Economic Performance of Purse Seine Fishing with Upgraded Fishing Vessel and Equipment: A Case Study in Pattani Province, Thailand

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Purse seine is a net fishing gear that surrounds fish schools from the bottom and is closed by a purse line passing through all purse rings attached at the bottom of the net (Yingyuad and Chanrachkij, 2010). Usually, hauling the net during fishing operations is done manually by 30–40 laborers, with the cod end of the net kept in the water for scooping the catch, thus requiring several crew members to be on board a purse seine fishing vessel.

Currently, Thai purse-seine fishing vessels have been upgraded by installing modern equipment, including radar, sonar, echo sounder, wireless radio communication systems, and global positioning system (GPS), as well as other auxiliary tools. The development of such innovations for Thai purse seine fishing vessels is necessary to improve energy efficiency, reduce fuel consumption, and minimize the workforce required in fishing operations.

The Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/TD) initiated the use of auxiliary equipment in purse seine fishing vessel, such as a hydraulic hauling device, known as Power Block, which was pilot tested in Pattani Province, Thailand (**Figure 1**) to improve the technology of the hauling system and reduce the number of laborers onboard fishing vessels (Thanasarnsakorn *et al*., 2019). The Power Block is a mechanized system that uses a crane and a specialized power-block winch attached to the crane. Powered by a hydraulic pump and generator engine, the Power Block system facilitates easier hauling of fishing nets, significantly increasing efficiency and reducing manual labor compared to traditional methods.

The installation of the hydraulic crane and power block on the pilot purse seine fishing vessel has been effective in reducing the number of crew members onboard during fishing operations and relieving them of the hard work of manually hauling the net (Thanasansakorn and Thimkrap, 2019). However, since it is crucial to consider the economic assessment of purse seine fishing using vessels with improved technology, including the overall cost of an upgraded fishing vessel and its operations and maintenance costs, as well as the anticipated benefit of purse seine fishing, SEAFDEC/TD, in collaboration with the Department of Fisheries (DOF) of Thailand, conducted a pilot economic study of purse seine fisheries in Pattani Province, Thailand. The study aimed to determine the economic performance of purse seine fishing using upgraded vessels equipped with a Power Block system. The purse seine fisheries data used were collected from the owner of the purse seine fishing vessel involved in the SEAFDEC/TD pilot study.

Fishing in Pattani Province, Thailand Using a Purse Seine Vessel Equipped with a Hydraulic Hauling System

The purse seine fishing vessel, Nor Larpprsert 8, is 91 GT, 21.85 m long, equipped with a hydraulic hauling system, and powered by a 525-HP engine. It operates in the Gulf of Thailand **(Figure 1)**, conducting purse seine fishing operations throughout the year (January to December) at distances of approximately 80 nautical miles offshore. Its typical fishing pattern involves three trips per month, with each trip lasting 7–10 days (Rattanasitorn S., personal communication, 23–24 April 2019).

This purse seine fishing vessel goes fishing at night by using luring lights and Fish Aggregating Devices (FADs) consisting of coconut leaves, rope, bamboo poles, stone, and a float. Several sets of FADs are placed at the bottom of the fishing grounds to attract schools of fish (Yamazaki, 1978). Two luring light boats are stationed at the FADs' location, operating the luring light to aggregate fish schools, before putting down the surrounding purse seine net (mesh size of the net is 25 mm). When the purse seine fishing operation is completed, the net is hauled using the hydraulic crane and power block system. In the upgraded fishing vessel, only 18 crew members are involved in the fishing operation, while about 30 were involved in the former operation that did not use the power block system. Then, the fish caught are scooped from the bunt into the fish hold, which takes about 2.0 hours. However, it usually takes 2.5 hours for the fishing operation when the net is manually hauled without a power block system. The purse seine fishing vessel could operate 2–3 times per night, and the main fish species caught are sardines, round scads, and mackerel, with an average catch of about 17,500 kg per trip **(Table 1)**. Upon arriving at the fishing port, fish workers transfer the catch and sort it by fish species, size, and quality. The fish are sold to fish vendors, fish canning factories, and exported to neighboring areas.

Figure 1. Map of Thailand showing the Gulf of Thailand and Pattani Province
Source: Adapted from Google Maps, https://maps.google.com

Table 1. Purse seine fishing operation in Pattani Province, Thailand, using a vessel equipped with a Power Block system

Purse seine fishing operation	Pilot fishing in Pattani Province, Thailand
Fishing vessel size (GT)	91
Fishing trips (trip/month)	3
Fishing days (days/trip)	7–10
Fishing operation (number of times/night)	2–3
Number of laborers (persons)	18
Harvesting period (hours)	2.0
Average catch (kg/trip)	17,500

Source: Interview with the vessel owner

Upgrading of a Purse Seine Fishing Vessel

Upgrading a purse seine fishing vessel and installing it with improved technology, such as the hydraulic purse seine hauling device, requires investment. The upgrading and modernization of the vessel's equipment to make it suitable for fishing operations comprises the installation of a Power Block system, repair of the fishing vessel structure, and improvement of the net fishing gear, as described in **Table 2**. Consequently, the costs for repairing the vessel and maintaining the equipment will be incurred annually.

Table 2. Components of vessel upgrading and modernization of equipment

Components of upgrading	Description
1) **Installation of the Power Block system**	An auxiliary equipment for hauling the net from the sea that minimizes the workforce required during fishing operations, the power block system comprises a crane and a power block winch powered by a hydraulic pump. It is intended to control the speed and direction of the generator engine. A crane, used for lifting, lowering, or moving materials, normally has 3 dynamic sections with a power block attachment. The Power Block is a mechanized system with a spindle-shaped winch for hauling the net from the water (**Figure 2**)
2) **Repair of the fishing vessel structure**	Reinforcement of the vessel's hull structure to accommodate the installation of a crane and power block for hauling heavy nets (**Figure 3**). This requires reinforcing the designated crane placement area on the vessel's deck. Steel and wood can be used to create a robust support structure capable of withstanding the crane's weight and operational loads. Additionally, strengthening the starboard side of the hull is necessary as this area experiences significant wear and tear during net release, sinker deployment, and purse ring removal from the net before pulling through the power block. Reinforcing the starboard side with steel plates can significantly reduce hull damage caused by these activities
3) **Improvement of the net fishing gear**	The net should be modified for suitable use with a hauling device. The bunt is assembled at the last part of the net, moving it from the middle part, to collect fish after hauling the net into the fishing vessel (**Figure 4**). To prevent the net from breaking, selvedge nets are added in the net connection with the main net, the float line, and the sinker line. The sinker and purse ring are designed to be separately removable from the sinker line before the net is pulled through the power block

Figure 2. Installation of hydraulic machinery (crane and power block)

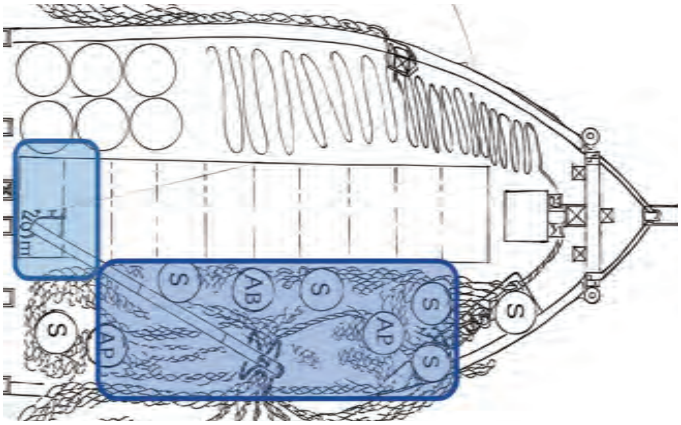

Figure 3. Repair of boat structure

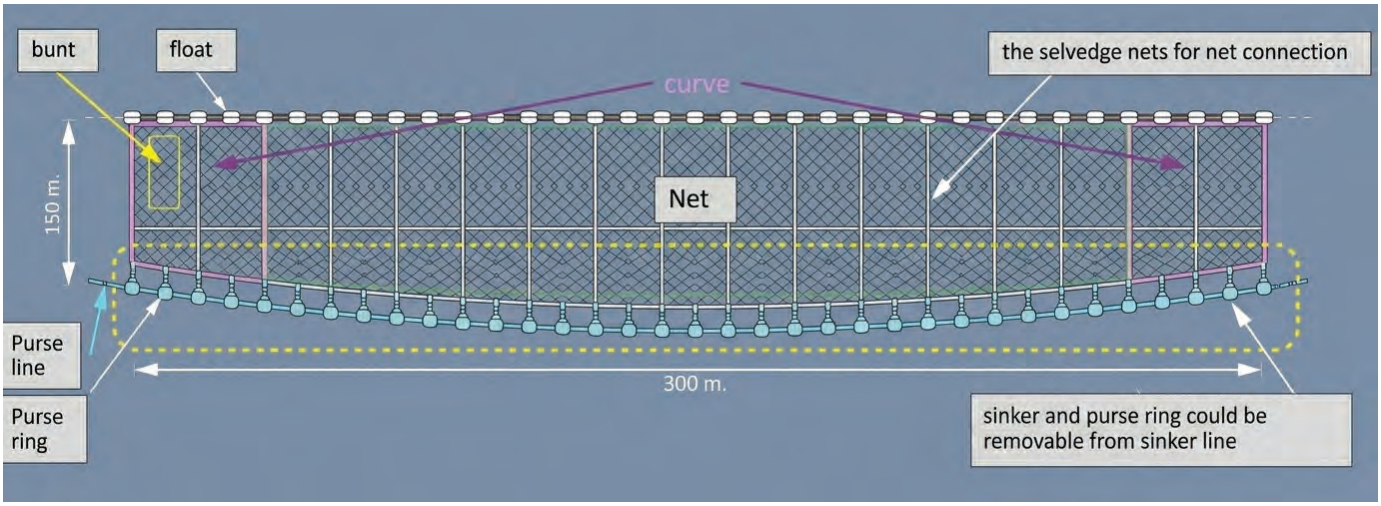

Figure 4. Improvement of net fishing gear

Cost and Return of Purse Seine Fisheries: The Pilot Case Study

The data used for the case study on the cost and return of purse seine fishing operation of the upgraded pilot purse seine vessel was compiled from the interview with the owner of the vessel equipped with the Power Block system. The cost of upgrading a fishing vessel includes the involvement of 18 fishing laborers for the fishing operation. In the case of a purse seine vessel without a power block system, 30 fishery workers are needed for net hauling. The cost and return are expressed in Thai Baht per trip.

Cost Structures

The costs of purse seine fisheries are categorized into fixed costs and variable costs. Fixed costs include the depreciation of fishing assets, such as the hull of a fishing vessel, engines, net fishing gear, and equipment. These costs should be funded when starting a purse seine fishing business. Depreciation costs are non-cash expenses calculated using a straight-line method based on the fishing vessel value, salvage value, and economic life. In this case, where the fishing vessel is equipped with a hydraulic net hauler, the depreciation of the power block system is included in the fixed cost.

Variable costs are the expenses incurred by the purse seine vessel to go to sea for fishing operations or the operating costs paid in cash. Variable costs comprised four components: materials, labor, vessel operational costs, and other costs (**Table 3**).

Table 3. Components of variable costs for purse seine fishing operations

Components of variable costs	Details
Materials costs	Include the cost of fuel, lubricants, ice, and materials for FADs installation
Labor costs	Consists of wages, food, and supplies for the crew, as well as labor charges such as registration for foreign labor, work permits, immigration clearance, medical examination, sea book, and insurance
Vessel operational costs	Expenses for repair and maintenance of the vessel, gear, and equipment onboard, and additional costs for the repair and maintenance of the power block system
Other costs	Include the fee for the use of a Vessel Monitoring System (VMS), harbor dues, and expenses for sorting and selling the fish catch

Return on Investment in Purse Seine Fishing

The revenue from purse seine fishing is the landing catch value in a fishing trip, which is calculated from the catch volumes and the price of the catch by fish species. The main fish species caught from purse seine fishing are sardines and mackerel. The return of purse seine fisheries takes into consideration the net income, which is total revenue minus the variable cost, and the profit after deducting all the costs of fishing represents the depreciation cost (DOF, 2008). The rate of return from purse seine fishing, which indicates the profitability of the fishing investment, is the profit divided by the cost of fishing and expressed as a percentage (Tietze *et al*., 2005).

Table 4 shows the economic performance of purse seine fishing in the pilot case study with the power block system. The net income of THB 54,719.08 per trip indicates that the fishing expenses, which are the cash costs, are covered. Taking into consideration the total costs, including depreciation, the purse seine fishing in the Pattani case study earned a profit of THB 8,441.30 per trip, with a rate of return of 1.97 percent. The factor that should be considered for a purse seine fishing operation is the income from the catch. Fishers can focus on variable costs rather than fixed costs and decide whether to operate purse seine fisheries as long as the income obtained covers the fishing expenses or cash costs.

Table 4. Economic performance of purse seine fisheries in the Pattani case study

Economic indicators	THB/trip	%
Revenue (THB/trip)	**437,500.00**	**-**
Variable cost	**382,780.92**	**89.2**
– Materials	160,483.33	37.4
– Labor	128,889.40	30.0
– Vessel operations	70,666.66	16.5
– Others	22,741.53	5.3
Net Income	**54,719.08**	**-**
Fixed cost	**46,277.78**	**10.8**
– Depreciation	46,277.78	10.8
Total Cost	**429,058.70**	**100.0**
Profit	**8,441.30**	**-**
Rate of Return	**1.97 %**	**-**

Results and Discussion

Based on the composition of variable costs for purse seine fisheries in Pattani Province as shown in **Figure 5**, materials and labor costs accounted for the majority of the expenses. The cost of materials, the most important component of variable costs in purse seine fishing vessels, accounted for the highest at 37.4 percent, followed by labor costs at 30 percent.

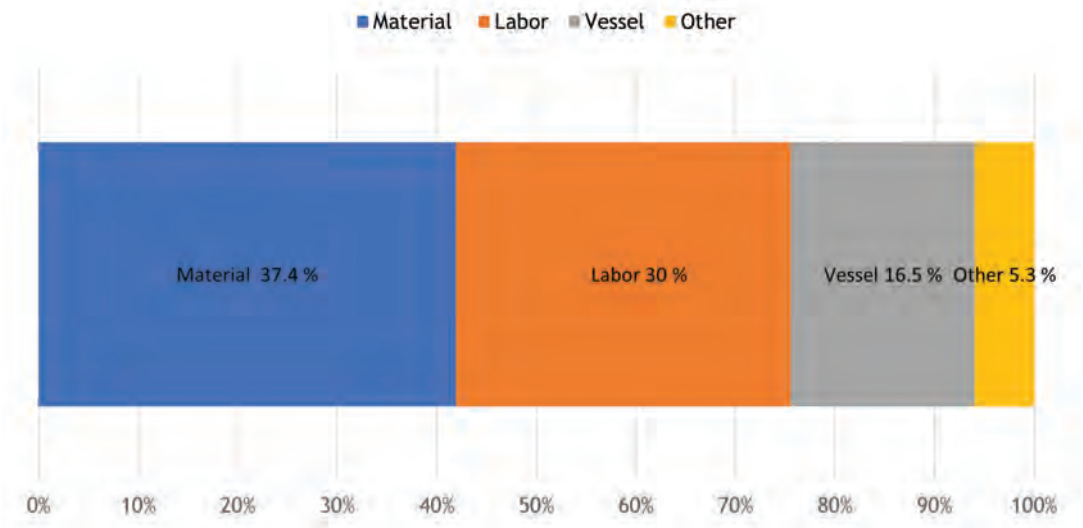

Figure 5. Variable costs of purse seine fisheries in the Pattani case study

Vessel operational costs of about 16.5 percent are used mainly for regular maintenance and repair of the net hauling equipment. The lowest component of variable costs is the other costs at 5.3 percent for fees and dues, and for sorting and selling the catch. The total cost of purse seine fisheries in the Pattani case study is shown in **Figure 6**, where the fixed cost comprises a minor part of the total fishing cost, and is associated with the age of the fishing vessel, equipment, and corresponding depreciation, accounting for 10.8 percent of the total cost, with the depreciation expenses for the installed hydraulic hauling equipment now included. Meanwhile, the variable cost, which accounts for 89.2 percent, is the major component of the total cost of purse seine fishing.

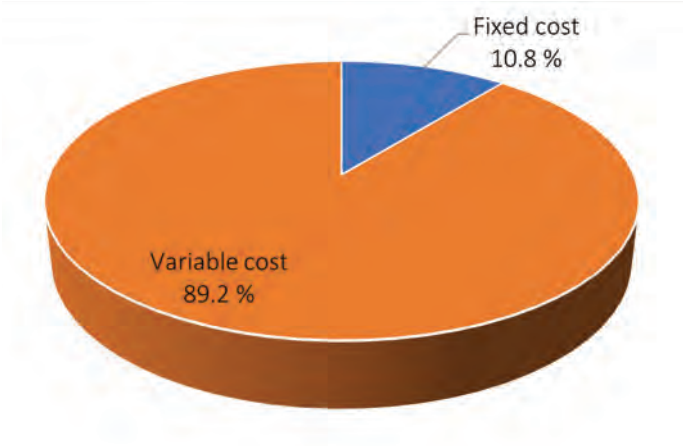

Figure 6. Total cost of purse seine fishing in the Pattani case study

The economic performance of purse seine fishing in the Pattani pilot case study was analyzed using the cost and return on investment, focusing on the vessel that had been upgraded with a Power Block system and with a smaller fishing crew. The purse seine fishing operation equipped with a Power Block system resulted in a positive profit. Income, which covers operating costs and depreciation of fishing assets, increased despite expenses for maintaining and repairing the hydraulic hauling device and fixed costs related to the depreciation of hydraulic machinery. At the same time, labor costs decreased because of lower wages for the smaller crew, as the Power Block system is used for hauling the fishing net.

Conclusion and Recommendations

Investing in the Power Block system offers a compelling solution to the labor shortage in Thailand, addressing workforce issues, improving working conditions by reducing physical strain on crew members, and fostering a better work environment and crew well-being. Efficiency in fishing operations has improved because the Power Block system has significantly sped up net hauling compared with the traditional manual method. The pilot case study has shown that purse seine fishing with the Power Block system is financially beneficial, contributing to overall profitability through increased efficiency and lower labor costs.

A key factor in increasing the fishers' income is their ability to obtain better prices for their catch, which is closely related to the quality of fish landed. Improvements in fish handling practiced onboard fishing vessels, such as the installation of a cooling storage system, can help preserve fish quality and enhance the market value of the catch.

This study, however, uses data from a single purse seine fishing vessel equipped with a Power Block system, which received technical and financial support from SEAFDEC. Therefore, the findings may not fully represent the overall performance of other vessels, as differences in vessel characteristics, crew size, and fishing areas may affect operational efficiency, costs, and returns. In addition, the data collection period was relatively short and conducted during the initial stage of the installation and trial operation of the Power Block system. During this period, technical adjustments, system stability, and crew familiarity with the equipment may have influenced operational performance. Furthermore, the data did not cover the entire fishing season. Although the Power Block system can help reduce labor requirements, labor remains essential, with approximately 20 crew members still required onboard to ensure continuous operations. Moreover, potential long-term costs for equipment repair and maintenance may offset some labor cost savings. Finally, fluctuations in fish prices, fuel costs, and labor wages may affect the analysis of costs and returns, meaning that the findings reflect conditions during the study period only.

Nonetheless, the results of this case study could provide useful information to support the development of policies by government agencies to assist purse seine fishers in accessing loans at lower interest rates and encouraging them to invest in upgrading their fishing equipment. The results could also serve as useful materials for training programs that could be developed and implemented to equip purse seine fishers with the necessary technical knowledge to effectively upgrade their fishing vessels with the Power Block system, including its operations and maintenance.

Way Forward

As fishing technologies continue to develop for purse seine fisheries, an assessment should be made of the ecological factors and fishery resources that could be affected by innovations and the uncontrolled capacity of fishing vessels. It would also be important to monitor the economic performance of fishing activities to establish the most appropriate fisheries management for sustainable fisheries.

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