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Income of Seaweed Farming Households: A Case Study From Lemo of Indonesia

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Abstract. Seaweed farming is widely considered to be a profitable source of income and lucrative livelihood for coastal communities in Indonesia. This paper aims to analyze the income of seaweed farming households in the village of Lemo, Poleang Tenggara sub district, Bombana district, SE Sulawesi, Indonesia. This paper also assess perception of farmers and their participation in diversified livelihoods. A formal household survey was conducted using a structured questionnaire covering the patterns of income from seaweed farming, fishing, and other occupations of 64 selected respondents. Results show that all respondents engaged in a combination of seaweed farming and fishing and non-fisheries activities. However, seaweed farming has the highest contribution to household income of all activities. In addition, the majority of seaweed farmer households in Lemo village have incomes below the National Poverty Line due to the low quality of human resources; lack of qualified farming technology, especially qualified seedlings plus lack of access to marketing networks, information and communication. Therefore, some recommendations for improving the seaweed farming methods need to be implemented.

Keywords: *Income, seaweed farming, fishing, Sulawesi*

1. Introduction

Seaweed farming is widely considered to be a profitable source of income and lucrative livelihood for coastal communities [1,2,3] whose incomes are below the national poverty line [3,4]. There is significant evidence that seaweed farming could offer continuous income and economic livelihood to coastal households [2,3,4,5,6] since the households have some difficulties in obtaining their daily needs by relying on fishing only [7,8]. Seaweed farming requires low costs, minimum technology and technical expertise [1,9,10]. From a production perspective, the farming has provided significant occupational opportunities for thousands of households and its contribution boosts income growth and national exports [5,10].



Indonesia is the biggest producer of seaweed in the world [10,11]. In 2015, Indonesia produced 11,270,000 Metric tonnes (MT) of seaweed [12]. The Ministry of Fisheries and Marine Affairs of the Republic of Indonesia/ KKP in 2017 aimed to increase the production of seaweed to 13.4 million MT from 11.4 million MT in [12]. In Indonesia, seaweed production has already spread into all provinces. Southeast (SE) Sulawesi province is one of the centres for seaweed production in Indonesia (General Directorate of Aquaculture [12]. SE Sulawesi has a marine area of 114.879 km², with the total coastline reaching 1.740 km [13]. Considering these facts, almost all regencies/cities in SE Sulawesi are potential cultivation areas for seaweed farming [6,14,15].

The cultured species of seaweed in SE Sulawesi is *K. alvarezii* and *Eucheuma denticulatum*. One district in SE-Sulawesi which has great potential for the development of seaweed farming is Bombana. In 2016, the seaweed production in Bombana reached 4,500-5,000 MT of dried seaweed per harvest period. Almost all coastal areas in Bombana are being used for seaweed farming, especially in the sub-district of Poleang Tenggara [16]. Indeed, the standard of living in many coastal villages in SE Sulawesi has improved since the introduction of seaweed farming [6,15,17]. However, information on the actual contribution of this seaweed farming activity to household income and its interaction with other economical activities is still scarce in SE Sulawesi, especially in Lemo village, in the sub district of Poleang Tenggara, Bombana. Some previous studies of the income of seaweed farmers had been done in SE Sulawesi [6,15,17] but in Lemo village it is poorly covered. From the studies, it was found that most seaweed farmers' household income falls below the national poverty line. Therefore, the aims of the study were to describe and analyze the income of seaweed farming households in the Lemo village.

2. Method

This study were held in October-November 2016. It was conducted in the village of Lemo, Poleang Tenggara sub district, Bombana district, SE Sulawesi, Indonesia (figure 1). The villagers of Lemo are highly dependent on marine resources including seaweed farming and fishing as there are very few alternative income-generating opportunities. The village is predominantly inhabited by people of Buginese ethnicity. The long line method is used for seaweed farming. For fishing activities, a limited range of fishing gears and methods are being used in the village. The gears and methods used are gillnets, and crab net. Most operations are done by individuals, but in some cases they are done by small groups of fishermen.

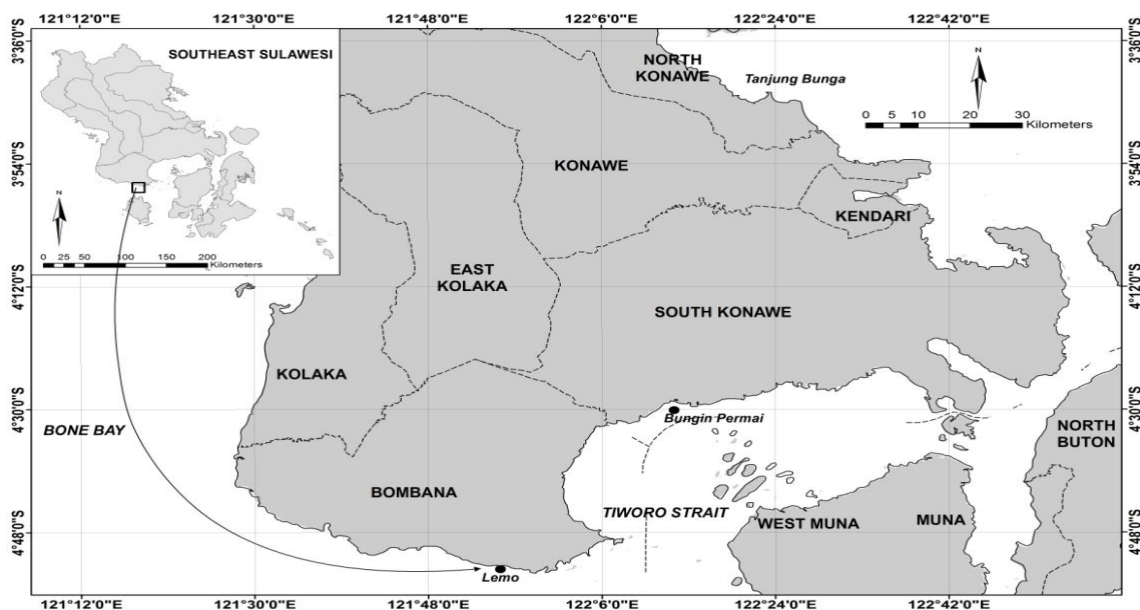


Figure 1. Map of Lemo Village, Poleang Tenggara sub district, Bombana district,

In-depth interviews were done with a range of informants; including leaders of Lemo village, elder respected people, official of government agencies and selected households. 64 households were selected by peer recommendation following discussion with village leaders, on the basis that they represented a range of involvement in both seaweed farming and fishing. A formal household survey was conducted using a structured questionnaire covering the patterns of income from seaweed farming, fishing, and other occupations. The survey noted the respondent's age, formal education, farming experience, and the number of children living in the household. Information collected also included occupational diversity for all interviewed households. Incomes were recorded in Indonesian Rupiah (IDR; average exchange rate of IDR13.515: US\$1 in October 2017). The survey also recorded perceptions about seaweed business management and problems encountered in seaweed farming.

[3]. Results

3.1. Respondent characteristics

All respondents in Lemo engaged in a combination on seaweed farming and fishing activities. They were diversifying their livelihood to reduce their financial problems. This combination was similarly found in North Sulawesi, Indonesia [18] and in Iloilo, Philippines [19]. All respondent characteristics are furnished in table 1.

Age of respondents - Farming and fishing was mostly done by farmers in the age group of 15-55; which constitutes about 89.06 per cent of the respondents (with the age average being 41.80). The average age found in this study was nearly the same as that in a previous study done by [20] in the Spermonde Islands, Indonesia. The percentage of farmers older than 55 was 10.93 per cent. It was important to note that most respondents are in their productive years. Seaweed farming and fishing appear as a viable option for livelihood on average in the age group of 40 years in Lemo village.

Table 1. Characteristics of the respondents

Characteristics	N	%
Age (years)		
15-55	57	89.06
> 55	7	10.93
Education		
Illiterate	0	0.00
Elementary School	52	81.25
Junior High School	5	7.81
Senior High School	7	10.93
Family members (persons)		
< 2	9	14.06
2-5	43	67.18
> 5	12	18.75
Length of experience of doing economic activities (years)		
< 4	11	17.18
4-11	43	67.18
> 11	10	15.63

Education Level - The level of education includes primary, middle, high school and above. The primary level indicated schooling till sixth grade (elementary school), middle level (junior elementary school) indicated by schooling till ninth grade, high school schooling (senior high school) till twelfth grade. All respondents at the research site had at least a basic education in elementary school. Most of respondents (81.25 per cent) completed elementary school, 7.81 per cent completed junior elementary school, 10.93 per cent completed senior high school. Data indicated that the majority of respondents had attended formal education, even though only until the levels of elementary and junior high schools.

This result was similar to that found in the Spermonde Archipelago, Indonesia [20] and in North Sulawesi, Indonesia [18] where the farmers mostly have a primary level of education. In addition, the low level of education among farmers needs to be solved by specific training efforts to enable them to better take up their farming activities [18].

Family members - More than half of respondents' households (67.18 per cent) have family members of 2-5 persons, with an average of 2.50 persons. Households with members fewer than 2 persons account for 14.06 per cent, while those with members of more than 5 persons are 18.75 per cent. The number of family members in a household contributes to the willingness to accept risks [18].

Farming experience– Seaweed farming has been practiced by the farmers for more than 11 years (15.63 per cent of the respondents), and the remaining (67.18 per cent) have farmed for 4-11 years, with the average of 8.02 years. This indicates that on average the farmers have experience in seaweed farming activities as well as in fishing activities. Many seaweed farmers learned directly from more experienced farmers. However, formal training, practical workshops or other alternative practices about seaweed farming should be done to improve farmer's knowledge and technical skills.

3.2 Income of households

3.2.1 Income from seaweed farming

Income of respondents from seaweed farming on average was IDR. 10.800.000/year. The lowest income IDR 3.600.000/year and the highest IDR 18.509.000/year. Average monthly incomes of the farmers in Lemo village was IDR 900,000. Indeed, incomes of respondents could be categorized as follows: low (<IDR. 3,600,000), middle (IDR. 3,600,000-IDR. 15,750,000) and high (>IDR. 15.750.000). Most farmers (92.2 per cent) had incomes in the middle range and only 6.3 per cent had high incomes.

Table 2. Income from seaweed farming household

Income of seaweed farm household	N	%
Low (<IDR. 3,600,000)	1	1.6
Middle (IDR. 3,600,000- IDR. 15,750,000)	59	92.2
High (>IDR. 15,750,000)	4	6.3
Average (IDR)	10.800.000	

The majority of respondents who had middle range incomes (IDR. 3,600,000- IDR. 15,750,000) also had long experience (4-11 years) of cultivating and managing the business of seaweed farming.

3.2.2. Income from fishing

The farmers engaged in fishing as a diversified livelihood to earn more income (table 3). The income obtained from fishing) using gill nets on average was IDR. 1,448,635/year. The lowest income was IDR 1,000,000/year and the highest was IDR 21,608,750/year. The average monthly income from fishing activities reached IDR. 120,719. Income from fishing using fish nets was divided into three categories: low (<IDR. 1,500,000), middle (IDR 1,500,000-4,500,000), and high (>IDR. 4,500,000). 45 of respondents (70.3 per cent) were in low category.

Table 3. Income of seaweed farmers generated from fishing activities using a gill net

Income from fish net	N	%
Low (<IDR. 1,500,000)	45	70.3
Middle (IDR. 1,500,000- IDR. 4,500,000)	10	15.6
High (>IDR. 4,500,000)	9	14.1
Average (IDR)	1,448,634.8	

Besides fishing, crab nets were also used by the seaweed farmers to catch crabs from the seaweed farming areas (table 4). This activity on average contributed IDR. 1,468,093,3 /year. The lowest income was IDR 800,000 /year, while the highest was IDR 10,200,000.

Table 4. Income of seaweed farm households generated from crab netting.

Income from crab net	N	%
Low (<IDR. 1.950.000)	51	79.7
Middle (IDR. 1.950.000- IDR. 3.470.000)	5	7.8
High (>IDR. 3.470.000)	8	12.5
Average (IDR)	1,468,093,28	

The income generated from crab collection using fish nets was divided into three categories: low (<IDR. 1,950,000), middle (IDR. 1,950,000-3,470,000), and high (>IDR 3,470,000). There were 51 respondents (79.7 per cent) in the middle category, and the other 8 respondents (12.5 per cent) were in the high income category.

3.2.3 Income from non-fisheries activities

Income from non-fishing activities engaged in by seaweed farming households was also found during this study (table 5). The respondents had small kiosks incorporated into their main houses. Initial investment for the kiosks often originated from seaweed farming and fishing activities. Loans were rarely used.

All kiosks sold basic needs to the villagers daily. The average yearly income generated by these activities was IDR 4,916,250. The lowest income from these activities/year was IDR 1,800,000 while the highest was IDR 60,000,000. The monthly income on average was IDR 409,688.127.

Table 5. Income from non-fishing activities done by seaweed farming households

Income from non-fisheries	N	%
Low (<IDR. 6.000.000)	54	84.38
Middle (IDR. 6.000.000- IDR. 30.000.000)	6	9.4
High (>IDR. 30.000.000)	4	6.3
Average	4.916.250	

There were 54 respondents (84.38 per cent) in the low category, and the other 4 respondents (6.3 per cent) were in the high income category.

3.2.4. Total Contribution from seaweed farming, fishing, and non-fisheries activities

Total income from seaweed farming, fishing and from non-fisheries activities received by the farmers in Lemo village was shown in table 6. The total income was IDR 17.184.343 per year or around IDR 1.432.029 per month.

Table 6. The total income from seaweed farming, fishing and non fisheries activities

Income	Income Sources				Total Income	Monthly income
	Seaweed farming	Gill net	Crab net	Non fisheries		
Average income (IDR)	10.800.000	1.448.635	1.468.093	4.916.250	17.184.343	1.432.029
Contribution (%)	62.84	8.43	8.54	28.61	100	

Seaweed farming has contributed significantly to household income in the village. Seaweed farming contributed 62.84 per cent to average household income (table 6). An average seaweed farm in Lemo was estimated to generate IDR 10.800.000 (USD 799) per year. Following that were non-fisheries activities (28.61 per cent), fishing using a gill net (8.43 per cent) and fishing using a crab net (8.54 per cent), respectively. On the other hand, the non-fishery activities should be conducted more intensively to promote livelihood diversification.

Perception about seaweed farming

There are several problems regarding seaweed farming activities in the Lemo village: price fluctuation, availability of seaweed seedlings stock, lack of guidances about marketing information and networks, postharvest processing and entrepreneurial skills and low participation in seaweed development programs. All the respondents were satisfied with the income created by seaweed farming and fishing activities. However, most of them complained that the dried seaweed prices constantly fluctuate and often seaweed farmers receive low prices from the seaweed buyers. Indeed, although the contribution of fishing to household income was comparatively lower than seaweed farming, the farmers were commonly satisfied with the income it created. The frequent income from fishing was used to finance daily basic needs, while infrequent income from seaweed farming was used to pay the school tuition fee for their children and to buy many household goods.

As for seaweed quality and farming efficiency, the respondents still complained about the limited quantity of seaweed seedlings provided through government assistance. The Bombana district government only provided very limited numbers of the qualified seedlings required by the farmers. The farmers are always asked by the government officials to produce their own seedlings using vegetative propagation method from the given seedlings, or to buy the seedlings from other farmers. However, the farmers complained that vegetative propagation always took a long time (around 25-35 days) and they could not buy seedlings from other farmers due to lack of money. The farmers need also need some guidance about marketing information and networks, postharvest processing and entrepreneurial. Post harvest processing for drying seaweed, for instance, was still poor. The seaweed were mostly dried on the ground and contaminated with sand and some organic debris. Seaweed buyers then usually bought the dried seaweed for low prices.

Participation of seaweed farmers in seaweed development programs provided by the government was still low. This was caused by poor government communication. Therefore, most seaweed farmers in Lemo village rely on their relatives, and friends for getting the latest news and information regarding the seaweed prices and marketing networks. Before any implementation of the program, all farmers believe the government should facilitate a better communication and engagement with all stakeholders, including farmers, buyers, processors, government officials and NGOs, as well as the fishermen living in the village.

4. Discussion

4.1 Seaweed farming and diversified livelihoods

Seaweed farming has been recognized as a valuable source of income and is a part of diversified livelihood in coastal communities in Indonesia [2,3] especially in SE Sulawesi [17, 21, 15, 6]. All seaweed farmers in Lemo village had two main lucrative livelihoods: seaweed farming, and fishing as was similarly also found in Laaikang bay, Indonesia [22] and in Iloilo, Philippines [19]. On the other hand, there are also components of non-fishery economic activities as a source of household income found in the village. Seaweed farming has made a significant contribution to improving the socio-economic level of coastal household in the village through: (i) providing diversified livelihoods to provide for daily basic needs of farmer's family; (ii) generating farmer's income and employment; (iii) supporting small and medium enterprises both in fishery and non-fishery activities, and (iv) developing market linkages and networks between the farmers and seaweed buyers. In recent years, seaweed farming has become the primary source of livelihoods in the Lemo village. More than 90 per cent of farmers's activities are spent in the preparation of materials, tying of seedlings, planting, monitoring, harvesting and packing of dried seaweed. In addition, all households involved in seaweed farming in Lemo village were also fishing as was similarly also found in Laikang Bay, South Sulawesi, Indonesia [22]. [2-3, 22] had reported that seaweed farming had not influenced the decrease of fishing activities. In this case, fishing could significantly be referred to as a supplementary source of income [2,3,22]. Are two main reasons given for households continuing to engage in seaweed farming and fishing.

Firstly, seaweed farming provides delayed-return incomes or only received after harvest income (e.g. to school the children or to pay major household needs) while fishing provides immediate incomes for daily needs (e.g. to buy daily consumables such as food and drinks). Secondly, seaweed farming tends to be a more stable annual income for households than fishing [23,24], while fishing has a capacity for frequent chances. Moreover, seaweed farming could generate frequent income. It can be achieved in two ways. Firstly, year-round income from seaweed farming could be achieved by a rotational or simultaneous system of planting or frequent planting at any season. Secondly, frequent income could be generated at any time by drying and/or storing the dried seaweed for later sale. Therefore, these two activities, seaweed farming and fishing, could stabilize the household income [25].

4.2 Income of seaweed farming

Seaweed farming activities contribute more than fishing and non-fisheries activities to household income in Lemo village (table 6). The farmers can earn, an average of IDR 10.8 million each year, equivalent to USD 800 per year. In contrast, income from fishing (using a gill net and a crab net) and non-fisheries activities, on average, each year generate IDR 2.92 million and IDR 4.92 million, respectively. This study showed that seaweed farming contributed 62.84 percent to average household income, followed by non-fisheries activities (28.61 per cent) and fishing activities (16.97 per cent). Based on this study, an average seaweed farm income in Lemo village was significantly higher than in Bau Bau, Indonesia [17]. The average income IDR 10.8 million each year was equivalent to IDR 900.000/capita/month or USD 66.67/capita/month from seaweed farming. It is higher than the previous study done by [17] in Baubau, where the average income of seaweed farmers is IDR 144,297.42/capita/month or equivalent to US\$15.74/capita/month. However, the majority of seaweed farmer households in Lemo village earn below the National Poverty Line (table 2-5). The national poverty line of Indonesia is IDR 354,386 equivalent to USD 25 per month as decided by the World Bank. This implies that the income of seaweed farmers is still below the international poverty line of USD1.25/day currently used by the World Bank.

4.3 Constraints and Opportunities

Most seaweed farmer households have their income below the Indonesian Poverty Line. This is mainly caused by low levels of education, lack of qualified farming technology especially qualified seedlings, lack of access to marketing networks, information and communication. From the human resource point of view, only a few household farmers had the opportunity to participate in the training, since the training was conducted far from their village or the farmers did not get any information regarding the training from the local government. Therefore, on-site training, workshops and extension services at relatively low costs are urgently needed by the farmers. Good quality seedling have a significantly positive impact on the seaweed production [17]. Repeated vegetative propagation is usually used by the farmers during their farming period. However, in recent years, it was observed that seedlings showed lower growth rates and an increased susceptibility of diseases [9]. In order to increase the productivity of seaweed seedling, tissue-cultured seedlings are urgently needed to produce a high number of uniform specimens with desirable characteristics in a short period of time [26] with higher growth rates [27,28].

5. Conclusions and Recommendations

In Lemo village, seaweed farming, mainly of the species *Kappaphycus alvarezii*, is the main livelihood and the primary source of household income. However some constraints still occur in this activity. Therefore, some recommendations for improving the seaweed farming activity need to be implemented. Firstly, the government should regularly conduct training and extension services for seaweed farm households. Secondly, the local government should support the farmers to use tissue-cultured seedlings. In the near future the seedlings should be certificated to maintain the high quality and continuous supply. Thirdly, the government should teach the farmers entrepreneurship skills. Such skills are very important to explore business networks, and to negotiate reasonable prices with buyers. Fourthly, all farmers should fully participate in decision-making processes facilitated by the local government.

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