The production and income from seaweed farming after the sedimentation in Kendari Bay

[1]Muhammad A. Limi, [2]La Sara, [1]Taane La Ola, [1]Lukman Yunus, [1]Suriana, [1]Sitti A. Adha Taridala, [1]Hartina Batoa, [1]Awaluddin Hamzah, [1]Syamsul A. Fyka, [1]Meilan Prapitasari

[1] Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia; [2] Department of Marine Resources Utilization, Faculty of Fishery and Marine Science, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia. Corresponding author: M. A. Limi, aswar_agribusiness@yahoo.com

Abstract. This study aims to determine the production and income from seaweed farming after the sedimentation in Kendari Bay and to know the efficiency level of seaweed farming in Sambuli Sub-District, Abeli, Kendari City after the sedimentation in Kendari Bay. This research was conducted on February 2017 in Sambuli Village, Abeli Sub-district, Kendari City. The site selection was based on the consideration that in 2009 around 158 heads of the households who lived in Sambuli Village worked as seaweed farmers. However, all farmers who cultivated the seaweed stopped seaweed farming due to the losses from the declining of production and the declining of income due to the less water quality of Kendari Bay as a result of the sedimentation. The data used here consisted of primary and secondary data. The research variables consisted of respondent identities (age, formal education and farming experience and the number of family members/family size), and farming characteristics (land area, production cost, seaweed production, production price, income from seaweed farming, revenue:cost ratio (R/C ratio)). The result of this research showed that due to the sedimentation in Kendari Bay, the seaweed farming production in Sambuli sub-district, Abeli, in Kendari city became lower. As a result, the income from farming was declining with the business efficiency of 1.16.
Key Words: seaweed production, farmer’s income, R/C ratio, sedimentation in Kendari Bay.

Introduction. Dahuri et al (2001) stated that Indonesia is a country rich in natural resources and having 5.8 million km^2 area, with a long coastline of 81,000 km. The condition of vast and fertile waters area in Indonesia reflects the high potential of sea product. Fish farming business in Indonesia has grown and developed. One of the farming business kinds that are developed is the cultivation of seaweed. There are thousands of different types of seaweeds around the world, and some of them are also cultivated for food (Foscarini & Prakash 1990). Furthermore, Park et al (2014) state that seaweed cultivation does not generate carbon derived from the change in land use and it requires less freshwater. In addition, seaweed cultivation does not require fertilization applications because it contains high nitrogen and phosphor. The widely cultivated seaweed species are *Eucheuma* sp. and *Gracilaria* sp. (Aslan 1998; Hernanto et al 2015).

Poeloengasih et al (2013) stated that seaweed-processing technology is easy to manage and the introduction of processing technology is developed to increase the income and the livelihood by improving the seaweed farmers’ skills and knowledge. Seaweed is used as raw material for cosmetics, pharmaceuticals, textile, paper, ceramic, photography, and in insecticide industries. In addition, it is also used as an ingredient for food industries such as gelatin, jelly food and it can also be made into seaweed *dodol* (Limi & Iskandar 2015; Batoa & Suriana 2015).

Southeast Sulawesi is one of the provinces that have a potential to develop seaweed farming. Nuryadi et al (2017) stated that seaweed business in South Konawe, Southeast Sulawesi is feasible by running with a profit of IDR 2,656,380/farm or IDR

6,194,916/acre, and the revenue:cost (R/C) ratio of 1.71. According to Tanda (2014), the potency for developing seaweed farming in Kendari City is 370 acres and it has been used around 95.07 acres only. The potential is spread in two sub-districts located in the coast of Kendari bay, which is currently included as the development area of Kendari Bay, namely Abeli District with an area of 200 acres and Kendari District with an area of 170 acres.

Seaweed is one of the agricultural sector commodities in Kendari City which become a source of income especially for the community in Sambuli Village, Abeli Sub-district, Kendari City. Seaweed commodity has been cultivated in Sambuli Village in a land area of 4,000 m² (*Dinas Perikanan Kota* Kendari: 2014). Suparman (2016) stated that Municipal government of Kendari through Marine Affairs and Fisheries Agency of Kendari develops and increases the production of seaweed farming business in Abeli sub-district i.e. sub-district of Sambuli, Tondonggeu, Bungkutoko, and Purirano. The Municipal Government of Kendari provided seedlings and seaweed farming equipment as well as the training for the farmer groups that perform seaweed cultivation.

Seaweed cultivation is done by the community in Sambuli Village since this area is a development zone for seaweed cultivation; thereby, seaweed farming is one of the activities of the fishermen who live in the coast of kendari bay (Abdullah et al 2012; Regional Government of Kendari 2013; Muis et al 2015). In 2011, the municipal government Kendari along with the provincial government of Southeast Sulawesi developed the infrastructure of Kendari Bay so that the coast of Kendari Bay could be developed rapidly and in 2012, the government implemented the revitalization program of Kendari Bay called "Water Front City" through the Kendari Bay reclamation so that the pressure of the development activities around the coast of Kendari Bay is increasingly high and it can result in a damage to Kendari Bay (Badan Perencanaan Pembangunan Daerah Provinsi Sulawesi Tenggara 2011; Pemerintah Provinsi Sulawesi Tenggara 2012; Iswandi et al 2012).

The development of Kendari Bay area made the bay polluted. Limi et al (2017) stated that the sustainability of the coastal area of Kendari Bay is threatened due to land conversion and high sedimentation rate that results in environmental change and a major impact on fisheries and marine resources. The water pollution can be identified from various sources such as fishery industry, public port, fishery port, hotel and shop waste, hospital waste, household waste, mining and other activities. This condition does not include the activities in all watersheds that flow into Kendari Bay as well as sea transportation activities of the residents and the fishermen of capture fishery. The development of Kendari Bay area also caused the silting of the bay. Iswandi (2003) stated that the silting of Kendari Bay is caused by 1) sedimentation due to development activities, 2) sedimentation from soil losses (land erosion) in water catchment areas of the bay, and 3) sedimentation from the garbage.

The pollution in Kendari Bay resulted in the decreasing of water productivity and it affected the seaweed farming production around the bay. In 2008, seaweed production in Kendari City reached 438 tons and in 2009, it reached 460 tons but there was a decrease in seaweed production so it reached 38,45 tons in 2015 (Tanda 2014; Central Bureau of Statistic of Kendari 2016). Furthermore, Tanda (2014) stated that seaweed farmers in Kendari City in 2009 were 17 groups that consisted of 2 sub-districts and 5 villages with 158 households in total. However, in 2016, the number of seaweed farmers was only 11 families and the seaweed farmer was only 1 family in 2017. The decrease in the number of seaweed cultivators in Kendari City is allegedly due to low production because of the environmental pollution and farmer’s low income that makes the farmers leave the seaweed cultivation business. Marinho-Soriano (2016) states that the decline in seaweed populations due to the excessive exploitation, poor quality, low prices, and lack of socioeconomic policies leads to the loss in almost all seaweed industries. This study aims to determine the production and income from seaweed farming after the sedimentation in the coastal area of Kendari Bay and to know the efficiency level of seaweed farming after the sedimentation in Kendari Bay development area in Sambuli Village, Abeli District, Kendari City.

Material and Method. The research was conducted on February 2017 in Sambuli Village, Abeli Sub-district, Kendari City. Sambuli Village has an area of 4,184 km^2. Sambuli Sub-district has border areas i.e. the northern part borders with Kendari Bay, the western part borders with Nambo District, the southern part borders with Konda Sub-district and the eastern part borders with Tondonggeu Village. The map of Sambuli sub-district in Abeli District can be seen in Figure 1.

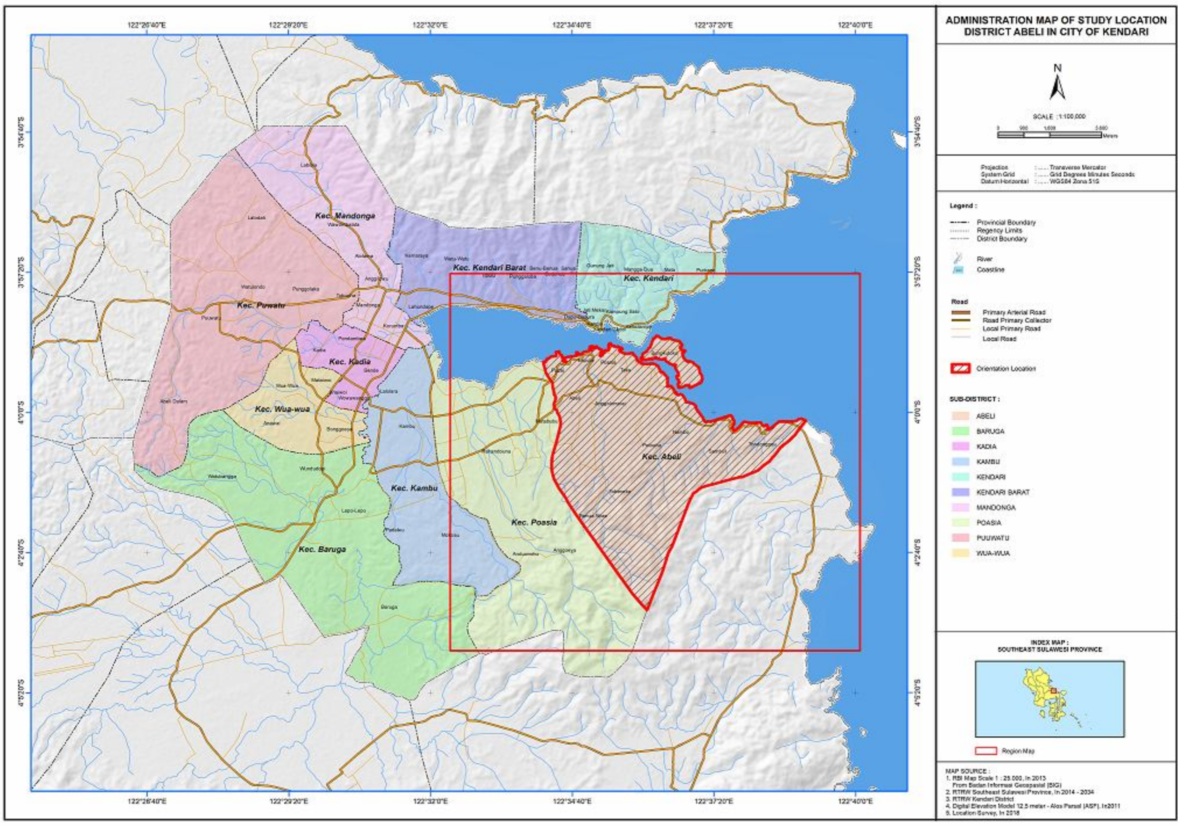

Figure 1. The map of Sambuli Sub-District, Abeli District, Kendari City.

The determination of location was done intentionally because the research object was located in Kendari City. The object of this research was the only seaweed farmer who was still performing seaweed farming in Sambuli sub-district, Abeli district, Kendari city. The type of the data used in this study was primary data and secondary data. The primary data was the data collected directly from the seaweed farmer in the field and the secondary data obtained from the documentation and publication of the results of the assessment and from the data collection that had been done previously.

The data collection technique is influenced by the type and the source of data that will be taken. Therefore, the data collection conducted in this research was the interview technique using questionnaires.

The general illustration of Sambuli Sub-district was analyzed using secondary data from the Central Bureau of Statistic of Kendari in 2016 and the parameters of water quality such as pH, temperature, current velocity, brightness, salinity measured using pH meters, water thermometer, current meter, Secchi disk, and salinity refractometer. The quantitative descriptive analysis was used to know the quantity of seaweed farming production and the income analysis was used to know the income from seaweed farming that was calculated by using formulation by Hernanto (1991) as follows:

$$I = TR - TC \quad (1)$$

where: I = income (IDR/month);
TR = total revenue (IDR/month);
TC = total cost (IDR/month).

The analysis on the efficiency level of seaweed farming was the ratio of revenue to total cost used, using the following formula by Suratiyah (2006) as follows:

$$R/C = TR/TC \quad (2)$$

The criteria is as follows:
- if R/C > 1 : the farm is considered as efficient;
- if R/C = 1 : the farm is considered as non-profitable with no losses;
- if R/C < 1 : the farm is considered as inefficient.

Results and Discussion. The water quality parameters in Sambuli sub-district can be seen in Table 1.

Table 1

The water quality in Kendari Bay

No.	*Parameter*	*Unit*	*Criteria value*		*Description*
			Kendari Bay[*]	*Seaweed cultivation criteria[**]*	
1	pH	mg L^{-1}	8.6	7-8.5	Not feasible
2	Temperature	^oC	28.5	27-30	Feasible
3	Current velocity	cm dt^{-1}	35	20-40	Feasible
4	Secchi disk reading	m	2	> 5	Not feasible
5	Salinity	ppt	28-31	29-33	Feasible

Source: [*]Water quality measurement results; [**]Kepmen No. 51/MENKLH/2004.

Based on the data in Table 1, it is known that some parameters of water quality in Sambuli sub-district do not fulfill the criteria for seaweed cultivation as stated in Kepmen No. 51 / MENKLH / 2004. It was allegedly because of the high sedimentation in Kendari Bay that affected the water quality parameters for seaweed cultivation. According to Camaya et al (2014), various seaweed community structures had a significant response to seasonal variations and the environmental factors. The correlation analysis showed that the seaweed abundance was due to the gradual rise of sea surface temperature and the intensification conditions of rainfall, wind speed, and wind direction.

Based on Table 1, the pH value of bay waters is not feasible for the growth of seaweed. According to Mithoo-Singh et al (2017), in general, seaweed is mostly affected by pH change except for other seaweed species such as *Padina australis*. Further, Tasmin et al (2014) stated that there is 50% increase in the decline of seaweed growth due to the rising water temperatures. Foscarini & Prakash (1990) stated that the water temperatures ranging from 25 to 30°C is the best condition for seaweed growth. In shallow waters near shore, the water temperature can be very high especially on a sunny day. The seaweed fertility is influenced by salinity or water salinity (Aslan 1998). Water salinity that is good for seaweed growth is around 28 to 34 ppt (parts per thousand) with an optimum value of 33 ppt (Akib et al 2015; Nur et al 2016). Ain et al (2014) stated that the brightness of coastal waters is needed by seaweed for carrying out photosynthesis in the waters. Sunlight is used by the seaweed as a source of energy for its growth and for the carbohydrate production such as carrageenan, a commercially valuable substance. Thus, it is very important to have plenty of sunlight. Clear seawater allows sunlight to penetrate into plants easier. This is why if the seaweed is planted close to the sea surface will grow faster and healthier than those that are planted close to the ocean floor or in a deep-water area. Since the seaweed prefers clear water and plenty of sunlight, even the turbid (muddy) waters will not maintain a good seaweed growth.

Characteristics of the respondents*.* The identity of seaweed farmer was a variable including the farmer's age, the duration of formal education, the number of family dependants, the experience in farming business as seen in Table 2.

Table 2

Characteristics of the respondent, year 2017

No.	*Variables*	*Values*
1	Age (years)	28
2	Education (years)	9
3	The amount of family members (person)	4
4	Experience in farming business (years)	14

Source: Processed primary data, 2017.

Based on Table 2, it is known that the seaweed farmer is at productive age i.e. 28 years. The Central Statistics Agency of the Republic of Indonesia (2011) describes that based on the population composition, the age of residents is grouped into 3 categories i.e. 0-14 years old - young age/unproductive age, 15-64 years - age of adult/working age/productive age and ±65 years old - old age/unproductive age.

The education level of the seaweed farmer was categorized as low i.e. 9 years. Therefore, the additional knowledge and skills for seaweed farmer were needed so that he could manage his farm well in order to achieve maximum production and maximum income.

The number of the seaweed farmer's dependants in his family was categorized as medium family i.e. 4 people. The number of family members could be classified based on the classification from the Central Statistics Agency (BPS) stating that a small family is a family with the number of family members around 1-3 people, medium family is a family consisted of 4-6 people, and large family is a family consisted of more than 6 family members.

The seaweed farmer's experience in seaweed cultivation was 14 years. So, it could be categorized as experienced farmer. Tohir (1991) gives an understanding that the experience in farming is the best teacher for the farmers. The longer the farmer in managing his farming is, the more experience he gains. The experience will, later on, affect the farmers' attitudes and actions in determining an attempt for increasing the production and income.

Costs. The amount of cost required at the beginning to open the seaweed farming was important to be used for financing the seaweed farming equipment. Investment costs in seaweed farming consisted of ropes, logs, boats, and machinery, waring net, as well as tarpaulins. From the components of the investment cost, it will be known the fixed costs incurred by the seaweed farmers in each growing season as can be seen in Table 3.

Table 3

The components of the investment cost and the depreciation cost of seaweed farming, year 2017

No.	*Cost type*	*Duration in usage*	*Investment cost (IDR)*	*Depreciation cost (IDR/season)*
1	Rope:			
	a. Rope no. 2.5	2 years	180,000	15,000
	b. Rope no. 4	3 years	1,110,000	41,000
2	Wood	3 months	250,000	84,000
3	Boat	5 years	1,200,000	8,000
4	Boat machine	4 years	800,000	4,200
5	Waring net	3 years	288,000	96,000
6	Tarpaulins	1 years	324,000	108,000
	Total		4,152,000	356,200

Source: Processed primary data, 2017.

Based on data in Table 3, it is known that the seaweed farming system requires relatively higher investment cost at the beginning of the business. The investment cost as the initial capital for seaweed farming in the research location was IDR 4,152,000-, while for the depreciation cost per growing season was IDR 356,200,-.

Seaweed farmers, besides spending for the cost of investment and the depreciation costs, also should disburse the variable costs per growing season (Table 4). The variable cost does not guarantee the production yield per season. The seaweed farmers sometimes got lower production than the previous harvest season because the seaweed plants were not well developed. So, the farmers needed some funds to buy seaweed seeds in order to be able to start planting in the next season.

Table 4

The variable costs in seaweed farming, year 2017

No.	*Cost type*	*Volume*	*Unit*	*Prices (IDR)*	*Total value (IDR)*
1	Tying seaweed seeds	30	Stretching lines	8,000	240,000
2	Planting	2	Work day	50,000	100,000
3	Maintenance	15	Liter	10,000	150,000
4	Harvest	2	Work day	50,000	100,000
5	Seeds	200	Kg	2,500	500,000
	Total				1,090,000

Source: Processed primary data, 2017.

Based on the data in Table 4, it is known that the seaweed farming requires a relatively higher variable cost at the beginning of each season. The variable cost of seaweed farming in the research location was IDR 1,090,000,-/growing season with the amount of lines was 30 stretching lines. The number of stretching lines used for the seaweed cultivation was very small according to the capital owned by the farmers. Foscarini & Prakash (1990) stated that the amount of capital needed to start seaweed farming depended on the size of the business where the small seaweed farming was only around 320 or 480 lines.

Production. Production is an effort to increase the benefits by changing the shapes, moving to places, and storing (Soeharno 2006). Foscarini & Prakash (1990) argue that in cultivating the seaweed, the seaweed will grow better and faster during the winter, but it can grow successfully over the year. As an illustration of how fast the seaweed grows, the weight of seaweed can be 10 times heavier in 6 to 8 weeks. In other words, if you have 150 grams of seaweed, after 6 until 8 weeks, the plant will weigh around 1.5 kilograms. It means that the seaweed has grown very fast and it can be an obvious benefit for the farmers.

The increased production without any support at a various price level will not provide a guarantee in increasing the farmer's revenues. The final result expected by the farmers for their business was the success of getting maximum production and receiving high selling price. The production of dried seaweed is the production of wet seaweed that has been dried for 3-4 days. The seaweed farming production meant in this study was the amount of dried seaweed collected by the farmers from seaweed farming (Table 5).

Table 5

The amount of seaweed farming production, year 2017

No.	*Indicator*	*Lines (kg)*	*Farming (kg/farming)*
1	Production	8	240

Source: Processed primary data, 2017.

Based on the data in Table 5, it shows that the production of dried seaweed obtained by the farmers as the respondents per line is 8 kg so that the production of the company is 240 kg per 30 lines. Poncomulyo et al (2008) stated that from one hectare of seaweed cultivation can be obtained around 1,500-2,000 kg of dried seaweed. The seaweed produced by the seaweed farmers was very low due to the condition of polluted waters so that the seaweed susceptible to "ice-ice" disease. Msuya et al (2013) stated that the problem of "ice-ice" disease faced by the countries in the Western Indian Ocean (WIO) was the cause of *Kappaphycus* seaweed being destroyed.

The increasing of seaweed production could be done by the government through controlling the development of Kendari Bay and improving the skills of the seaweed farmers. Rebours et al (2014) states that each country needs a long-term, ecosystem-based management plan to ensure the sustainable seaweed exploitation. Thus, there is a need for regulation and the best practice in harvesting, managing, and cultivating seaweed and the trained human resources for providing information and education to the communities that are involved. Thereby, the seaweed utilization can be a lucrative business and it can provide better income opportunities for the coastal communities.

The seaweed production obtained by the farmers in Sambuli Village was sold at an average price of IDR 7,000/kg. The purchasing price determined by the trader follows the prevailing price in the local market. Valderrama (2012) states that despite the attributes were quite much, it cannot be said that carrying out seaweed farming has no its own challenges. As the commodities traded in international markets, the prices in farm-level depend on the volatility. This had been proven mainly during the "seaweed price bubble" in 2008 when the agricultural prices hit the highest level and then it declined within a few months.

Income and business efficiency. The seaweed farmers carried out the seaweed farming as maximum as possible to obtain a high production number and to obtain a reasonable price. Thereby, they could earn sufficient income to meet their families' needs and for the additional capital by adding the number of stretch lines. The revenue obtained by the seaweed farmers analyzed was the net income from the result of seaweed farming. The number of seaweed sales was influenced by the prevailing price level applicable in the research location. The revenue and the income from seaweed farming year 2017 can be seen in Table 6.

Table 6

The revenue and the income from seaweed farming, year 2017

No.	*Descriptions*	*Unit*	*Per farm*
1	Cost (C)		
	Fixed cost (FC)	IDR	356,200
	Variable cost (VC)	IDR	1,090,000
	Total cost (TC)	IDR	1,446,200
2	Revenue (R)		
	Production	Kg	240
	Price	IDR	7,000
	Total revenue (TR)	IDR	1,680,000
3	Income (I) (TR-TC)	IDR	233,800
4	R/C	Ratio	1.16

Source: Processed primary data, 2017.

Table 6 shows that the seaweed farmers produce low income per farm i.e.IDR 233,800,-. Lentisco & Needham (2013) state that even though the revenue stream has been at the regular condition, the seaweed producers get the lowest rank in the value chain, and they generate relatively low income. The level of income when it was compared to the Provincial Minimum Wage in 2017, the income level of the farmers was still low or below the Provincial Minimum Wage (IDR 2,002,625,-). Therefore, the farmers as the respondents were actually unable to meet the needs of their lives from the seaweed farming income. On the other hand, the income of the seaweed farmers was still influenced by fishery resources. Limi et al (2017) stated that the level of the fishermen welfare is specifically still influenced by fishery resources in the coastal area of Kendari Bay. Furthermore, based on Table 6, it is also known that the efficiency of seaweed farming in the research location is still efficient where the RC ratio value is 1.16, indicating that from IDR. 1, - of the cost spent by the seaweed farmers will generate the revenue of IDR 1.16.

Conclusions. Based on these research findings, it can be concluded that the production of seaweed farming in Sambuli sub-district Abeli district, Kendari is getting lower that results in the decreasing in the farming income with the business efficiency of 1.16. As a consequence, most of the farmers leave their farms. Based on the research findings, it is expected that the government could control the development of infrastructure in Kendari Bay.

Acknowledgements. The authors would like to express their gratitude to the Directorate of Research and Development of the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia, The Chairman of research institutes and community service of Halu Oleo University and The Head of the Faculty of Agriculture of Halu Oleo University who have given the researchers an opportunity for conducting this research.

References

Abdullah S., Nurgayah W., Daud L., 2012 [Empowering fishermen women through transforming appropriate technology in seaweed business in Abeli District]. AGRIPLUS 22(1):37-42. [in Indonesian]

Ain N., Ruswahyun, Widyorini N., 2014 [Relationship between seaweed density and different base substrata in Bandengan Beach waters, Jepara]. Diponegoro Journal of Maquares, Management of Aquatic Resources 3(1):99-107. [in Indonesian]

Akib A., Litaay M., Ambeng, Asnady M., 2015 [Water quality fitness for cultivation of *Eucheuma cottoni* based on physics, chemitstry and biology aspects in District Islands Selayar]. Jurnal Pesisir dan Laut Tropis 1(1):25-36. [in Indonesian]

Aslan L. M., 1998 [Seaweed cultivation]. Kanisius, Yogyakarta, 97 pp. [in Indonesian]

Badan Perencanaan Pembangunan Daerah Provinsi Sulawesi Tenggara, 2011 [Report on the coordination of coastal, marine and small islands in southeast Sulawesi Province in 2011]. Bappeda Sultra, Kendari, 190 pp. [in Indonesian]

Batoa H., Suriana, 2015 [Group of seaweed processing women In Marobo Village, Marobo Sub-District, Muna Regency]. Laporan Pengabdian Ipteks Bagi Masyarakat, LPPM UHO, Kendari, 25 pp. [in Indonesian]

Camaya A. P., Soliman V. S., Mendoza Jr. A. B., Okuda K., 2014 Status of seaweeds in San Miguel Island, Lagonoy Gulf, Philippines: a review related to the effects of changing environment and local issues. AAB Bioflux 6(3):199-218.

Central Bureau of Statistic of Kendari, 2016 [Kendari city in figures 2016]. Badan Pusat Statistik Kota Kendari, Kendari, 370 pp. [in Indonesian]

Central Bureau of Statistics of the Republic of Indonesia, 2011 [Household welfare indicators in Indonesia]. BPS, Jakarta, 231 pp. [in Indonesian]

Dahuri R., Jacub R., Sapta P. G., Sitepu M. J., 2001 [Integrated management of coastal and oceanic resources]. PT Pradnya Paramita, Jakarta, 326 pp. [in Indonesian]

Dinas Perikanan Kota Kendari, 2014 [Seaweed cultivation data]. DKP Kota Kendari, Kendari, 47 pp. [in Indonesian]

Foscarini R., Prakash J., 1990 Handbook on *Eucheuma* seaweed cultivation in Fiji. Ministry of Primary Industries, Fisheries Division and South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, GCP/RAS/116/JPN.

Hernanto A. D., Rejeki S., Ariyati R. W., 2015 [Growth of seaweed culture (*Eucheuma cottoni* and *Gracilaria* sp.) with long line method in Bulu Sea Jepara]. Journal of Aquaculture Management and Technology 4(2):60-66. [in Indonesian]

Hernanto F., 1991 [Agricultural science]. Penebar Swadaya, Yayasan Indonesia, Jakarta, 77 pp. [in Indonesian]

Iswandi M., 2003 [Analysis of the impact of Kendari Bay uprooting on community activities and its countermeasures strategy]. PhD Thesis, Institut Pertanian Bogor, Bogor, Indonesia, 163 pp. [in Indonesian]
Iswandi M., Ramli M., Baco L., Alie A., Abidin L., Irianto T., Sanusi A., Abu B., Nursalam S., 2012 [Strategic environmental assessment (SEA) in the policy, plan and program (KRP) revitalization of Kendari Bay "Water Front City"]. BAPPEDA Provinsi Sulawesi Tenggara, Kendari, 73 pp. [in Indonesian]
Keputusan Menteri Negara Lingkungan Hidup Nomor 51 Tahun 2004 on the Sea Water Quality Standard, pp. 53- 62. [in Indonesian]
Lentisco A., Needham S., 2013 Seaweed for a better life. Available at: http://www.fao.org/fileadmin/templates/rap/files/NRE/Fisheries/case_study_seaweed_for_a_better_life.pdf. Accessed: June, 2017.
Limi M. A., Iskandar, 2015 [Group of Bajo fisherman women processing seaweed in South Mola Village]. Laporan Pengabdian Ipteks Bagi Masyarakat, LPPM UHO, Kendari, 27 pp. [in Indonesian]
Limi M. A., Sara L., La Ola T., Yunus L., 2017 Environmental changes and fisherman welfare in coastal area of Kendari Bay. Agriculture, Forestry and Fisheries 6(1):20-25.
Marinho-Soriano E., 2016 Historical context of commercial exploitation of seaweeds in Brazil. Journal of Applied Phycology 29:665-671.
Mithoo-Singh P. K., Keng F. S., Phang S. M., Leedham Elvidge E. C., Sturges W. T., Malin G., Abd Rahman N., 2017 Halocarbon emissions by selected tropical seaweeds: species-specific and compound-specific responses under changing pH. PeerJ 5:e2918.
Msuya F. E., Buriyo A. S., Omar I., Pascal B. J., Narrain K., Ravina J. J. M., Mrabu E., Wakibia J. G., 2013 Cultivation and utilisation of red seaweeds in the western Indian Ocean (WIO) region. Journal of Applied Phycology 26(2):699-705.
Muis, Sara L., Sidu D., 2015 [Coastal area development in Abeli Sub-District Kendari]. Jurnal Bisnis Perikanan FPIK UHO 2(1):1-16. [in Indonesian]
Nur A. I., Syam H., Patang, 2016 [Effect of water quality on seaweed production (*Kappaphycus alvarezii*)]. Jurnal Pendidikan Teknologi Pertanian 2:27-40. [in Indonesian]
Nuryadi A. M., Sara L., Rianda L., Bafadal A., Muthalib A. A., Hartati, Nur M., Rosmalah S., 2017 Agrobusiness of seaweeds in South Konawe. AACL Bioflux 10(3):499-506.
Park H. R., Jung K. A., Lim S. R., Park J. M., 2014 Quantitative sustainability assessment of seaweed biomass as bioethanol feedstock. Bioenergy Research 7:974-985.
Pemerintah Provinsi Sulawesi Tenggara, 2012 [Direction and explanation of the Governor of Southeast Sulawesi on the plan for dredging and reclamation of Kendari Bay]. [Delivered at the meeting with Kendari City Parliament], 11 June 2012, 22 pp. [in Indonesian]
Poeloengasih C. D., Bardant T. B., Rosyida V. T., Maryana R., Wahono S. K., 2013 Coastal community empowerment in processing *Kappaphycus alvarezii*: a case study in Ceningan Island, Bali, Indonesia. Journal of Applied Phycology 26:1539-1546.
Poncomulyo T., Maryani H., Kristiana L., 2008 [Seaweed cultivation and processing]. PT Agromedia Pustaka, Jakarta Selatan, 137 pp. [in Indonesian]
Rebours C., Marinho-Soriano E., Zertuche-González J. A., Hayashi L., Vasquez J., A., Kradolfer P., Soriano G., Ugarte R., Abreu M. H., Bay-Larsen I., Hovelsrud G., Rodven R., Robledo R., 2014 Seaweeds: an opportunity for wealth and sustainable livelihood for coastal communities. Journal of Applied Phycology 26:1939-1951.
Regional Government of Kendari, 2013 [Kendari City Regional Regulation Number 5 of 2013 concerning the Zoning Plan for Coastal Areas and Small Islands of Kendari City in 2011-2031]. 74 pp. [in Indonesian]
Soeharno, 2006 [Theory of micro economics]. Penerbit ANDI, Yogyakarta, 336 pp. [in Indonesian]

Suparman, 2016 [Kendari develops seaweed cultivation in Abeli]. Available at: http://www.antarasultra.com/berita/283064/kendari-kembangkan-budidaya-rumput-laut-di-abeli. Accessed: January, 2017. [in Indonesian]
Suratiyah K., 2006 [Agricultural science]. Penebar Swadaya, Jakarta, 124 pp. [in Indonesian]
Tanda L., 2014 [Increased production of seaweed-basedf group in Southeast Sulawesi]. Available at: http://unhalel.blogspot.co.id/2014/07/budidaya-perairan-uho.html. Accessed: February, 2016. [in Indonesian]
Tasmin R., Shimasaki Y., Tsuyama M., Qiu X., Khalil F., Okino N., Yamada N., Fukuda S., Kang I. J., Oshima Y., 2014 Elevated water temperature reduces the acute toxicity of the widely used herbicide Diuron to a green alga, *Pseudokirchneriella subcapitata*. Environmental Science and Pollution Research International 21:1064-1070.
Tohir, 1991 [A knowledge of Indonesian farming]. Rineka Cipta, Jakarta, 213 pp. [in Indonesian]
Valderrama D., 2012 Social and economic dimensions of seaweed farming: a global review. In: IIFET 2012 Tanzania Proceedings, 11 pp.

Received: 11 June 2018. Accepted: 03 September 2018. Published online: 15 December 2018.
Authors:
Muhammad Aswar Limi, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: aswar_agribusiness@yahoo.com, muhammad.limi@uho.ac.id
La Sara, Department of Marine Resources Utilization, Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: lasara_unhalu@yahoo.com
Taane La Ola, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: laola_taane@yahoo.com
Lukman Yunus, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: lukuyus@yahoo.com
Suriana, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: suriana@yahoo.com
Sitti Aida Adha Taridala, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: aidataridala@yahoo.com
Hartina Batoa, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: hartina_batoa@yahoo.co.id
Awaluddin Hamzah, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: awal.hamzah@gmail.com
Syamsul Alam Fyka, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: samsul_uho@yahoo.co.id
Meylan Prapitasari, Department of Agribusiness, Faculty of Agriculture, Halu Oleo University, Kampus Bumi Tridharma, Kendari 93232, Southeast Sulawesi, Indonesia, e-mail: meylanprapita@gmail.com

How to cite this article:
Limi M. A., Sara L., La Ola T., Yunus L., Suriana, Taridala S. A. A., Batoa H., Hamzah A., Fyka S. A., Prapitasari M., 2018 The production and income from seaweed farming after the sedimentation in Kendari Bay. AACL Bioflux 11(6):1927-1936.