prohibits several fishing gears; one of them is seine nets. MMAF Ministry regulation no. 71 of 2016 details the size of seine nets, including Purse Seine, which are not allowed [12]. It is prohibited because the fishers capture any kind and any size of fish that will deplete fishing resources. It takes longer to recover fishing resources, compared to the time frame when they harvest it (literature). Purse seine has become favorable to the fishermen because they can get the highest production results compared to the other fishing technology at the moment [9,10,13]. Even though it is prohibited, purse seine still can be used in some areas if it meets the regulation, like using certain mesh sizes and operated at certain capture...
pathways. Thus, fishers still believe that fishing using purse seine with a large fleet can get more benefits than using hand line fishing gear with a small fleet.

On the other hand, hand line fishing gear only captures certain fish according to the net and hook use. In some places, using hand line fishing gear will take more effort and time to capture fish than using purse seine fishing gear. In PPN Kwandang, North Gorontalo Regency, hand line fishing gear only requires small vessels (under 10 GT or smaller) that sail for only one day with an average number of eight fishers. In comparison, purse seine fishing gear usually uses bigger vessels with a minimum of 10 GT with an average number of 13 fishers on board that can sail for more than seven days. Thus, if the fishermen are production-oriented, they will use fishing gear that is not environment-friendly, like purse seine fishing gear.

In choosing fishing gear, fishers usually consider profit to continue their business. Because of the lack of data in operational cost and fishing price, this research only analyze the production, average capture effort per fishing vessel, and productivity of a vessel. Thus, the purpose of this study is to determine whether the purse seine fishing gear is more productive than the hand line fishing gear. This study evaluated how the choice of fishing gear technology could affect production. This study analyzed other aspects that determine fishers to use hand line instead of purse seine. Those aspects are the production, average capture effort per fishing vessel, the productivity of a vessel, and also the reason why fishers choose the biggest number of vessels operated, which is determined by a lower impact on the environment and sustainable fishery.

2. Methods
North Gorontalo is a province that was established on January 2, 2007, based on law No. 11 of 2007. North Gorontalo is located in the lowlands with an average altitude of 55.5 meters above sea level [14]. It is located at 1 007'55 "North Latitude and 00041'23" North Latitude, and 121058'59 ", 123016'29" East Longitude. The area of North Gorontalo is for about 1,777,022 km². By the end of 2017, the North Gorilla Regency administrative area consisted of 11 sub-districts. The agriculture, forestry, and fisheries sectors have contributed 50.7% of regional income [14]. The ports are located in Gentuma Raya and Kwandang Districts. Based on BPS data in 2016, the total number of fishers in Gentuma Raya sub-district was 218. Whereas, based on BPS data in 2016, the total number of fishers in Kwandang sub-district was 314 people [14].

There are two National Fishing Ports (PPN) in North Gorontalo Regency: PPN Gentuma and PPN Kwandang. In 2018, the majority of vessels that anchored in PPN Gentuma used the purse seine fishing gear, while only one vessel used hand line fishing gear. While the most significant proportion in PPN Gentuma was purse seine and only one vessel with size <10 GT used hand line fishing gear. In contrast, there were several vessels either using hand line fishing gear (around 47 vessels) or purse seine fishing gear (around seven vessels) in the PPN Kwandang in 2018, in which it can be data to support this study.

The capture fleet in PPN Kwandang consists of hand line <10 GT, hand line 10-30 GT, purse seine 10-30 GT, purse seine > 30GT, and spears 5GT. Vessels under 10 GT are fishing fleets, one-day fishing fleets, ships from 10-30 GT that are weekly fishing fleets, and ships over 30 GT that are weekly to several week fishing fleets. Also, ships with a size of 10 GT should process their licensing at the district service. 10-30 GT should process their licensing at the province service, and over 30 GT should process their licensing at MMAF Jakarta. The difference between local and central requirements is the existence of a fishing logbook. Besides, the time for the process depends on the completeness of the initial supporting documents. Many ships operating in the North Gorontalo Regency are administered in regencies and provinces, so they do not require a long time for license processing.

The data used in this paper were the production data starting from March to November 2018 from Letters of Evidence Report for Fishing Ship Arrival (STBLK) in PPN Kwandang, North Gorontalo Regency [15]. The production data obtained are fact-based real reports inputted by the port officer according to the real production. The data used were total production in tons per GT of a vessel, average capture effort per fishing vessel, and vessel productivity to analyze whether the purse seine fishing gear have bigger productivity or the hand line fishing gear. Besides, the number of vessels
entering or leaving the port was collected by ship register identification and fishing gear group. Literature studies were conducted to find out the lower impact on the environment and sustainable fishery. Simple statistic comparison was used to analyze the data [16–18]. Productivity was analyzed by dividing the production by the ship size of GT (Kg/GT obtained). The assumptions used are ships with larger size cost more than the small size ships, and vessels with purse seine as fishing tools have more operation costs than hand line fishing gear.

3. Results and discussion

3.1. Fishing production at PPN Kwandang 2018
There is an exciting phenomenon where capture instruments such as a hand line fishing gear with small vessels can produce more fish than purse seine fishing gear with a larger vessel (Figure 1). In February 2018, the production of purse seine fishing gear was higher than the production of hand line fishing gear. The trend shows that vessels with <10GT engines have several production peak points, namely in May and September (Figure 1). Although the excellent production time starts from March to November, there have been several production fluctuations. However, it seems that ships with <10 GT engine using hand line fishing gear can produce for one full year without experiencing famine. Ships using hand line fishing gear with larger size (10-30GT) meet their peak time from July to November. Ships with these specifications can still make catches throughout the year. Ships with a size of 10-30GT, which have purse seine fishing gear, can also make catches throughout the year. However, most catches are in February, October, and November. Ships with more than 30GT with purse seine fishing gear can only produce from July to December.

![Fish Production (Kg) Based on Capture Instrument in 2018](image_url)

**Figure 1.** Fish production (kg) based on capture instrument at PPN Kwandang in 2018 [15].

It is assumed that in 2018, there is a policy change in MMAF where the capture instrument was not friendly to the environment. Fishers still believe that fishing using purse seine with a large fleet is more profitable than hand line fishing gear with a small fleet [15].

The catch history shows that the production of vessels <10GT with hand line fishing gear is higher than the production of vessels 10-30GT, either with purse seine fishing gear or with hand line fishing gear. Also, Vessels <10GT with hand line fishing gear are more profitable than ships 10-30GT with any fishing gear. The operational costs of smaller ships should be cheaper than larger ships. Thus, the benefits gained should also be higher. However, it is too early to draw conclusion that the number of 10-30GT ships in port were less than the ships <10GT or vice versa. It is necessary to look at the number of ships recorded to find out and compare the ship production of <10GT and 10-30GT vessels.
3.2. Average capture effort of fishing vessel per month at PPN Kwandang 2018

Total production cannot be used as a benchmark to compare which technology is the best because the number of fleets for each capture gear is not at the same number. Another way to compare is by using average productivity per month (Figure 2). Afterward, the effort to capture the <10 GT vessel using hand line fishing gear and the 10-30 GT vessel using hand line fishing gear is higher than the ship using purse seine monthly data [15]. The data on average capture effort (Kg/GT/month) in PPN Kwandang shows that the highest vessel productivity is in January. There are only five vessels with average productivity of 1,570 Kg/GT. The average productivity for this group is 736 Kg/GT. Productivity above the average is recorded around May, October, and November. November was the highest productivity month in 2018; on the other hand, the production plummeted because there were 13 ships with below-average productivity.

Based on this monthly productivity, the productivity of purse seine fishing gear with a 10-30GT fleet is below hand line fishing gear with <10GT fleet. The productivity of this hand line fishing gear with <10GT fleet is more than double that of the purse seine fishing gear with a 10-30GT fleet. In December, it could reach 21 times compared to the productivity for purse seine fishing gear with a 10-30GT fleet. However, the data show that not every vessel was recorded every month, especially vessel using purse seine fishing gear. Thus, the average total productivity for each fishing vessel in PPN Kwandang has to be compared on an annual basis.

![Figure 2. Average capture effort (Kg/GT) per month in PPN Kwandang in 2018 [15].](image)

3.3. Total productivity of fishing vessel in PPN Kwandang in 2018

Total productivity for one year shows that the productivity of <10GT vessels with hand line fishing gear is much higher than 10-30 GT vessels, either using hand line fishing gear or purse seine fishing gear (Figure 3). The <10GT Vessels can reach more than three times the production of 10-30 GT vessels. The smallest productivity occurred on the > 30GT vessel using purse seine fishing gear and fishers using Spear as fishing tool. This production becomes bigger because the vessel of <10 GT with hand line fishing gear uses the smaller boat. When the fishing season comes, they can return to their fishing place several times so that they can produce more. Thus, it has become more efficient in production. However, if they are out of the fishing season, they produce less.
3.4. Number of fishing vessel at PPN Kwandang 2018
The fishing spot around PPN Kwandang makes hand line fishing gear more favorable than purse seine fishing gear. It can be seen that the highest number of ships are in the size of <10GT with hand line fishing gear, and the second-highest number of ships are in the size of 10-30GT with purse seine fishing gear (Figure 4). If we look at the number of ships in and out of PP Kwandang in 2018, April to October is the highest frequency of fishing vessels <10 Gt operated with hand line fishing gear. It is consistent with the number of catches that increased in those months. The 10-30GT hand line fishing gear increased from August to December. Production also increased in July. The production did not change much though more catching occurred in August and fell in October. This decreasing trend happened because it already exceeded the number of vessels needed.

The number of 10-30GT ships with purse seine fishing gear is relatively stable between 4-5 ships per month. The catches’ peak occurred in February, October, and November. The number of ships reduction at certain times depends on the time the ships moored because they need to repair fishing gear, engines, or preparations to go to the sea later. The overlay shows that the production is higher, the number of ships will increase for the next following two months. If they do not get optimal results, then the number of vessels will decrease again. It indicates that the owners are trying to reduce their expenses by looking at productivity before pushing the productions.

3.5. Environmental friendly fishing vessel in PPN Kwandang in 2018
The main reason fishers return to their fishing place several times is that they can produce more. If we compare the same size ships with different fishing gear, the productions with hand line fishing gear
also turn out to be higher than with purse seine. In February, July, August, until October, there was a higher productivity with purse seine fishing gear than with hand line fishing gear. The other hand line fishing gear is higher than purse seine fishing gear. The more environmentally friendly the fishing gear, the more fish the fishers catch. Thus, hand line fishing gear is a fishing instrument that is friendly to the environment and has considerable fishing productivity.

The assumptions used are that with larger size ships will cost more than the small size ships. While vessels with purse seine fishing gear as fishing tools has more operation costs than hand line fishing gear. On the contrary, Comparing the productivity of <10GT and 10-30GT ships can avoid misleading because each ship size with its fishing gear will have different characteristics. Thus, we have to know the fish price because each fish may have a different price. On the contrary, the weakness of this hand line fishing gear is that it needs good bait. The bait can be fresh fish or artificial fish. Both of them require extra costs. In some cases, a vessel using hand line fishing gear also brings net to capture its fishing bait. By using this technique, the production costs can be cheaper. Thus, the ship can use two fishing gears that are more environmentally friendly. The main catch is to catch using a hand line fishing gear. The size of the fish caught will follow the size of the bait because it is more environmentally friendly. The second reason is that the purse seine fishing gears are prohibited because they catch fish in various sizes and types, including small fish and fish with eggs. If these fish are caught, the resources will gradually decrease. The other reason is that purse seine fishing gear with >30GT fishing vessel has to renew its annual licenses at the MMAF office. It takes longer time to compare small and annual licenses. Purse seine is likely to environmental issues in MMAF Ministry regulation no. 71 of 2016.

The over 30 GT vessels with purse seine fishing gear were active in July because they had already renewed the licenses annually and the licenses were active until April 2019. In production, the production of this vessel size is relatively flat with the highest catch in September. With a large vessel size, production should be more effective and efficient to get more catches, but the data do not show that the yield can be larger than smaller vessels. Moreover, the over 30GT vessel is an aid ship from MMAF for the fishermen group. At that time, maybe the fishermen who received the aid ship were not able to take full advantage of the ship, so they could not catch fish at an optimum level. They need to review how to optimize the capture with this ship.

4. Conclusion

Technology can make humans activities easier. This research compared two fishing technologies, which are purse seine fishing gear and hand line fishing gear. It is widely believed that purse seine fishing gear has better production than hand line fishing gear. This research was conducted in PPN Kwandang in the North Gorontalo Regency. The data used were obtained from Letters of Evidence Report for Fishing Ship Arrival (STBLK) in PPN Kwandang starting from March to November 2018. Purse seine still can be used in some water territory based on MMAF Ministry regulation no. 71 of 2016. The research shows that production, capture effort, and productivity of <10GT vessel with hand line fishing gear are bigger than that of the 10-30GT vessel with purse seine fishing gear. This research was conducted because of the lack of data available at that moment. Thus, hand line fishing gear is a fishing instrument that is friendly to the environment and has considerable fishing productivity compared to purse seine fishing gear. It needs further study to see whether other ports or other locations have the same phenomenon.

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