

# A study on economic ripple effect and small-scale mariculture micro data: an insight of current evidence in Provinces of Bali and Lampung, Indonesia

<sup>1,2</sup>Maulana Firdaus, <sup>1</sup>Katsumori Hatanaka, <sup>1</sup>Ramadhona Saville,  
<sup>2</sup>Achmad Zamroni

<sup>1</sup> Department of Agribusiness Management, Graduate School of Agriculture, Tokyo University of Agriculture, Tokyo, Japan; <sup>2</sup> Research Centre for Marine and Fisheries Socio-Economic, Indonesia Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia.

Corresponding author: M. Firdaus, 46719401@nodai.ac.jp

**Abstract.** This research explores the significance of the fisheries sector to the region and fish farmers, particularly mariculture, using economic ripple effect analysis and microdata analysis of small-scale mariculture in Bali and Lampung provinces, which are significant mariculture centres in Indonesia. However, the research on the economic effects of the fisheries sector on regions and fish farmers is still inadequate. Previous studies mainly provide an overview based on secondary statistical data. We perform the analysis using a combination of primary microdata and secondary statistical data. A field survey with 41 respondents was conducted in Bali and Lampung, Indonesia, in 2020 and 2021. The Indonesian Central Statistics Agency provided secondary data. Input-Output Analysis and the Minimum Requirement Approach were used to assess the economic ripple effect of the fisheries sector and its role in this study. The economic characteristics of the household were acquired to provide more detailed evidence. Engel's coefficient was used to investigate the living standard. The Input-Output analysis shows that the fisheries sector positively impacts the income multiplier and output multiplier effect in the target areas. Based on the Minimum Requirement Approach analysis, the multiplier base value of the fisheries sector in Bali Province in every IDR 1,000,000 RGDP in the fisheries sector would encourage the creation of IDR 2,290,000 GRDP in the other sectors. Furthermore, for Lampung Province, the fisheries sector will encourage the creation of IDR 1,085,000 RGDP in the other sectors. The fisheries sector in target areas has great potential to become one of the leading or primary sectors. Mariculture accounts for more than 70% of household income, making it a primary source of income. However, finfish mariculture households in the target areas are classified as "well off" with Engel's coefficient values ranging from 40 to 50 per cent.

**Key Words:** economic effect, finfish mariculture, fisheries, livelihood, small-scale.

**Introduction.** Over decades poverty has been a significant economic problem globally, including in Indonesia. Indonesia is the world's largest archipelagic state with some 17,508 islands and 54,716 km of coastline and is blessed with enormous natural resource potential. It is hoped that this potential can be utilized and positively impact poverty reduction. However, based on data from the National Development Planning Agency of the Republic of Indonesia in 2017, the Indonesian government has failed to reduce poverty to 7.55% nationwide (Dewi et al 2018). With many islands (more than 17,000) and the second-longest coastline in the world, the fisheries sector is Indonesia's flagship for driving its economy and plays a vital role in Indonesia's economy through income generation, livelihoods diversification, supply of protein, and foreign exchange earnings (Nurkholis et al 2016; Tran et al 2017). The fisheries sector constitutes an essential pillar of the Indonesian. In 2015 the industry accounted for 3% of GDP and provided 5% of the country's labor force of 113 million, especially in poorer regions with few alternative job opportunities (Rizal et al 2017).

Indonesia is the world's largest archipelagic state, and this geographical condition provides enormous opportunities for marine aquaculture (mariculture). Mariculture is

expected to satisfy the growing demand for fish products in Indonesia and the world, especially under the modest increase of wild fish catch. Mariculture is an essential component for aquaculture production in Indonesia, with total production reaching 9,034,756 tons (USD 1,951,097.72) by 2014, and 579,463 people are involved in mariculture activities (MMAF 2015). In addition to sources of aquatic food production, mariculture has excellent potential for the purpose of poverty alleviation and the generation of wealth for the coastal communities. In 2017, Indonesia was listed as one of the finfish mariculture producing countries in the world, with a 12.5% contribution to total production at the global level (FAO 2017). At the global level, aquaculture contributes to the fulfillment of fish and seafood needs by 89% (FAO 2017), and most of it, which is more than 70% of aquaculture production, comes from mariculture. This shows that aquaculture, especially mariculture, is very important not only for Indonesia but globally.

To achieve the most considerable poverty reduction effect from economic growth, is crucial to identify the sectors that have the most substantial impact on poverty reduction, which are investigated in this study by focusing at the fisheries sector. Many previous studies have investigated the fisheries sector's contribution, specifically for captured fisheries and aquaculture, in the economic context (Leung & Pooley 2001; Harper et al 2013; Bennet 2015). Many researchers have conducted outstanding works to evaluate the economic growth and analyzed the fisheries sector structure. Bjorndal et al (2015) evaluated the contribution of the Portuguese fisheries sector using the time series secondary macro data (50 years series data). Zuhdi (2016a) explored the economic conditions of Indonesia using the Input-Output table for 2005; in his analysis, the fishery sector is still incorporated in a large set of sectors consisting of agriculture, livestock, forestry, and fishery. So, it is challenging to fully see the role of a single fishery sector in the economy. However, it has been conveyed in other research (Zuhdi 2016b) about the fishery sector, which has a positive impact on the Indonesian economy. However, this study has not been able to investigate in-depth the characteristics of the fishing industry at the micro or household level. In addition, research by Hutajulu et al (2019) investigated the roles of the fisheries sector in the regional area, which has an impact on economic growth and multiplier income at the regional level. In general, the previous studies show that the fisheries sector has a positive impact on the economy. An increase in income is one indicator of economic development and growth (Baster 1972; Paukert 1973; Sacks et al 2010).

The fisheries sector is an essential industry in Indonesia, with substantial economic effects (National Development Planning Agency of the Republic of Indonesia 2014). Currently, the fisheries sector is capable of sustaining itself in crises, supplying food (a source of fish protein) for the population, a source of revenue, and employing a large number of workers. The fisheries sector contributes to economic growth in Indonesia and several other countries, including the United States, Japan, China, and European nations. According to Fauzi (2010), the fishery sector in several countries worldwide has become a source of "energy" for economic growth as well as an "engine of growth" for the regional economy. Fish are "culturally" important in some other countries as well. Furthermore, the importance of the fisheries sector in several countries is reflected in a significant increase in global fishery production.

The territory is a significant issue in terms of regional development. The term territory stresses the interaction between people and resources in a geographical unit; exploring a region or geographical unit will provide information about the community's interaction and utilization of a resource (Rizal et al 2017). Bali and Lampung Provinces are provinces in Indonesia as fisheries centers, especially mariculture production centers. The fisheries sub-sector in Bali Province provides the 8th most significant regional gross domestic product (RGDP) contribution out of 35 sub-sectors. In comparison, the fisheries sub-sector in Lampung Province contributes the 6th largest of the 16 sub-sectors (BPS 2020). These two provinces can be developed as fisheries centers in Indonesia, especially for maritime development. In general, Indonesia has quite a significant mariculture potential, with an estimated culture area of 24.53 million hectares. In 2017, the value of mariculture production contributed 9% to the total value of fishery production (MMAF

2018). This study is concerned with roles that the fisheries sector can play in this challenging context and mariculture. This study tries to complement the existing literature by trying to analyze the fisheries sector using a simple methodology by comparing the results of secondary data with data at the household level in a regional area. Specifically, the purpose of this research is to conduct an investigation of the fisheries sector to the region and fish farmers, especially mariculture, via economic ripple effect analysis and microdata analysis of small-scale mariculture fish farmers. By analyzing the role of the fishery sector at the regional level, particularly in the two mariculture centres in Indonesia, and combining it with data at the micro-level, It is expected that this research would contribute to expanding the existing literature.

## Material and Method

**Research design.** The primary data source for economic ripple effect calculations in the target area is the input-output table (I-O Table) for 2010 and RGDP by Indonesia National Agency Statistics or Badan Pusat Statistik (BPS 2010). RGDP is one indicator that can describe the ability of a region to create an output (added value) at a specific time. In addition, this study also uses the primary data collected through a field survey of small-scale finfish mariculture farmers in the form of business and household income data. The field survey was conducted in February-March 2020 and October-November 2021 in Lampung Province and Bali Province, Indonesia (Figure 1). Respondents were selected purposively, namely small-scale finfish farmers, through personal interviews conducted at home or culture sites with a total sample size is 41 respondents.



Figure 1. Study areas Lampung Province and Bali Province, Indonesia  
(Source: <https://365psd.com/vector/free-vector-map-of-indonesia-30727>).

**Data analysis.** The novelty of this analysis is that it is a mix between the macro data (from secondary data: IO Table and RGDP) and microdata (primary data at household level) to provide more comprehensive evidence on the role of the fisheries sector, mariculture regionally, also households (fish farmers) in responsively. The structure of household income and expenditure was derived from the respondents' responses and then calculated in units of one year. To see the living standard of the respondent's household in the target area using Engel's coefficient, by calculating: Food consumption expenditure/Total consumption expenditure. Engel's coefficient is a standard indicator to analyze people's living standards, generated from Engel's Law, which is considered to be the most popular index measuring living standard. Engel's Law states that aggregate household expenditures on food decline with an income increase. In other words, the income elasticity of demand for food in the aggregate will decline from less than one toward zero with income growth (Timmer et al 1983; Zhi-Guo et al 2010). Engel's coefficient values range between 0 and 1. The smaller the value indicates, the more

affluence (Wang & Woo 2010). Data collected were organized into charts, tables, and graphs in Microsoft Excel.

**Input output analysis.** The input-output analysis shows the relationship between the flows of the various sectors in the economy, whereby the relationship between the producers and the consumers and the interdependence among industries can be shown. It can also track the flow of commodities (goods and services) from one industry to another. Input-output tables provide a database of regional trade flows and production and consumption recipes. Using an IO table, it is possible to identify the economic ripple effect on income and output multiplier. The 2010 I-O tables for Bali and Lampung Provinces were used in this analysis. I-O is made based on the input coefficient matrix. Further analysis is carried out to determine the role of the fisheries sector through the linkage of the fisheries sector, both Backward Linkage Index and Forward Linkage Index with other sectors, as well as through multipliers, the effect both the output multiplier and the income multiplier (Bulmer 1982; Langham & Retzlaff 1982; Miller & Blair 2009; Rustiadi et al 2011).

**Minimum requirement approach (MRA).** MRA is one of the tools in the regional economy used to describe the regional economy as a whole or specific to a sector, for example, fisheries to other economic sectors. This approach can describe the macro condition of the fisheries sector at the research location and see the specific picture of the fisheries sector against other economic sectors in an area. The MRA approach assumes that an area will not meet external demand before meeting its own need first. The MRA approach measures the strength of the basic sector by measuring its base multiplier. The formula is as follows (Fauzi 2010):

$$X_a^i = \left( \frac{RGDP_a^i}{RGDP_a} - \frac{RGDP_{min\ peer}^i}{RGDP_{min\ peer}} \right) RGDP_a^i$$

In this case, the MRA measurement uses the regional gross regional domestic product (RGDP) as one indicator. RGDP can measure the increase in the level of community income. The increase can be affected by two factors: an increase in income that can increase the population's purchasing power (actual increase) and income caused by inflation (Robinson 2014). The formula above states that the basic RGDP sector i (in this case fisheries) in region a is the multiplication of the total RGDP sector i in the region a with the difference between the share of the fisheries sector, with the minimum share of the closest sectors (peers). MRA techniques rely on areas with the same characteristics as a reference or peer. Lampung Province is a base for non-base areas (buffers), namely Banten Province, DKI Jakarta Province, and Riau Islands Province. These three regions were chosen based on their location close to Lampung Province.

## Results and Discussion

**Overview of Indonesia fisheries sector: role of fisheries sector.** The role of an economic sector in creating gross domestic product (GDP) is one indicator of its performance in the national economy. Figure 2 shows that the role of the marine and fisheries sector in the creation of national GDP in 2010 was 2.09%. In 2011 and 2012, the contribution increased by 2.12% and 2.13%. In 2013 and 2014, the contribution of the marine and fisheries sector experienced a faster increase compared to previous years, reaching 2.16% and 2.21%. At the end of 2014, aquaculture contributed 1.27% and this value was more significant than the contribution of capture fisheries (1.08%).

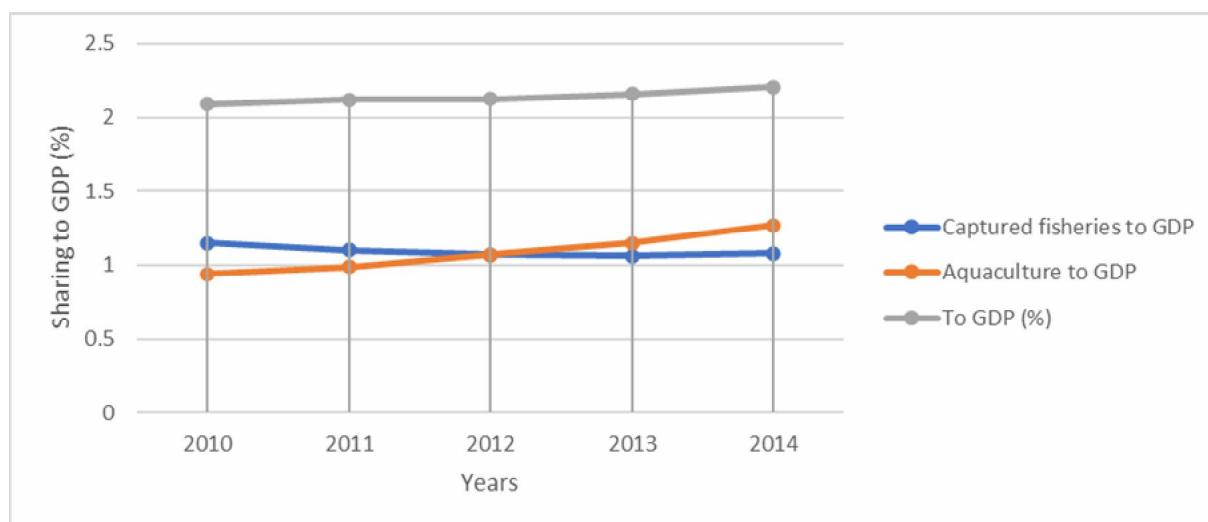


Figure 2. Indonesia fisheries GDP sharing 2010-2014 (Source: BPS 2015 (processed)).

According to Figure 3, GDP growth for the aquaculture sub-sector was 3.3% each year from 2011 to 2014, whereas it was 2.9% for the agriculture and forestry group sector. Meanwhile, the fisheries sector and the capture fisheries sub-sector recorded negative growth of  $-0.4\%$  year<sup>-1</sup> and  $-7.7\%$  year<sup>-1</sup>. This situation demonstrates that the aquaculture sub-sector, including mariculture, seems to positively impact GDP contribution compared to the captured fisheries sub-sector. It is becoming increasingly compelling that it can become a significant sub-sector in the future. In terms of production value, mariculture, including brackish water production, generated 74% of total fishery production in 2017 (MMAF 2017). The advantages of mariculture over other types of aquaculture are that the product is generally an export commodity with a high selling value. The massive potential of mariculture area (more than 12 million hectares) in Indonesia provides a comparative advantage over others; Indonesia is located in a tropical location suited for the cultivation of many species of finfish, mollusca, and seaweed (Rimmer 2010; Aslan et al 2015; MMAF 2015; Wirawati et al 2016).

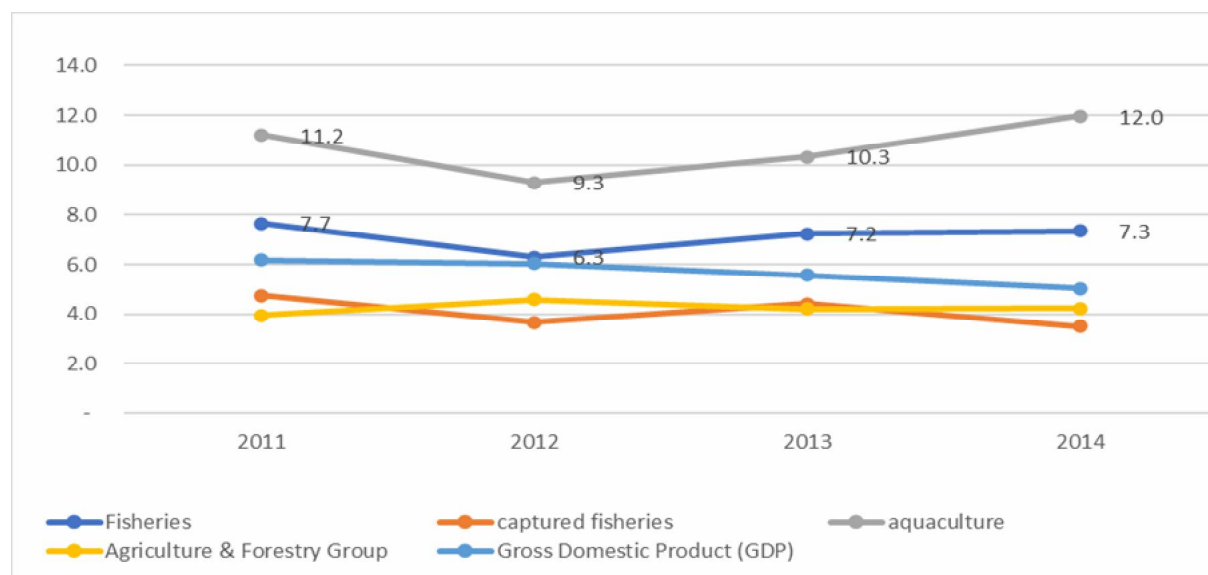


Figure 3. GDP growth of Indonesia fisheries sector, 2010-2014.

**Overview of Indonesia fisheries sector: mariculture contribution.** Mariculture is an essential component of Indonesian aquaculture. Most mariculture production (seaweed, grouper, Asian seabass, and other finfish commonly exported as live fish) is focused on producing for export markets. Mariculture production is an essential source of foreign

earnings for Indonesia's economy (Rimmer 2010). Total mariculture production from 2011 to 2017 continued to increase, from around 4.6 million tons to 9.9 million tons, with an average production trend of 15% year<sup>-1</sup>. Mariculture's contribution to the total fishery production is 41% year<sup>-1</sup>. The value of mariculture production in 2011 was around IDR 11.6 million year<sup>-1</sup>, and in 2017 it increased to IDR 33.6 million year<sup>-1</sup>, with an average annual increase of 30% year<sup>-1</sup>. The contribution of the value of mariculture to the total types of fishery production is 8.4% year<sup>-1</sup> (detailed shown in Figure 4).

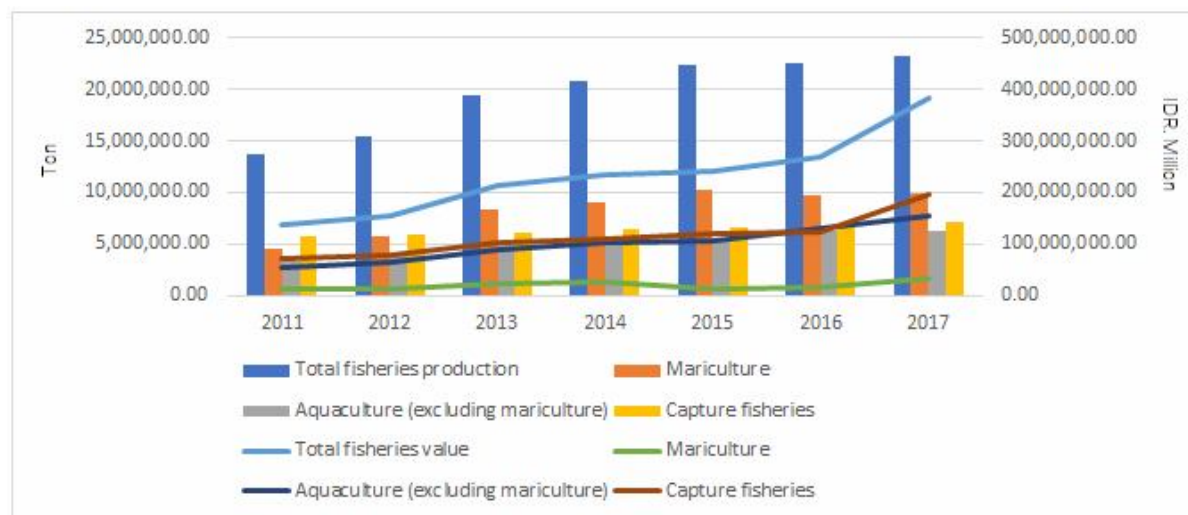


Figure 4. Total of fisheries production and value in Indonesia, 2011-2017.

**Economic ripple effect of fisheries sector in target area: linkage of fisheries with other sectors.** Bali and Lampung Provinces are fishery centers in Indonesia. Out of 35 sub-sectors, the fisheries sub-sector in Bali Province contributes the 8th highest RGDP. In comparison, Lampung Province's fisheries sub-sector is the sixth largest among the 16 sub-sectors. These two provinces can become fisheries centers in Indonesia, particularly for mariculture growth. Indonesia has many potentials, with an estimated 24.53 million hectares suitable for mariculture. The potential area for mariculture activities stretches from the tip of the western part of Indonesia to the eastern region of Indonesia. In 2017, the value of mariculture production contributed 9% to the total value of fishery production (MMAF 2018). Commodities cultivated in this area include grouper, barramundi, kerrang, sea cucumber, and seaweed (Dahuri 2003). Priority mariculture commodities feasible to develop in Indonesia include groupers, barramundi, lobster, and seaweed (Nurdjana et al 1999).

Based on the Input-Output analysis results, the fisheries sub-sector in Bali Province has a Backward Linkage (BL) value of 1.18 and a Forward Linkage (FL) of 0.96 (Table 1). Meanwhile, the fisheries sub-sector in Lampung Province has a BL value of 0.87 and an FL of 1.08 (Table 2). This demonstrates that the fisheries sector in Bali Province is a sector that uses intermediate inputs more than the total intermediate output to meet all demand, or that the fisheries sector uses the output from other sectors as input for its sector rather than producing output that can be used as direct input by other sectors. The fisheries sub-sector cannot attract upstream sectors and cannot promote downstream sectors (end sectors) that use their products as production inputs. Meanwhile, the sub-sector of fisheries in Lampung Province is the opposite. The fisheries subsector in Lampung Province produces a higher intermediate output to be used as input for other sectors. The value of the BL index for Bali Province has a value of > 1, which means that the backward linkage of the fisheries sector is above the average of all economic sectors or fisheries sectors, which can attract upstream sectors to develop. The value of the backward linkage index for Lampung Province has a value of < 1, which has the opposite implication to conditions in Bali Province. For Bali Province, the sectors with the highest BL index are the paper industry and printed goods. The FL is a feature that shows the relative contribution of a sector in meeting the entire economic sector's final



demand. FL index values are more significant than one, indicating that the sector can drive production growth in its downstream sector using its inputs. The fisheries sector has a small degree of forwarding linkages index of 0.96. The fisheries sector FL of 0.96 means that the average power to supply inputs to other downstream sectors is 0.96 units (Table 2). In Lampung Province, the sectors with the highest backward linkage index value are agriculture, forestry, and fisheries. The fisheries subsector in Lampung Province has an essential role in encouraging its upstream sector to develop. Likewise, the FL index values for the fisheries subsector also significantly can drive production growth in its downstream sector using inputs from the sector. The fisheries sector has a forward linkage index of 1.08 means that the average power to supply inputs to other downstream sectors is 1.08 units (Table 1).

According to the Income Multiplier Index value, the fisheries subsector in the two provinces has a favorable impact on raising regional income. The income multiplier index for the fisheries sub-sector in Bali Province is 0.19 (Table 2), which means that for every IDR 1,000,000 rise in final demand for the fisheries sub-sector, the impact on regional income will be IDR 190,000. Meanwhile, the fisheries sub-sector in Lampung Province has an income multiplier index value of 0.62 (Table 1), which means that for every IDR 1,000,000 rise in final demand for the fisheries sub-sector, the impact on regional income will grow by IDR 620,000. As a result, the development of fisheries in both regions is critical since it can enhance regional income.

Table 1

Linkage of subsectors and multipliers, Lampung Province

No	Sector	BL	FL	IM	OM
1	a. Agriculture, forestry and fisheries	1.16	1.59	0.62	1.23
	b. Fisheries*	0.87	1.08	-	-
2	Mining and excavation	1.16	1.47	0.38	1.13
3	Processing industry	1.14	1.42	0.36	1.47
4	Electricity, gas, steam / water & cold air	1.12	1.13	0.27	1.66
5	Construction	1.09	1.10	0.26	1.66
6	Wholesale and retail trade	1.06	1.08	0.25	1.34
7	Transportation and warehousing	1.03	1.00	0.24	1.56
8	Accommodation, food, and drink	1.00	0.87	0.23	1.51
9	Information and communication	1.00	0.86	0.22	1.42
10	Financial services and insurance	0.99	0.85	0.21	1.2
11	Real estate	0.94	0.78	0.2	1.25
12	Company services	0.94	0.77	0.19	1.43
13	Government administration	0.88	0.77	0.18	1.35
14	Defense and social security	0.86	0.77	0.17	1.43
15	Education, health, and social services	0.84	0.77	0.17	1.63
16	Other services	0.79	0.75	0.15	1.6

Note: BL = Backward Linkages Index; FL = Forward Linkages Index; IM = Income Multiplier Index; OM = Output Effect Multiplier Index; \*source from Central Statistics Agency Lampung Province, 2010 (processed).

According to the output effect multiplier index (OM), the fisheries sub-sector in Bali Province has an OM value of 1.45 (Table 2), which means that for every IDR 1,000,000 rise in final demand for the fisheries sub-sector, the impact on regional economic output increases by IDR 1,450,000. Meanwhile, Lampung Province's OM value is 1.23 (Table 1), which suggests that each final demand for the fisheries subsector grows by IDR 1,000,000, resulting in a regional economic output of IDR 1,230,000. The fisheries sub-sector in Bali Province has a more significant impact on demand output than the sub-sector in Lampung Province. However, the fisheries sub-sector in Lampung Province has a more significant impact on regional revenue than the sub-sector in Bali Province.

Based on all linkage indicators and multiplier effects through the I-O analysis above, it is known that the fisheries sub-sector in Bali and Lampung Provinces has become a strategic sector. Strategic sectors have extensive forward and backward

linkages and can create large multipliers. This is related to one of the asymmetric characteristics of the sector caused by (1) commodity characteristics and (2) characteristics of the primary sector actors (Rustiadi et al 2011). The fisheries sub-sector, with its commodities available in nature (capture fisheries) and traditional aquaculture, and the sector's primary actors, in this case, fishers and farmers who are still focused on selling their fish products for short-term gains, have weakened links with other sectors. If forward links with the downstream sector are enhanced, the fisheries sub-sector will become strategic. For example, the linkage with the fisheries sub-sector is through superior fish breeding activities, with the hotel and restaurant sub-sector through promoting fishery products in the tourism sector or through culinary tours. With the non-oil and gas industry sub-sector through post-harvest handling related to large-scale fish processing industries or creative small industries made from fish raw materials, it is hoped that it can absorb much labor.

Table 2

Linkage of subsectors and multipliers, Bali Province

<i>No</i>	<i>Sector</i>	<i>BL</i>	<i>FL</i>	<i>IM</i>	<i>OM</i>
1	Paddy	1.03	1.02	0.11	1.26
2	Other food crops	0.93	0.89	0.04	1.14
3	Horticultural	1.10	1.53	0.06	1.36
4	Animal husbandry and its products	1.30	1.15	0.09	1.60
5	Forestry	0.85	0.81	0.20	1.05
6	Fisheries	1.18	0.96	0.19	1.45
7	Crude, petroleum, natural gas and geothermal	0.81	0.81	-	1.00
8	Coal, iron ore mining, others	0.92	0.90	0.39	1.13
9	Petroleum refining	0.81	0.81	-	1.00
10	Palm oil industry	1.09	0.82	0.06	1.35
11	Seafood processing industry	1.04	0.82	0.06	1.28
12	Food beverage industry	1.20	1.05	0.06	1.48
13	Textile industry and textile products	1.05	0.98	0.13	1.30
14	Footwear and leather industry	0.97	0.85	0.18	1.20
15	Manufacture of wood, rattan and bamboo goods	0.99	0.97	0.11	1.22
16	Pulp and paper industry	0.91	0.83	0.15	1.12
17	Rubber industry and rubber goods	1.30	0.88	0.09	1.61
18	Petrochemical industry	0.94	0.90	0.09	1.15
19	Cement industry	0.81	0.81	-	1.00
20	Iron and steel base industry and nonferrous base metals	0.81	0.81	-	1.00
21	Metal goods industry	1.03	0.84	0.13	1.27
22	Electric machinery and electrical equipment industry	0.90	0.81	0.60	1.10
23	Transportation equipment industry and its repair	0.91	0.82	0.22	1.12
24	Other industries	0.99	0.84	0.23	1.22
25	Electricity, gas and clean water	0.89	1.10	0.06	1.10
26	Building	1.10	1.06	0.20	1.36
27	Trading	1.03	1.70	0.20	1.26
28	Hotel and restaurant	1.09	0.85	0.11	1.34
29	Land transportation	1.11	1.15	0.16	1.37
30	Water transportation	1.15	0.86	0.15	1.41
31	Air transportation	0.97	0.91	0.03	1.19
32	Communication	0.93	1.29	0.11	1.15
33	Financial institutions and agricultural services	0.95	1.61	0.09	1.17
34	General government and defense	0.85	0.81	0.50	1.05
35	Other services	1.03	1.75	0.12	1.27

Note: BL = Backward Linkages Index; FL = Forward Linkages Index; IM = Income Multiplier Index; OM = Output Effect Multiplier Index.



**Economic ripple effect of fisheries sector in target area: economic sector multiplier basis.** Based on the results of the MRA analysis, it is known that the sectors that have the most extensive multiplier base in the Central Indonesia region are Agriculture, Livestock, Hunting, and Agriculture Services. This indicates that for the central part of Indonesia, the sector still largely depends on Agriculture, Livestock, Hunting, and Agriculture Services and encourages other sectors to develop in the central region. The analysis results using MRA showed that the multiplier base value of the fisheries sector in Bali Province was 2.29 (Table 3); this implies that every IDR 1,000,000 RGDP in the base sector (fisheries sector) would encourage the creation of IDR 2,290,000 RGDP in the non-sector base. If it is estimated using the contribution of mariculture production value to the fisheries sector by 9% (MMAF 2018) then mariculture in Bali Province has contributed to other sectors as much as IDR 206,100 from every IDR 1,000,000 increase in GRDP from the fisheries sector. For Lampung Province, the results of MRA show that the multiplier base value of the fisheries sector in Lampung Province is 1.085 (Table 4), this implies that each IDR 1,000,000 RGDP creation in the base sector (fisheries sector) will encourage the creation of IDR 1,085,000 RGDP in the sector non-basis. If it is estimated using the contribution of mariculture production value to the fisheries sector by 9%, then mariculture in Lampung Province has contributed to other sectors as much as IDR 97,650 from every IDR 1,000,000 increase RGDP from the fisheries sector.

Table 3

Inter-sector base multiplier in Bali Province, 2019

No	Sector	Sector share	Minimum share peer	Total GRDP sector	Basic multiplier
1	Agriculture, livestock, hunting and agriculture services	0.095	0.090	1,126.782	19.726
2	Forestry and logging	0.000	0.000	-	-
3	Fishery	0.043	0.024	4,408.700	2.298
4	Mining and quarrying	0.009	0.009	-	-
5	Manufacturing	0.061	0.061	-	-
6	Electricity and gas	0.002	0.001	400.962	1.378
7	Water supply, sewerage, waste management and remediation activities	0.002	0.001	206.657	2.010
8	Construction	0.094	0.094	-	-
9	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.084	0.084	-	-
10	Transportation and storage	0.095	0.034	14,230.997	1.565
11	Accommodation and food services activities	0.233	0.014	51,416.911	1.064
12	Information and communication	0.052	0.045	1,605.541	7.616
13	Financial and insurance activities	0.039	0.027	2,695.989	3.358
14	Real estate activities	0.038	0.016	5,180.611	1.735
15	Business activities	0.010	0.005	1,385.336	1.766
16	Public administration and defense compulsory social security	0.053	0.023	6,892.700	1.786
17	Education activities	0.051	0.026	5,913.193	2.029
18	Human health and social work activities	0.022	0.006	3,690.223	1.394
19	Other services activities	0.016	0.014	511.565	7.224
Total		1			

Table 4

## Inter-sector base multiplier in Lampung Province, 2019

No	Sector	Share sector	Minimum share peer	Total RGDP sector	Basic multiplier
1	Agriculture, livestock, hunting and agriculture services	0.031	0.00047	7,609.637	1.015
2	Forestry and logging	0.0053	-	1,301.392	1.000
3	Fishery	0.005	0.00035	1,099.676	1.085
4	Mining and quarrying	0.079	0.00254	19,280.310	1.033
5	Manufacturing	0.266	0.13147	64,873.647	1.975
6	Electricity and gas	0.002	0.002	521.805	-
7	Water supply, sewerage, waste management and remediation activities	0.001	0.000	344.992	1.335
8	Construction	0.129	0.106	31,511.091	5.570
9	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.153	0.089	37,203.952	2.382
10	Transportation and storage	0.071	0.031	17,239.017	1.764
11	Accommodation and food services activities	0.022	0.022	5,261.096	-
12	Information and communication	0.054	0.020	13,074.276	1.605
13	Financial and insurance activities	0.029	0.027	7,135.066	15.082
14	Real estate activities	0.039	0.014	9,537.012	1.549
15	Business activities	0.002	0.000	499.126	1.025
16	Public administration and defence compulsory social security	0.047	0.020	11,496.778	1.736
17	Education	0.039	0.015	9,431.493	1.634
18	Human health and social work activities	0.013	0.009	3,112.994	3.346
19	Other services activities	0.013	0.005	3,051.727	1.733
Total		1			

Based on the results of the MRA analysis, the fisheries sector in Bali and Lampung Province has great potential to become the leading sectors or base sectors. The RGDP approach used in measuring sector bases can be a basis for measures to increase regional income (Aguiar et al 2016). The fisheries sector provides a massive multiplier to other sectors (non-basic sector) because it positively impacts other sectors. The encouragement of RGDP creation in other sectors means that added value in the fisheries sector adds value to other sectors because there are forward and backward linkages between sectors in an area. Compared to the food supply sector (Agriculture, Animal Husbandry, Hunting, and Agricultural Services), the fisheries sector is generally still below it. The research results conducted by Greyling (2012) have shown that the agricultural sector has been the leading food provider since time immemorial. However, the results of the MRA analysis show that the fisheries sector in Bali and Lampung Province can become the leading food supply sector for the community because the goods produced from these industries can be of direct consumption.

**Mariculture farmers in Bali and Lampung.** Primary commodities of finfish mariculture in the target area are grouper and Asian sea bass or barramundi. These two types of commodities are also the primary commodities in Indonesia in general (Mayerle et al

2020). The number of mariculture households in Indonesia continues to decline, with an average value of a declining trend over the 2012-2017 period of  $-2.52\% \text{ year}^{-1}$  (MMAF 2018). In study areas, the number of mariculture households continued to decline in the 2012-2017 period, where the declining number for Lampung Province ( $-24.47\% \text{ year}^{-1}$ ) was higher than Bali Province ( $-6.37\% \text{ year}^{-1}$ ). Mariculture in both areas performed in floating net cages. There are three types of floating net cages used in target areas, i.e. (1) a square with 3 x 3 m and 4 x 4 m with a depth of 3 to 5 meters, (2) a rectangle with a size of 3 x 4 m, 3 x 5 m and 4 x 6 m with a depth of 3 to 5 meters, and (3) Circles with a diameter of 4-10 m with a depth of 3 to 8 m. One unit of finfish mariculture consists of 6-9 cages (Firdaus et al 2020). Finfish farming in Lampung categorized in the micro and small-scale business (Fisheries Offices of Lampung Province 2019), while for the finfish farming in Bali categorized in the small scale and industrial scale business categories (BPS 2016).

Based on the survey, the average number of farmer household members in Lampung and Bali is the same, as many as four people, with the average number of children being two people. Generally, the larger the family size is, the greater the daily consumption will be thus, the heavier the burden on the laborers (Xu et al 2012). In general, small-scale farmers in both locations have workers. However, the difference is that the workers at the mariculture facilities in Lampung Province are primarily single and stay in the facilities, while the workers at the mariculture facilities in Bali Province are generally married. Most of them commute every day from house to a place Work.

The findings show that mariculture is the main livelihood for farmer's households. Livelihood refers to the means of earning a living or activities undertaken by a family to obtain the primary material needed to sustain household survival and development (Xu et al 2012). Farm household net income was divided into four types: finfish mariculture net income, agriculture net income, household member net income, and miscellaneous income (calculated as the sum of all income not included under finfish mariculture net income, agriculture net income, and household member net income). Farmers household income consists of income from finfish mariculture (obtained from the head of the family), income from agricultural activities, household members (children and wife), and others, such as transportation and commercial service providers. The most significant household income comes from finfish mariculture in both target areas, contributing more than 70% of total household income. Mariculture is the primary source of income for households. These conditions make households have a significant dependence on mariculture activities. Sources of income outside of mariculture for both target areas, less than 30% (Table 5). This is the average value of the head of the family's total income, excluding mariculture, as well as other household members such as wife and children, calculated as part of the income given to parents or for shared needs.

Household expenditure consists of food and non-food. Study results showed that the ratio of food expenditure from the total household expenditure was very high. From Table 5, it is known that finfish farmer's households in Bali Province are IDR 27.8 million  $\text{year}^{-1}$  (50.8%) and finfish farmer's households in Lampung Province, IDR 28.2 million  $\text{year}^{-1}$  (63.4%). Meanwhile, non-food expenditures in Bali province and Lampung province were IDR 26.9 million  $\text{year}^{-1}$  (49.2%) and IDR 16.3 million  $\text{year}^{-1}$  (36.6%). The highest portion of their food budgets was spent on staple foods for both target areas. In this study, staple food consists of rice, meat, fish, and eggs while spending on vegetables and fruits. Such a high percentage of food expenditure indicated that most households had low levels of well-being. This result is in line with the findings of many studies (Sekhampu 2012; Venn et al 2018; Zani et al 2019), which states that households with higher food expenditures indicate that the household is less prosperous. More significant non-food expenditures indicate that the household has met its immediate needs. The fulfillment of secondary and tertiary needs indicates that the family is more prosperous than the household with more significant food expenditure. Food is generally regarded as a normal good and basic necessity; thus, food expenditure follows the pattern suggested by Engel's law, where the proportion of income spent on food will decrease as income increases (Sekhampu 2012). Many things affect the amount of food expenditure; based on many studies, several variables that significantly affect household food expenditure

include household income, education of heads of household, and family size (Babalola & Isitor 2014; Kearney 2019). The ratio of total income to total expenditure for farmer households in the two target areas is more than 1, respectively, for finfish farmers households in Bali Province and 1.25 in Lampung Province. The value indicates that household income has met the standard of living wage value. In 1968 the International Labor Organization (ILO) defined a living wage as the "amount necessary to meet the reasonable needs (or basic needs) of an unskilled laborer with a family of average size."

Table 5  
Income, expenditure and Engel's coefficient of finfish farmers household in target area

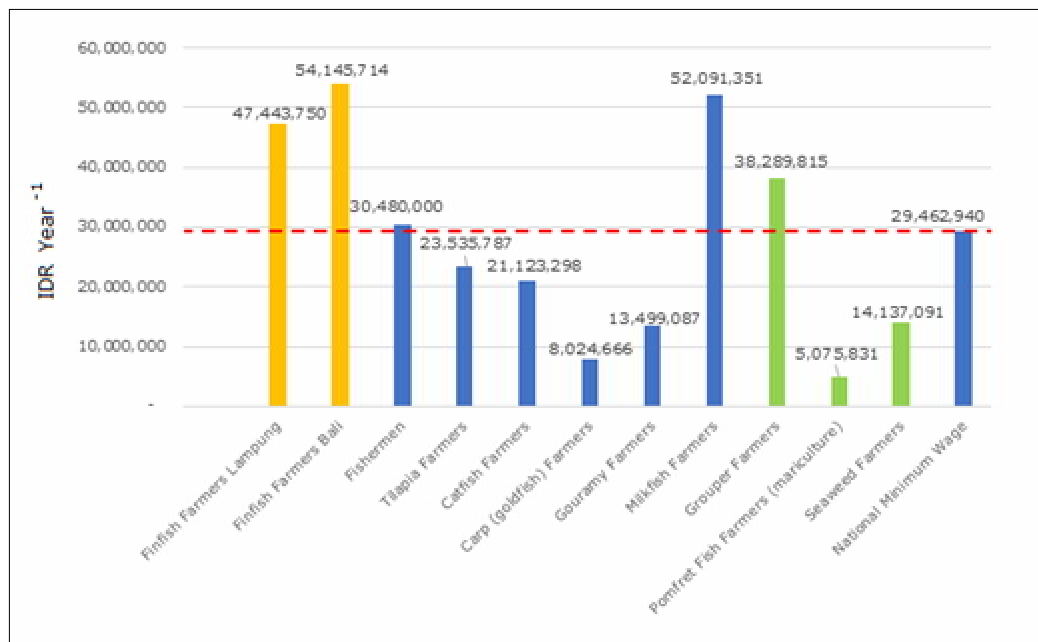
Items	Bali		Lampung	
	Value (IDR Year <sup>-1</sup> )	Percentage	Value (IDR Year <sup>-1</sup> )	Percentage
I. Income				
1.1 Finfish mariculture	54,145,714	78.9%	47,443,750	74.6%
1.2 Agriculture	2,871,429	4.2%	5,633,333	8.9%
1.3 Household members	11,150,000	16.3%	6,562,500	10.3%
1.4 Others	428,571	0.6%	4,000,000	6.3%
Total income	68,595,714	100%	63,639,583	100%
II. Expenditure				
2.1 Food				
2.1.1 Staple food etc.	18,051,429	32.9%	23,462,500	52.6%
2.1.2 Beverages	6,158,571	11.2%	600,417	1.3%
2.1.3 Cigarrete	3,605,143	6.6%	4,221,000	9.5%
Total food	27,815,143	50.8%	28,283,917	63.4%
2.2 Non-Food				
2.2.1 Education	5,732,857	10.5%	3,683,333	8.3%
2.2.2 Transportation cost	5,867,143	10.7%	6,540,000	14.7%
2.2.3 Electricity cost	2,610,000	4.8%	1,717,000	3.8%
2.2.4 Communication cost	2,412,857	4.4%	1,742,500	3.9%
2.2.5 Housing cost	10,360,857	18.9%	2,630,765	5.9%
Total non-food	26,983,714	49.2%	16,313,598	36.6%
Total expenditure	54,798,857	100%	44,597,515	100%
Engels coefficient	40.5%		44.4%	

\*According to the United Nations Food and Agriculture Organization (FAO) proposed standards, Engel's coefficient of more than 59% in poverty, 50-59% for food and clothing, 40-50% for a well-off, 30-40% for rich and less than 30% for the most affluent.

The results of the economic analysis of the ripple effect of the fisheries sector regionally in the target area show that the fishery sector has a positive impact on increasing regional income and regional output and being the base sector in the region. At the micro-level or at the household level, it is also proven to be a significant source of income. In general, income from finfish mariculture in the target area is above the national minimum wage (Figure 5). The minimum wage of a region will represent the region's welfare; the higher the minimum wage in the region, the higher the welfare of its people (Yunita & Sirait 2019). In addition, nationally, the income value is higher than the mariculture household income obtained from national data. Based on this evidence, it is increasingly convincing that the fisheries sector, especially mariculture in the target area, is an activity that provides benefits and becomes a strategy to increase income and reduce poverty.

The value of Engel's coefficient for finfish farmer's households in the two target areas, respectively, for Bali Province, is 40.5%, and Lampung Province is 44.4% (Table 5). According to the FAO, according to the standard Engel's coefficient, households in both study areas are in the category of "a well off," with Engel's coefficient value between 40-50%. According to Zhi-Guo et al (2010), Engel's coefficient is helpful to represent the effect of social-economic factors on residential, so that the smaller Engel's coefficient value will indicate a better socioeconomic condition of the population. Social, economic indicators can be represented by income growth, cost of living, health, and level of crime

(Diener & Suh 1997). The citizens are "better off" economically when consumption is sustainable, when total income is more equitably shared and when individuals have more security in their economic lives (Osberg & Sharpe 2005).



Note: - - - National minimum wage line

Yellow = finfish farmers income (primary data)

Blue = Other fisheries livelihoods (National secondary data)

Green = mariculture farmers income (National secondary data)

Figure 5. Farmer's income based on the commodities (IDR/year)  
(Source: BPS 2020; MMAF 2020 (processed), primary data 2020 (processed)).

**Conclusions.** The fisheries sector in Indonesia has a significant contribution to the economy, which is marked by positive growth. The aquaculture sub-sector, in particular, has had a positive impact on the GDP growth of the fisheries sector. At the same time, the fisheries sector in general and the capture fisheries sub-sector have decreased. In particular, mariculture is the most significant contributor and has a comparative advantage because it has a high production value and vast potential for land suitability. Specifically, the fisheries sector in the provinces of Bali and Lampung provides an economic ripple effect as shown by the I-O analysis; the fisheries sector in the two provinces can provide supply inputs to other downstream sectors. Also has an essential role in encouraging its upstream sector to develop. In addition, it is proven from the I-O analysis that the fisheries sector can have a positive impact on the income multiplier and output multiplier effect in the two provinces. Based on the results of the MRA analysis, the multiplier base value of the fisheries sector in Bali Province in every IDR 1,000,000 RGDP in the fisheries sector would encourage the creation of IDR 2,290,000 RGDP in the other sectors. Furthermore, for Lampung Province, each IDR 1,000,000 RGDP creation in the fisheries sector will encourage the creation of IDR 1,085,000 RGDP in the other sectors. The fisheries sector in Bali and Lampung Province has great potential to become the leading sectors or base sectors. Furthermore, in particular, the economic ripple effect of mariculture at the level of finfish farmers, where mariculture contributes to the household income of more than 70%, making mariculture a primary livelihood. This condition has shifted because most coastal communities in Indonesia use mariculture as a side livelihood, and some use income from mariculture as savings. In general, income from finfish mariculture in target areas is higher than the national minimum wage, which means that this income has been able to meet the needs of a standard of living. However, in general, finfish mariculture households in the target areas are in the category of "a well off," with Engel's coefficient value between 40-50%.

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**Conflict of interest.** The authors declare that there is no conflict of interest.

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#### Authors:

Maulana Firdaus, Department of Agribusiness Management, Graduate School of Agriculture, Tokyo University of Agriculture, Tokyo, Japan; Research Centre for Marine and Fisheries Socio-Economic, Indonesia Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia, e-mail: 46719401@nodai.ac.jp

Katsumori Hatanaka, Department of Agribusiness Management, Graduate School of Agriculture, Tokyo University of Agriculture, Tokyo, Japan, e-mail: k3hatana@nodai.ac.jp

Ramadhona Saville, Department of Agribusiness Management, Graduate School of Agriculture, Tokyo University of Agriculture, Tokyo, Japan, e-mail: sr203424@nodai.ac.jp

Achmad Zamroni, Research Centre for Marine and Fisheries Socio-Economic, Indonesia Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia, e-mail: roni\_socio@yahoo.com

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