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Livelihood Features of Seaweed Farming Households: A Case study from Bungin Permai Village, South Konawe, South East (SE) Sulawesi, Indonesia

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Abstract. The aim of this study was to analyse the variations and structure of seaweed farming household incomes; to quantify the income coming from various income sources and to analyse the efficiency of seaweed farming. The study was conducted in the village of Bungin Permai, South Konawe from July to September 2016 using structured interviews. In total there were 96 household respondents involved. Income structures and strategies were analysed descriptively, while the amount of income was determined using income analysis. The results showed that most respondents worked in the fisheries sector as seaweed farmers (n=75; 77%) and also as fishermen. The average income generated by seaweed farming households was IDR. 29,154,121 annually; the income from seaweed farming was IDR. 10,556,724 annually, while the income obtained from non-fishing activities was IDR. 11,071,875 annually. The respondents generated additional income by catching crabs, fishing using traps and anchored lift nets (*bagan*). When all the depreciated assets (e.g. ropes, floats, and traditional boats) were included in the expenses, the mean C/R (cost-to-revenue) value of seaweed farming was 1.88. The lowest R/C was 0.96 while the highest was 21.04. Those R/C values mean that seaweed faming in Bungin Permai was generally efficient and profitable.

1. Introduction

Seaweed farming has made a significant contribution for economic improvement particularly in coastal communities in Indonesia [1–3]. From an economic perspective, seaweed farming can offer continuous income and economic livelihoods for the farmers and their families in many coastal areas [2–6]. The majority of these farmers are marginalized fishermen who have some difficulties in

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fulfilling their daily needs because their incomes are still below the Indonesia poverty line [1,7,8]. From a production point of view, seaweed farming has contributed to significant occupation opportunities for thousands of households and to boosting 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]. In 2017 the Ministry of Marine Affairs and Fisheries (MMAF) aimed to increase the production of seaweed from 11.4 million MT to 13.4 million MT [12]. In Indonesia, seaweed production is well distributed across all provinces.

Southeast (SE) Sulawesi Province is one of the centres for seaweed production in Indonesia [12]. SE Sulawesi has a marine area of ± 114.879 km^2, with a total coastline measuring 1.740 km [13]. Therefore, almost all regencies/cities in SE Sulawesi are potential cultivation areas for seaweed farming [6,14,15]. The most widely cultivated seaweed species in SE Sulawesi waters is *Kappaphycus alvarezii* [16–18]. This species can be cultivated with low capital and production costs and has a high market demand coupled with a short production cycle. Among the 17 districts in SE Sulawesi, South Konawe is one district which has great potential for seaweed farming development. The seaweed cultivation area in South Konawe district is about 3,210 ha with production reaching 275,256.41 [16]. Additionally, since the introduction of seaweed farming, the standard of living in many coastal villages in SE Sulawesi has improved [6,15,17]. However, information on the actual contribution of this seaweed farming activity to household income and its interaction with other economic activities is still scarce in SE Sulawesi, especially in Bungin Permai village in the sub-district of Tinanggea, South Konawe. Some previous studies on the income of seaweed farmers have been done in SE Sulawesi [12,15,17] but Bungin Permai village is poorly covered [17]. From these previous studies, it was found that the income of most seaweed farming household was below the national poverty line.

This research is very important for supporting the seaweed farming business development in the area of South Konawe, especially the 'supply and demand' aspect. Business development is one of the factors that can increase income through cost and income efficiency to enable sustainable, efficient business practices in seaweed farming. This will finally support and encourage the farmers to become sustainable business managers in the seaweed business. Therefore, the aims of the study were to analyse the variations and structure of seaweed farming household income, to quantify the income from various sources and to analyse the efficiency of seaweed farming in Bungin Permai village.

2. Methods

This study was conducted from July to September, 2016 in Bungin Permai village, Tinanggea Sub District, South Konawe District, SE Sulawesi Province, Indonesia (Figure 1).

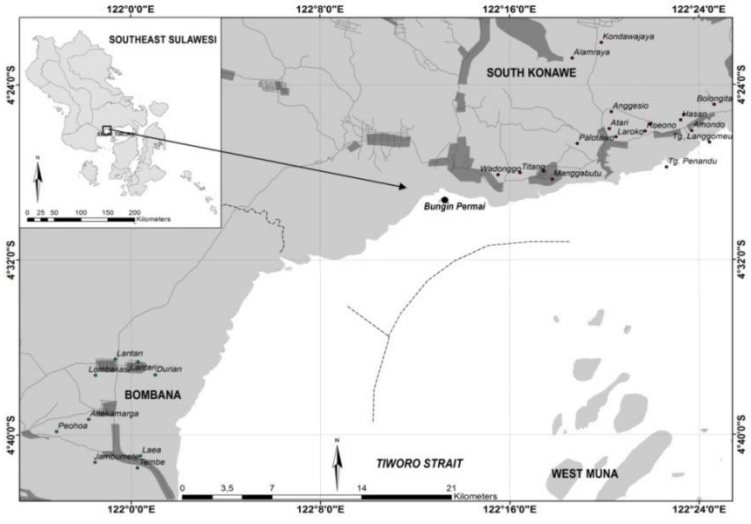

Figure 1. Map of Bungin Permai village, Tinanggea, South Konawe, SE Sulawesi.

The village of Bungin Permai is a centre for seaweed farming production in SE Sulawesi especially in South Konawe. A long-line method is used for seaweed farming. In addition, a limited range of fishing equipment and methods are currently used by local farmers In-depth interviews were done with some informants, including selected seaweed farmer households, local village leaders, respected elders and official of government agencies. A total of 96 households were selected based on peer recommendation following discussion with village leaders and respected elders and on the basis that those chosen represented a range of involvement in seaweed farming.

A formal household survey was conducted using a structured questionnaire covering the ethnicity, respondent's age, formal education, farming experience and number of children. It also asked for the household patterns of income from seaweed farming, fishing, and other non-fisheries occupations. Information collected also covered occupational and income diversity for all interviewed households. Incomes were recorded in Indonesian Rupiah (IDR; average exchange rate of IDR. 13,175: US$1 in December 2016).

2.1. Data analysis

Income analysis was used to analyse the income of farmers while cost efficiency was analysed using R-C Ratio. R/C is the ratio of total revenues obtained to the total costs incurred. R is total revenue and C is total cost. The criteria used are that if R/C > 1, then the business is profitable; if the value of R/C = 1, then business activities are not profitable (break even); and if the R/C value is <1, then the managed business suffers a loss. The business income obtained was calculated by the formula:

$$\pi = R\text{-}C \quad (1)$$

$$R = Y*Py \quad (2)$$

$$C = TVC + TFC \quad (3)$$

$$= X_i*Px_i + TFC \quad (4)$$

where:

π	= Income (IDR)
R	= Total receipt (IDR)
Y	= Seaweed production (kg)
P	= Price per kilogram of seaweed (IDR)
X	= Amount of i-input
Pxi	= Price of input to i
C	= Total cost / production costs (IDR)
TVC	= Total Variable Cost (IDR)
TFC	= Fixed Cost Total (IDR)

3. Results and Discussion

3.1. Characteristics of Respondents

The characteristic of the respondents (ethnicity, age, education level, family member and farming experience) are shown in table 1**.** Most respondents interviewed were of Bajo ethnicity (76.53%) followed by Buginese (12.24%), Tolakinese (2.04%) and other ethnicities (9.18%). All worked mainly as seaweed farmers to obtain income.

Most respondents (86.73%) were in the 25-49 years age range (with the average being 40.94 years), whereas respondents aged more than 49 years account for 8.16%. This means that most respondents were in the productive age range This is similar to previous studies done in Lemo, SE Sulawesi [19] and in the Spermonde islands [20]; where it was found that most respondents were in their productive years. The majority of respondents had attended formal education at the levels of elementary and junior high schools, while around 10% had never attended formal education (illiterate). This is similar to the cases in Lemo, SE Sulawesi [19] and in North Sulawesi [15] where most seaweed farmers had at least a primary level of education. The relatively low level of education (very few respondents

continued to senior high school or above) was due to the very limited educational facilities, infrastructure and support found in Bungin Permai village.

Table 1. Characteristics of interview respondents.

Characteristics	N	%
Ethnicity		
Bajo (sea gypsy)	75	76.53
Buginese	12	12.24
Tolakinese	2	2.04
Others	9	9.18
Age (years)		
< 25	8	5.10
25-49	85	86.73
> 49	5	8.16
Education		
Illiterate	10	10.02
Elementary School	52	40.82
Junior High School	31	31.63
Senior High School	4	4.08
University	1	1.02
Family members (persons)		
< 1	1	4.08
1-7	93	94.89
> 7	4	1.02
Length of experience in seaweed farming activities (years)		
< 2	16	16.33
2-7	75	76.53
> 7	16	7.14

Most respondents (close to 95%) had a family membership of 2-7 persons. A high number of family members is very important to support seaweed farming activities, especially for tying the seedlings, planting, maintaining the seaweed during the cultivation period and harvesting the seaweed. This trend was similar to that found in Lemo, SE Sulawesi, Indonesia [19].

Most respondents (over 75%) had been involved in seaweed farming for 2-7 years, the remainder had been active for fewer than 2 years and more than 7 years. Respondents in this study were on average less experienced than the farmers in Lemo, SE Sulawesi where most respondents had more than 10 years experience in seaweed farming [19]. Nonetheless, the data indicate that, in general, the respondents currently had sufficient experience of seaweed farming activities.

3.2. Diversified Livelihoods

Most of the respondents in Bungin Permai village (n=75; 78.13%) engaged in various fisheries sectors such as seaweed farming and fishing. From the overall respondents (n=96), there were only 21 respondents (21.88%) whose activities were not related to the mariculture sector. In this study 13 respondents (13.54%) ran an open fronted shop (kiosk); 3 respondents (3.13%) worked as boat drivers, 2 respondents (2.08%) were labourers, and only 1 respondent (1.04%) worked in in agriculture and private business. None of the respondents worked as a government officer.

There are two main sources of income in Bungin Permai village: fisheries-related livelihoods (seaweed farming and fishing) and non-fisheries livelihoods. A similar situation was found also in Lemo, SE Sulawesi, Indonesia [19] Laikang bay, South Sulawesi, Indonesia [20] and in Iloilo,

Philippines [16]. Seaweed farming has already contributed significantly to the improvement of farmers' incomes, the availability of job opportunities and to diversified livelihoods [19].

3.3. Household incomes and their income sources

There were various income sources of the farmers and these could be divided into two main income sources. First, in the fishery sector, respondents worked both in seaweed farming and fishing activities. Second, in non-fishery sectors, they worked as an open-fronted shop (kiosk) operator, boat drivers, general labourers, agricultural labourers and in private business.

From the overall incomes, the average income was IDR. 29,154,121 annually. The lowest income was IDR. 975,000/year while the highest was IDR.156,948,500/year. When those average incomes were converted into monthly income, the farmers earned IDR. 2,429,510/month. This amount is higher than the regional minimum wage (RMP) in South Konawe. On average, these household incomes were, therefore, more prosperous than those of other household incomes in South Konawe. All respondents could be grouped into three income categories: low (<IDR. 1,401,337), middle (IDR. 1,401,337-IDR. 22.514.785) and high (>IDR. 22,514,785). Most farmers (74 respondents; 74.08%) had incomes in the middle range while only 12.50% had high incomes (Table 2).

Table 2. Total income of the household.

Categories	N	%
Low (<IDR. 1,401,337)	10	10.42
Middle (IDR. 1,401,337- IDR. 22,514,785)	74	77.08
High (>IDR. 22,514,785)	12	12.50

The majority of respondents in the middle income range as seaweed farmers in this village had sufficient farming experience. The average respondent had ± 7 years experience (Table 1) in managing seaweed farming. Long experience in seaweed farming was also found in Bombana regency, SE Sulawesi where the farmers had worked as seaweed farmers for around 4-11 years (67.18%) [19]. Respondents with sufficient experience will have adequate knowledge regarding the natural environment around the location of seaweed planting, so they will have more information in estimating the risk of production, processing and marketing of seaweed produced.

The ability to eliminate risk in itself encourages higher farm income. Such experience is important to help the farmers to estimate production risks and product management before the marketing of their seaweed farming and other activities. The ability to eliminate risks enables farmers to gain a better income. In addition, the higher average income received by seaweed farmers compared to the RMP was affected by the social status of the farmers. It was found that 73 respondents (74.00%) were farm owners who controlled their production equipment. They owned the assets used for seaweed farming and their fishing gear. Because of such asset ownership, they could independently make decisions related to seaweed farming and fishing activities.

3.4. Income of seaweed farming households

The average income of respondents (n=96) from seaweed farming was IDR. 10,556,724/year. The lowest income was IDR. 430.000/year, while the highest IDR. 70,460,000/year or IDR. 879,727/month. The range of income of seaweed farmers in Bungin Permai was quite similar to that of farmers in Lemo. Monthly and annual incomes of the farmers in Lemo, SE Sulawesi were IDR. 900,000 and IDR 10,800,000, respectively [19].

3.5. Income from fishing

There were 64 farmers who worked as fishermen using nets or large anchored lift nets (*bagan*) to catch fish, crabs, squid, etc. The average income obtained from net fishing was IDR. 5,252,936/year. The lowest income was IDR. 150,000/year and the highest was IDR. 29,450,000/year. Income from

fishing activity using fish nets was divided into three categories: low (<IDR. 2,230,592), middle (IDR. 2,230,592-9,265,757) and high (>IDR. 9,265,757) (Table 3). Such incomes were higher than those of farmers from Lemo, SE Sulawesi where they mostly had IDR. 1,500,000-IDR, 4,500,000 [19].

Table 3. Income from fishing using fish nets.

Categories	N	%
Low (<IDR. 2,230,592)	7	10.94
Middle (IDR. 2,230,592- IDR. 9,265,757)	49	76.56
High (>IDR. 9,265,757)	8	12.50

Fish nets were also used by some seaweed farmers (n=9) to collect crabs. This activity contributed IDR. 1,960,000/year. The lowest income was IDR. 1,160,000/year while the highest was IDR. 2,810,000/year or IDR. 217,777,78/month. The income generated from this activity was divided into three categories: high (>IDR. 2,556,167); middle (IDR. 1,363,833-2,556,167); and low (<IDR. 1,363,833). There were 5 respondents (55.56%) in the middle category, and the other 3 respondents (33.33%) were in the high income category (IDR. 2,500,000/month) (Table 4). The income from crab fishing was higher than from crab fishing in Lemo [19].

Table 4. Income from fishing using crab nets.

Categories	N	%
Low (<IDR. 1.363.833)	1	11.11
Middle (IDR. 1.363.833- IDR. 2.556.167)	5	55.56
High (>IDR. 2.556.167)	3	33.33

Some seaweed farmers also collected crabs from the wild using a kind of trap (n =4). Crab fishing contributed IDR. 6,281,833/year. The lowest income was IDR. 485,000/year and the highest was IDR. 14,193,333/year or 1,570,458/month. Although there were few people involved, it was found that their income was fairly high. The income was divided into three categories: high category (>IDR. 7,903,309); middle (IDR. 7,903,309-4,660,358); and low (<IDR. 4,660,358) (**Table 5**). There were 3 respondents (75.00%) in the middle category and 1 respondent (25.00%) was in the low category.

Table 5. Income from crab fishing using traps.

Categories	N	%
Low (<IDR. 4.660.358)	0	00.00
Middle (IDR. 4.660.358- IDR. 7.903.309)	1	25.00
High (>IDR. 7.903.309)	3	75.00

The farmers also used anchored lift net rafts to catch various fish species, including squid. The seaweed farmers could earn an extra income of IDR. 113,998,300/year, with the lowest income was IDR. 1,062,900,000/year, while the highest income was IDR. 50,445,000/year or IDR. 37,999,433/month. Of the 96 respondents 3 used lift nets for fishing. The low number of farmers operating this gear was due to the high capital requirements. The income generated from anchored lift nets was divided into three categories: high (>IDR. 82,369,838), middle (IDR. 18,858,734-IDR. 82,369,838); low (<IDR. 18, 858,734). There were 2 respondents (66.67%) in the high category, while 1 respondent was in middle category (33.33%) (Table 6).

Table 6. Income from fishing using lift nets.

Income categories	N	%
Low (<IDR. 18.858.734)	2	66.67
Middle (IDR. 18.858.734- IDR. 82.369.838)	1	33.33
High (>IDR. 82.369.838)	0	00.00

3.6. Income from non-fisheries activities

The present study showed that there were 21 respondents (22.00%) working in non-fisheries activities. These mostly worked as traders to supply daily basic needs to people around Bungin Permai village, in particular snack foods for children. The average annual income generated by seaweed farmers outside of the fisheries sector was IDR. 11,071,875, with the lowest amount being IDR.3,900,000 and the highest IDR, 182,400,000 or 627,127/month. The income from non-fisheries activities in Bungin Permai was higher than that in the previous study in Lemo, SE Sulawesi, where most respondents had the income range IDR <6,000,000 [19].

3.7. Contribution from seaweed farming, fisheries, and non-fisheries activities

The income of Bungin Permai seaweed farmers was mainly dominated by non-fisheries and seaweed farming activities (Table 7). The income from non-fisheries activity was IDR.11,071,875/year (37.98%) while from seaweed farming it was IDR. 10,556,724/year (36.21%) from the overall total of income generated by the farmers. This means seaweed farmers are not solely dependent on income from seaweed cultivation.

Table 7. The contribution to incomes from seaweed farming and non-seaweed farming activities in Bungin Permai.

Income	Types of activities						Total
	Seaweed farming	Net Fishing	Catching crabs	Trap Fishing	Lift net fishing	Non-fishery	
Average (IDR)	10,556,724	3,517,583	183,750	261,743	3,562,447	11,071,875	29,154,121
Contribution (%)	36.21	12.07	0.63	0.90	12.22	37.98	100.00

This situation is similar to that in Lemo, SE Sulawesi, where respondents work not only as seaweed farmers but also as fishermen and in non-fisheries activities [19]. However, in Lemo, most income (62.84%) was obtained from seaweed farming [19]. Even though the contribution from seaweed farming to household income was lower than the income from non-fisheries activities, seaweed farming still played an important role in the income structure of seaweed farmers. This was the reason why seaweed farmers in Bungin Permai village were focused on management. In addition, Bungin Permai village is a suitable place to cultivate seaweed as the water quality in the area is usually in the normal range for seaweed farming [21]. The average income of IDR 10.56 million each year from seaweed farming is equivalent to IDR 880.000/capita/month, or USD 66.79/capita/month. It is higher than the previous study done in Bau Bau, Indonesia where the average income of seaweed farmers is IDR 144,297.42/capita/month, or equivalent to US$10.85/capita/month by [14]. However, the majority of seaweed farmer households in Bungin Permai village have an income below the National Poverty Line. The national poverty line of Indonesia is IDR 401,220, equivalent to USD 27.72 a month, or around IDR 11,000 (USD 27.72) a day. This implies that the income of seaweed farmers is still below the international poverty line of USD 1.25/day; which is currently used by the World Bank. Thus, It is very reasonable that most farmers need to diversify into supplementary or additional income generating activities.

3.8. Efficiency of seaweed farming

The respondents obtain a profit because the total of revenue is higher than total costs as indicated by the C/R value which is > 1.00 (Table 8). When all assets (nylon lines, floats, wooden pegs, and boat) were calculated for the C/R value, the ratio was 1.88. It means that seaweed farming in Bungin Permai is efficient and profitable. The C/R value was 3.73. It means that when the farmers spend IDR. 1.00, they will generate a revenue of IDR. 3.73. Such a calculation is commonly found in fish farming where non-cash items are excluded from farming costs. In income analysis, however, the depreciation items are included. Minimum C/R values were found below 1 (Table 8). This indicates that some respondents run unprofitable seaweed farms. A similar phenomenon was also found in Philippines where unprofitable seaweed farming occurred during lean months but profits were made during peak months [1].

Table 8. Efficiency (C-R *ratio*) of seaweed farming in Bungin Permai Village (IDR./annual).

	C-R Ratio	
	Including depreciated expenses	Excluding depreciated expenses
Average	188	3.73
Minimum	0.32	0.96
Maximum	10.02	21.40

The C/R value for seaweed farming was lower (1.88) when compared to the value for paddy gogo cultivation (6.48). The low value was not an indication of low revenue, but depended on the selling price of the commodity. Seaweed commodity value is priced higher than paddy gogo per unit, thus the profit earned is higher.[22] reported that the low productivity and income instability of seaweed farmers relates to the competency of the farmer. Poor competency results in inefficiency of seaweed production and incurs losses as a result.

4. Conclusion

The seaweed farmers in Bungin Permai village obtained their main income from fishery and non-fisheries activities. Most farmers worked in the fisheries sector as seaweed farmers and also as fishermen. The average income generated by seaweed farming households was IDR. 29,154,121 annually while that from seaweed farming was IDR. 10,556,724 annually and the income obtained from non-fishing activities was IDR. 11,071,875 annually. The respondents generated additional income by fishing for crabs, fishing using traps (*bubu*) and anchored lift nets. The mean C/R (cost-to-revenue) value of seaweed farming was 1.88. The lowest R/C was 0.96, while the highest was 21.04. These R/C values mean that seaweed faming was relatively efficient and profitable.

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