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Research Article

Socio-economic analysis: A snapshot of fishers' livelihoods for improving small-pelagic fisheries management in the northern Persian Gulf

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Abstract

Iran's marine catches are mostly captured by the small-scale fisheries (SSF) section, which is inherently difficult to manage. Socio-economic data is a key component of a community-based management approach to achieving sustainable SSF. A socio-economic survey was conducted to evaluate the profitability of small-pelagic purse seine fisheries in the northern Persian Gulf from 2020-2021. The study area covered three main fishing grounds of Sardine and Anchovy in the northern Persian Gulf. Data were collected by random sampling technique, using 104 standard questionnaire forms. The results showed that 104,000 tons of fish were landed by 348 purse seiners in 2020, which supports ~96% of the fisherman's household income. In total, 3811 fishers were engaged on the pair-boat purse seiners with an average (±SD) age of 32.1±11.6 years. In terms of literacy, ~52% of fishers had secondary and high school education. On average, the number of engaged crew per vessel was 9.7 people, and each crew worked 843 hours per year which is 42% of national FTE. Total variable costs for purse seine fleet were 6.57 million Euro, of which personnel costs 47.5%, energy costs 32.5%, operational costs 7.8%, maintenance costs 7%, commercial costs 5%, and fixed costs 0.2%. The value of total investment (vessels and gears) was estimated at 9.77 million Euros, which is close to the total revenue of 10.46 million Euros in 2020. The purse seine fleet consumed 17.2 million liters fuel in 2020, their energy efficiency was calculated at 0.165 for 1 ton landed fish. This study showed that the purse seine fishery in the northern Persian Gulf, which utilized 0.93 of its capacity, is a livelihood-oriented activity. Therefore, it is recommended that the fisheries management approach is aimed at ensuring sustainable exploitation and employment stability.

Keywords: Small Scale Fisheries (SSF), Purse seine, Socio-economic, Persian Gulf

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Introduction

Small- scale fisheries (SSF) sector is expected to play important role at local and national (or even global) levels in economic, social, environmental, cultural, food security, poverty alleviation, and the well-being of many fisher folks (Béné, 2006). Small-scale fisheries are responsible for nearly half of global seafood catches, and also form an important source of diet for over one billion people (FAO, 2020). According to certain estimates, for instance, by the FAO, about half of the world's 51 million fishers are small-scale, and most of them live in developing countries. In addition, hundreds of millions of people depend on fisheries for their livelihood throughout the value chain (Jentoft *et al*., 2017). In Iran, small scale fisheries are playing a major role to improve the socio-economic condition of coastal communities of Iran in both south (Persian Gulf and Oman Sea) and north (Caspian Sea), through providing employment, livelihood, and food (Taghavimotlagh, 2018). Marine fisheries contribute at least 61% of total fish production in Iran and >99% of the catch comes from small scale fishing, with approximately 140,000 people directly depends on the sector. Total fish landings in Iran were 715,401 tons, around 95% of which came from the Persian Gulf and Oman Sea fishing grounds (IFO, 2020).

Due to species richness in the region, diverse species are caught by different fishing gears such as gillnet, trawl, intertidal fixed stake net, trap, longline, purse seine, hooks, etc. The commercial species landed are categorized into five groups including large pelagic fish such as tuna (with 47% proportion of total landings); small pelagic fishes like sardine, anchovy, and Indian mackerel (13%); demersal fish such as snappers, grunts, and groupers, etc. (36%); myctophids (3%) and crustaceans (mostly shrimp and crab) (1%) (IFO, 2020). Small pelagic fishes (sardines and anchovies) are mainly caught by pair-boat purse seine, classified as small-scale fishing reaching 13% of landed catch in the northern Persian Gulf. *Sardinella sindensis* and *Encrasicholina punctifer* are the main species of small pelagic fishes that are usually exploited commercially in the area (Salarpouri *et al*., 2018; Salarpouri, 2022). Iran is the second largest country, after the Sultanate of Oman, in the exploitation of small pelagic fish of the Persian Gulf and Oman Sea region (i.e., 41% of total catches) in 2017. The review of time series catch data (1980 to 2020) indicates a rising trend in total landings of sardines and anchovies in Iran (Salarpouri, 2022). Most studies on small scale fisheries in developing countries have tended to emphasize small scale fisherfolk resource dependence and the open access nature of fisheries that lead to recourse degradation, poverty, and marginalization (Allison and Ellis, 2001). Socio-economic data are a key component of the scientific advice required for the evidence-based management of fisheries, yet in many countries, these data are limited, usually because of a lack of technical capacity

for their collection (Aghazadeh, 1994; Pinello *et al.*, 2017). Small-scale fisheries have traditionally received less research effort than large-scale fisheries and are generally under-studied. Limited studies have been done on the fisheries socio-economy in Iran, including kilka fisheries in the Caspian Sea (Vazifeshenas, 2007; Taghavimotlagh *et al.*, 2021), myctophids fishing in the Oman Sea (Valinassab *et al.*, 2007; Nazari Bajgan *et al.*, 2019), and shrimp fishing in the Persian Gulf (Taghavimotlagh *et al.*, 2022). A challenge facing sustainable management of SSF in Iranian territorial waters is weak fisheries governance and data-poor, particularly in terms of fisheries sociology (Kamrani *et al.*, 2020; Daliri *et al.*, 2023). This study was performed to evaluate the fishing profitability of pair-boat purse seine fisheries in order to improve community-based fisheries management in the northern Persian Gulf. First, we gathered the socio-demographic data of small-pelagic fishers in summary and then explored the economic indicators (fixed costs, variable costs, etc.) environmental and technical indices (fuel consumption efficiency, capacity utilization, etc.) of fishing by these small-scale purse seiners.

Materials and methods

Study area

Iran, with a 2440 km coastline, is the largest capture fisheries country in the Persian Gulf and Oman Sea region. (Fig. 1). Approximately 74% of Iranian small pelagic fish landings were captured in the Qeshm Island, as well as Bandar Lengeh (14%), Bandar Jask (8%), Kangan area (3%) and Chabahar area (2%) (IFO, 2020). Sardine and anchovy are caught by pair-boat purse seiners (outboard engine small boats). The fishing season of small pelagics begins in the north of Persian Gulf and Oman Sea from September to July every year (Moradinasab, 2020; Salarpouri, 2022).

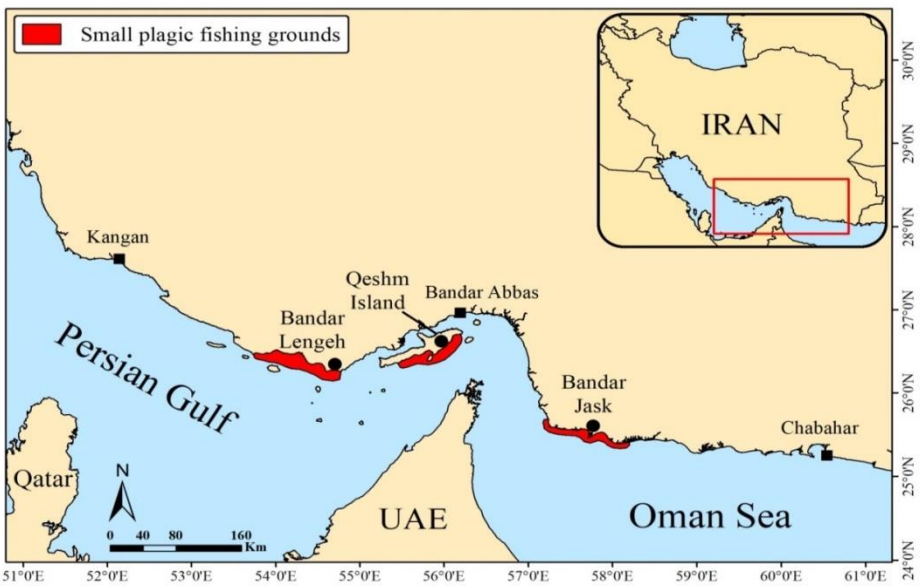

Figure 1: Location of small pelagic (sardine and anchovy) fishing grounds on the northern Persian Gulf and Oman Sea.

Research methodology

The standard questionnaire of FAO (Pinello *et al*., 2017) was used to collect socio-economic data on the small pelagic fisheries in the study area. Our statistical population was pair-boat purse seiners in the northern Persian Gulf and Oman Sea. One hundred-four fishers, representing different purse seiners' fishing groups, voluntarily completed questionnaires between September 2020 to July 2021. There are 348 pair-boat purse seiners (186 in Qeshm Island, 123 in Bandar Lengeh, and 39 in Bandar Jask), as all vessels have the same overall length (with a LOA of 8-10 m) therefore all of them are categorized in one segment, and questionnaires were completed and analyzed for all together. The participants correspond to ~ 30% of the research population (348 purse seiners' fishing groups**).** According to Sapsford and Jupp (2006**)**, this sample size was representative of the statistical population. In order to better understanding of the fishers, the general questionnaires were presented in detail with practical examples. The questionnaire contained 76 variables, including economic variables like costs, income, investment, and social information namely, the size of fishermen's households, age, and literacy level. Each vessel owner was interviewed by a data collector to fill out the questionnaire. Social data such as age, level of literacy, the size of crew family, etc., were collected for 10 crew of each vessel. Fixed costs including, bookkeeping, vessel insurance, legal expenses, bank loans, and fishing license renewal do not vary with the changes in the quantity of fishing operations, while variable costs are (crews, fuel, bait, food and beverages, repair and maintenance, commercial and other operational costs) vary with the changes in the number of fishing operations. The questionnaire contained questions about (1) demographic data and literacy level of crew, (2) the economic indicators like variable and fixed costs, (3) the investment costs such as purchases of engines, fishing gears, and equipment, (4) incomes and gross value added, and (5) environmental and technical indicators (Pinello *et al*., 2017). The Excel 2016 software was used to analyze economic data.

Results

Socio-demographic characteristics of purse seine fishery

The age of 104 vessel owners who participated in this study, ranged from 23-75 with a mean (±SD) of 43.1±11.7 years. The average fishing experience of vessel owners was very high with a mean (±SD) of 23.2±12.8 years. The total crews engaged in purse seine fishery were 3811 people, with an average (±SD) age of 32.1±11.6 years, and 51.6% of crews were educated in secondary and higher levels. The total household size of crews was estimated at 17493 people, ~40% of them engaged in fishing activity, and the mean (±SD) number of crew family engaged in fishing activities was 1.6±1.1 people. Approximately, 95.7% of household income was from fishing activity. Table 1 presents a summary of the socio demographic characteristics of purse seine fishery.

Table 1: Targeted questions and explanation of variables of the questionnaire (Pinello *et al*., 2017).

Targeted questions	explanation of variables
Demographic data and literacy	demographic information, ages, gender, family members, nationality the literacy level of the crew members
Economic indicators	variable costs (energy, personnel, repair/ maintenance, commercial, other operational,) fixed costs (bank loans, fishing license renewal, other fixed costs)
Investment costs	purchase of engine, fishing gears, equipment
Incomes and gross value added	revenue obtained by using the vessel for fishing activities and other than fishing net output of a sector after deducting intermediate inputs from all outputs
Environmental and technical indicators	fuel efficiency of seafood landing, Landing per ton of fuel consumed Capacity utilization, The ratio of actual to potential output

Fishing activity and employment of purse seine fishermen

Results showed that 104,033 tons of small pelagic fishes (sardine and anchovy) were caught by 348 pair-boat purse seiners during the fishing season of 2020 in the northern Persian Gulf. The average catch per vessel was estimated at 299 tons. On average, each pair-boat purse seiner spends 170 days at sea annually, the mean (±SD) working hours per day for each vessel were estimated at 5.6±1.1 hours. The engaged crews per vessel ranged between 8-10.8 people, with a mean (±SD) of 9.5±1.3 people in total. The average (±SD) working hours (including the route to the fishing ground) of crews per year was estimated at 843±166.3 hours (Table 2).

Table 2: Socio-demographic characteristics of purse seine fishermen in the northern Persian Gulf (2020).

Particulars	Total
Number of respondents	104
Average age of respondents (years)	43.1±11.7
Average fishing experience of respondents (years)	23.2±12.8
Number of crews (people)	3811
Mean age of crews (years)	32.1±11.6
Household size of crews (people)	17493
Education level of crews (%) secondary and higher school	51.6
Number of crew households engaged in fishing	5935
Household income from fishing activity (%)	95.7

Estimation of fishery variable coasts

The value of the total fishing cost of the purse seiners was calculated 6.57 million Euro, of which personnel costs 47.5%, energy costs 32.5%, operational costs 7.8%, maintenance costs 7%, commercial costs 5%, and fixed costs 0.2% (Fig. 2).

Investments and income index of fishery

The value of the whole pair-boat purse seiners and their nets was estimated at 9.77 million Euros in 2020. Total revenues from small pelagic purse seine fishery in the region were calculated at 10.46 million Euro (1 EUR€=293,000 IR Rials in 2020). Total gross cash flow was also estimated at 3.89 million Euros. The average gross cash flow per capita

was calculated at 14.57 thousand Euros. The average gross value added per capita was estimated at 20.17 thousand Euros. The average depreciation costs per capita for the purse seine fleet was calculated at 8.84 thousand Euros. The average remuneration per crew based on national Full Time Equivalent (FTE) was calculated at 1.94 thousand Euro (Tables 3 and 4).

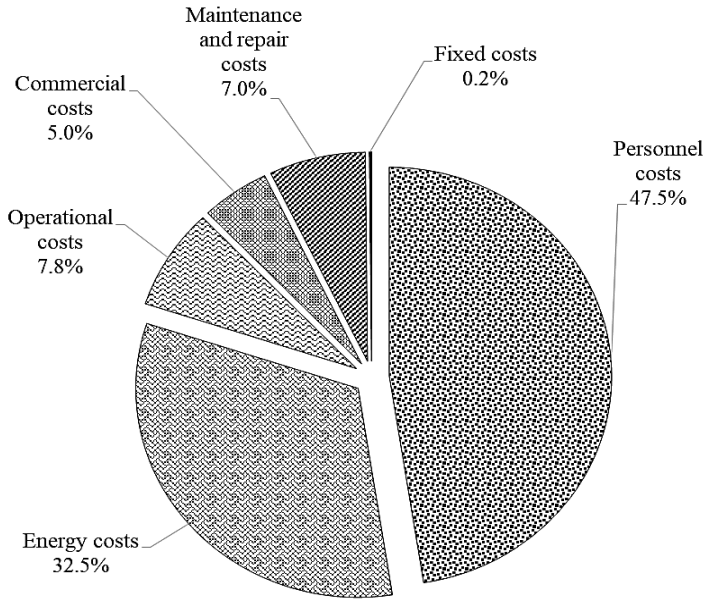

Figure 2: Contribution of variable costs of double boat purse seine fishing vessels from the northern Persian Gulf (2020).

Table 3: Fishing activity and employment of pair-boat purse seine fishery in the northern Persian Gulf (2020).

Particulars	Total
Number of active pair-boat purse seine vessels	348
Total catch (ton)	104023
Catch per Capita (ton/vessel)	299
Average(±SD) effort of each vessel in a year (days at sea)	167.2±13.2
Average working hours per vessel/day	5.6±1.1
Mean engaged crews per vessel (people)	9.5±1.3
Average working hours of each crew (hours per year)	843±166.3

Table 4: Investment and income of purse seine fishery from the northern Persian Gulf (2020).

Investment and income (Euro)	Total
Total value of vessels (million Euro)	9.77
Revenues (million Euro)	10.46
Gross cash flow (million Euro)	3.89
Gross cash flow per capita (thousand Euro)	14.57
Gross value added per capita (thousand Euro)	20.17
Depreciation costs per capita (thousand Euro)	8.84
Remuneration per FTE (thousand Euro)	1.94

Technical and environmental index of fishery

A total of 17.2 million liters of fuel were consumed by small-pelagic purse seiners in the northern Persian Gulf during the study. The fuel efficiency based on consumed fuel per 1 ton landed by each purse seiner was calculated at 0.16, which indicates that 165.4 liters of fuel have been consumed per 1-ton landings. The capacity utilization index of whole pair-boat purse seiners was also calculated at 0.93.

Discussion

A synchronic study of the social, economic, and ecological dimensions of a capture fishery, such as small-pelagics, would lead to favorable consequences for fisheries managers and communities. Socio-economic analyses help interpretation the cost-benefit analysis of fishing activities, prioritize requirements, and encourage policies that maximize societal benefits from ocean and coastal resources while also conserving the marine ecosystem (Tietze *et al.*, 2001; Bennett *et al.*, 2021). There are 140,000 active fishers in Iran's capture fisheries section, which +131,000 of them (i.e., 94%) live in the south of Iran (IFO, 2020). The 3,811 purse seine fishermen, contributed around 12% of Iranian fishermen who support 17,493 people in their household, and ~34% of them engaged in the fishing activity (Table 1). This is more than the Kilka fishery (5%) in the Caspian Sea and the shrimp fishery (27%) in the Persian Gulf. The mean age of crew members in this study (32.1 years) was close to the Strait of Hormuz shrimp fishery (30.6 years), while lower than the northwest Persian Gulf shrimp fishery with 39.5 years, and Kilka fishery (47.7 years) of the Caspian Sea. In this research, we found that about 96 percent of the household income of fishers depended on purse seine fishing activity, while the dependence was 92% for shrimp and Kilka fishing (The literacy level of pair-boat purse seine crews (51.6 % of secondary and higher school) was more than shrimp fishery crews (25-35%), and less than Kilka fishery (with 90%) (Taghavimotlagh *et al.*, 2021, 2022) The literacy rate in Brazilian artisanal fishing communities was 44.6% among men and 53.5% among women (Kalikoski and Vasconcellos, 2012). It sounds like pair-boat purse seine is mainly carried out by young and educated people, which increases the probability of success in their training programs. Since the livelihood of crew households is almost entirely dependent on this type of fishing activity, it can be stated that planning for sustainable and responsible exploitation of small pelagic fishes, guarantees the improvement of the life quality of the beneficiaries.

Total variable costs for pair-boat purse seines fishery were also calculated at 6.57 million Euro, of which 47.5% belonged to personnel costs, energy costs 32.5%, and other variable costs contributed 20.0% of total variable costs (Fig. 2). The personnel costs in the Caspian Sea Kilka fishery were reported 64% (Taghavimotlagh *et al.*, 2021), and for the Iranian shrimp fishery were

estimated 51- 59% (Taghavimotlagh *et al*., 2022). Considering the high portion of personnel costs (47.5%), and dependency of household income from this fishery were calculated to be 96%. it can be stated that small pelagic fishery in the northern Persian Gulf is a livelihood-oriented activity. The crew salaries in Egyptian fisheries represented 35% of the operating costs, while operational costs were 27% followed by energy costs (17%), commercial costs (14%), and maintenance costs (6%) (FAO, 2014). The gross cash flow of the purse seiners was also estimated at 3.89 million Euros, significantly higher than shrimp fishery in the north -west of Persian Gulf with 2.35 million Euros (Taghavimotlagh *et al*., 2022). In this study, total remuneration per national FTE was estimated at 1.94 thousand Euro, this index was higher than shrimp fishery in the Persian Gulf (0.92 thousand Euro), and Kilka fishery in the Caspian Sea (Taghavimotlagh *et al*., 2021, 2022).

Here, 17.2 million liters of fuel (gasoline) were consumed by the purse seiner's overlay, which constitutes 32.5% of the share of variable costs. Whereas the energy costs were reported ~12% for the shrimp fishery (Taghavimotlagh *et al*., 2022), and 11% for the Kilka fishery (Taghavimotlagh *et al*., 2021). The type of fuel used (gasoline), higher motor power, number of days at sea, and lack of fuel subsidies are the main reasons for increasing the energy costs in small pelagic fishery. The energy efficiency of small-scale purse seine fishery was also calculated at 0.165, it means that 1 ton landed fish needs 0.165-ton fuel. The energy efficiency for the shrimp fishery was calculated at 3.5-4.5, and for the Kilka fishery was 0.11 (Taghavimotlagh *et al*., 2021, 2022). The differences in energy efficiency are mainly due to the active purse seine fishing method, and schooling behavior of small pelagic fishes. The relative ease with which small pelagic fishes are caught by purse seiners, owing to their schooling behavior, and the enormous biomasses, has made them important economic resources (Cole and McGlade, 1998). The total capacity utilization index was estimated at 0.93, this is the ratio of actual to potential output, and this means that purse seine vessels are using 0.93 of their capacity utilization for exploiting the small pelagic fish stocks. Most studies of small-scale fisheries in developing countries have tended to emphasize small-scale fisherfolks' resource dependence and the open-access nature of fisheries that lead to resource degradation, poverty, and marginalization (Pauly, 1997; Allison and Ellis, 2001). In conformity with the other developing countries, Iran fisheries facing lack of employment in coastal areas, low financial, social, and educational status of the fishermen, lack of alternative income sources, and low environmental awareness. This study showed that the purse seine fishery in the north of the Persian Gulf is a livelihood-oriented activity. The livelihood approach is explained, and the insights it provides into conventional fisheries management policies in developing

countries are explored (Allison and Ellis, 2001). Therefore, it is recommended that the fisheries management approach is aimed at ensuring sustainable exploitation and employment stability.

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