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Full Length Research Paper

Small scale entrepreunership of seaweed in Serewe Bay, East Lombok, Indonesia: Challenges and Opportunities

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Improving the livelihoods and socio-economic conditions of coastal communities is important to make people more secure and less vulnerable to both external pressures and inevitable socio-economic changes. This study aims to describe the characteristics of small-scale entrepreneurs based on seaweed and market characteristics, describe the challenges and opportunities of seaweed business, and find out the government intervention and potential recommendation. Structured and semi-structured questionnaires were prepared to obtain qualitative and quantitative data. Interviews were conducted with seaweed farmers and other related actors involved in seaweed value chains. The finding shows that SMEs of seaweed in Serewe are dominant in production activity (farming) by using floating longline in small-scale under bonding with local collector. Developing seaweed industry in East Lombok has some obstacles related to low seeds quality, disease attack (that is, *ice-ice*), post-harvest quality, high dependency of farmers on traders, unstable financial capital, less advocacy from extension service, and natural impact of climate change, and market. Therefore, some collaborative actions between central government and local government need to be taken to improve diversification of seaweed for value-added product, capacity building, and encourage dissemination of research products (that is, seed and technology) to local community to achieve better seaweed farming production and prices.

Key words: Small-medium scale entrepreneurs (SMEs), Seaweed, Serewe Bay.

INTRODUCTION

Aquaculture development policy in West Nusa Tenggara Province (*NTB*) aims to improve aquaculture production, using three (3) main approaches, namely;

(1) Regional based aquaculture development
(2) Top priority commodities based development, and
(3) Small-scale enterprises development.

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West Nusa Tenggara Province is divided into three development regions, namely;

(1) Lombok Island was prioritized for mariculture development, freshwater fisheries, and brackish water aquaculture.
(2) The Sumbawa Island was prioritized for brackish water aquaculture, mariculture, capture fisheries, inland fishery and freshwater aquaculture.
(3) Eastern part of Sumbawa Island was prioritized for capture fisheries, brackish water aquaculture, mariculture, inland fishery and freshwater aquaculture.

Minister of Marine Affairs and Fisheries issued the Minister Regulation (*Permen-KP*) number 12/men/2010 regarding *Minapolitan Program* mentioned that *Minapolitan* concept is based on the principles of integration, efficiency and quality. *Minapolitan* region is a part of a region that has an economic primary function consisting of production, processing, marketing of fishery commodities, shipping services, and/or other supporting activities. The minister regulation above was followed up by Regional Regulation (*Perda*) number 2/2012 regarding the Spatial Planning of East Lombok District for 2012 to 2032, which set up a *Kawasan Strategis Kabupaten*-KSK or District Strategic Region for economic interests; *Minapolitan* region involved the village of Keruak, Jerowaru, Batu Nampar, Sukaraja and Pemongkong.

The main issue of developing seaweed farming in coastal village of Lombok was associated with seeds supply. Since 2010, the problem of seed supply was due to the fluctuation of *K. alvarezii* production in Lombok and seaweed production decreased as a result. In post-harvest process, several problems still exist in both places (Gerupuk and Serewe), including;

(1) Lack of financial capacity for investing in drying and processing equipment or facilities such as drying rack *(para-para)*.
(2) Poor awareness to quality control that affects the production price.
(3) Poor market information and price. Furthermore, there were a small number of seaweed processors for value added, which produce sweets, jellies, crackers, tortilla and other derivatives in small-scale. Many of those involved were originally corn processors (making tortilla-style crackers).

Therefore, this study focuses on three objectives;

(1) To describe the characteristics of small-scale entrepreneurs based on seaweed and market characteristics in Serewe Bay.
(2) To describe the challenges and opportunities of seaweed business, and
(3) To find out the intervention and potential recommendation.

MATERIALS AND METHODS

Study area

This study was located in Serewe Village in West Nusa Tenggara Province East Lombok (Figure 1). West Nusa Tenggara Province is divided into 8 (eight) districts and two cities (Table 1); with a total population of around 4.5 million (DKP NTB, 2013 in Figure 1) distributed in 20,153.15 Km^2 (Figure 1).

Data collection and samples

Data collection was conducted from April to September 2015. The total sample was selected randomly from Serewe Villages; 57 respondents were involved with seaweed business. In Serewe, individual interviews were conducted and utilized enumerators with 40 respondents of seaweed farmers and 10 respondents of seaweed collectors and traders. The purpose of individual interviews was to collect individual information from seaweed farmers, seaweed collectors, traders and wholesalers. Then, 10 of 40 respondents were selected for in-depth interviews. In-depth interviews were conducted to explore information about farming techniques, post-harvest techniques, marketing and market players, and any problems occurring in the seaweed farming business. Focus Group Discussion (FGD) was conducted during field surveys to cross-check the validity of information derived from individual interviews. Many opinions of developing seaweed culture in Serewe Village have been explored during the discussions. Discussions clarified the supply chain that consists of producers, collectors and wholesalers. Secondary data consist of statistics, scientific reports, scientific publication and other reports were collected from *Dinas Kelautan dan Perikanan*-DKP in West Nusa Barat Province, East Lombok District and in *Balai Budidaya Laut Lombok* in Gerupuk and Sekotong. Secondary data were used to support the information of primary data.

Data analysis

The data were analyzed using simple statistical methods of descriptive statistics to derive percentage, arithmetic mean, number and standard deviation. Descriptive statistics is the branch of statistics that focuses on collecting, summarizing and presenting a set of data (Levine and Stephan, 2005). Descriptive statistics essentially aims to provide a better understanding of how frequent the data value, and how much variability there is around a typical value in the data (Fernandes, 2009). A significance level of $p>0.05$ was set for the statistical analysis in this study. The results obtained from field observation, key informants opinions, and informal investigations were used to support the analysis. A Likert-type scale analysis was used when the respondents were asked to point out their perceptions about the obstacles and opportunities of seaweed business. Descriptive analysis focuses on socio- economic condition of respondents and the research locations, small-scale entrepreneurs and market characteristics, which include input suppliers, producers, processors and buyers.

RESULTS AND DISCUSSION

Characteristics of seaweed farming in Serewe Bay

Mariculture commodities in West Nusa Tenggara Province consist of seaweed, pearls, groupers, lobsters, etc. Seaweed is one of the developed commodities,

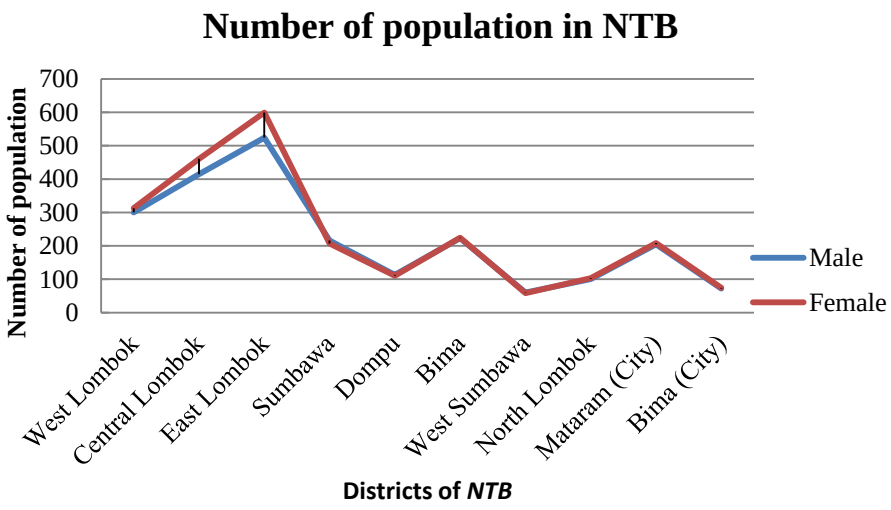

Figure 1. The number of population in NTB province (2013).
Source: (NTB, 2013) in Figure 1.

Table 1. Total area of Nusa Tenggara Barat province.

S/N	District/City	Number of Sub. District	Number of Village	Area (Km^2)	Percentage
1	West Lombok	10	122	1.053,92	5.23
2	Central Lombok	12	139	1.208,40	6.00
3	East Lombok	20	254	1.605,55	7.97
4	Sumbawa	5	33	809,53	4.02
5	Dompu	24	166	6,643,98	32.97
6	Bima	8	81	2.324,60	11.53
7	West Sumbawa	18	198	4.389,40	21.78
8	North Lombok	8	65	1.849,02	9.17
9	Mataram (City)	6	50	61,30	0.30
10	Bima (City)	5	38	207,50	1.03
Total		116	1.146	20.153,15	100

Source: NTB in figure (2013).

which have potential area of 41,000 hectares and potential production of 1,800,000 tons. Currently, utilization of areas that are potential for seaweed only produces as much as 657,757 tons, thus there is 54.46% of seaweed potential area remaining untapped in West Nusa Tenggara Province (Table 2).

The aforementioned data provide an overview of business opportunities in the field of mariculture fisheries in the West Nusa Tenggara Province and may also be able to motivate potential entrepreneurs to manage areas that have not been utilized to the fullest. Seaweed farmers in the Jerowaru Sub District amounted to 1,392 farmers. The numbers of aquaculture facilities are 7,542 units with an area of 5,224,340 million m^2, aquaculture using longline, stakes and rafts system. The ownership of farming areas was measured between 2,500 m^2 to 17,500 m^2, with an average size of 5000 to 10,000 m^2. There were 375 households in Serewe Village, of which 80% of the households are seaweed farmers or 300 people. A total of 221 farmers or 73.7% have ties with collectors. Wet seaweed production of each farmer in Serewe Village was less than 10 to15 tons in averge (1 unit = 4-5 tons). Almost all (0± 95%) of the seaweeds in Serewe Village were sold as dried products. Seaweed processing is still under developed and produced by two groups that process seaweed in Serewe Village namely the group of “Putri Nyale Selatan” and the “Putri Mandalika”.

The processed products of seaweed in East Lombok District were produced traditionally and small scale business, such as sweets and crackers. Seaweed in East Lombok has the opportunity to be developed as an alternative livelihood of fishermen that can be used as a solution when the fish catches are declining. However, low production costs and the market are still opened for development. Meanwhile, the problems are still faced by

Table 2. Potency of fisheries resource in NTB province.

S/N	Commodity	Potency area (Ha)	Potency of resource (Tons)	Utilization (Tons)	Percentage
1	Seaweed	41.000	1,800,000	657.757	36.54
2	Pearl/Oyster	25.000	1.5	0.1	6.67
3	Groupers, lobster and others	17.000	30.000	451.31	1.5

Source: Dinas Kelautan dan Perikanan NTB (2014) (Data update on February, 2014).

the fishermen related to the quality of seaweed, low price from buyer. Seaweed farming is particularly prone to bottom and bust cycles given the large number of small scale price-takers in the industry (Valderrama et al., 2015). Indeed, Valderrama mentions that seaweed farmers, traders and processors frequently make decisions based on speculations or misinformation.

Input supply

In average, seaweed farmers in Serewe Village have 2 to 3 plots of seaweed farm, which produces 2.5 tons of wet seaweed per crop (30 days) or equal to 1.2 tons of dry seaweed. Dried seaweeds are sold to collectors in sub-village level and then sold to next collector in the village level and then wholesalers in Jerowaru Sub District. The production of seaweed per plot was 2 tons wet or 170 kg dry (1 ton wet = 85 kg dry).

The yield of each harvest is as much as 300 - 400 Kg per month (dry) at a price of IDR. 7500/kg, which means a monthly income of seaweed farmer, was IDR 3,000,000. Based on the achievements of the *Minapolitan* program of 2009 to 2013 in West Nusa Tenggara Province, there was an increase in the supply component of seaweed that includes width area, number of farmers, production volume, productivity which increases revenue (Table 3). Indonesian Government has embraced seaweed industry as one of the key economic drivers in fisheries sector by improved production (The Economist, 2013).

Dinas Kelautan dan Perikanan-DKP (Marine and Fisheries Office) of West Nusa Tenggara Province) have provided assistance in the form of racks for drying seaweed and longlines or ropes to create the aquaculture plots. Racks are very helpful to maintain seaweed cleanliness from dirt or debris. The materials of racks are made from woods, measuring 10 m x 10 m x 3 m, with construction costs of 1 unit around IDR. 6,250,000, - (Table 4).

In addition, the Marine and Fisheries Office of the East Lombok District had given assistance to farmers such as seaweed seedlings, racks and drying floors through *KUR* (*Kredit Usaha Rakyat*/SMEs Credit). However, seaweed farmers were more likely to have access to wholesalers compared to other resources to get financial capital. Seaweeds in Serewe are mostly harvested for 30 days. According to respondents (farmers), they are harvested in 30 days for three reasons;

(1) Weather
(2) Household financial source
(3) Diseases.

Hurtado et al. (2014) emphasize production in “wet season” is lean; this occurs in Indonesia from October to March. It is different from other countries that is, Malaysia (November to March) and the Philippines (July to October). This statement matches with the condition in Serewe-East Lombok. Changes in the period of monsoon seasons in Indonesia in recent years influence the planting season of seaweed as well as production pattern. The price of seaweed is determined by collectors/traders, especially for seaweed farmers that have ties with collectors. In addition, farmers also set seaweed price based on agreement between collector-traders and seaweed farmers. This is done by seaweed farmers who do not have ties with the collectors.

Farming technology

Seaweed farming in Lombok has utilized the raft method since the 1990s up to 2006. Since 2007, the use of the longline method has increased while that of the raft method is diminishing till date. However, a problem that later arose was the insufficient supply of seed stocks for seaweed cultivation. The shortage is due to crops being sold without leaving any seeds for further cultivation. To overcome that problem, farmers sought seaweed seed stocks from the surrounding villages. The Government, through the Agency for Marine and Fisheries Research and Development (AMAFRAD) is still conducting field trials for applying farming method using the net culture system. This technique was tested in Serewe Village with four plots (4 plots x 200 lines) or 800 lines. The comparison of financial utilizations between raft and longline methods can be seen in Table 6.

The method of seaweed farming in Serewe-East Lombok utilizes the floating longline method. Seaweed farming has been going on since 1975. The size of each plot is 50 x 20 m. The longline method in seaweed

Table 3. Achievement of supply component of seaweed.

Indicator	Year	Unit	Target	Realization	Percentage
	2009	Ha	6.953.42	3.523.94	50.68
	2010	Ha	5.664.00	4.719.94	83.33
Area	2011	Ha	12.248.00	10.637.69	86.85
	2012	Ha	12.248.00	11,914.10	97.27
	2013	Ha	15.000.00	14.536.09	96.91
	2009	Persons	13.852	13.852	100.00
	2010	Persons	15.237	14.102	92.55
Number of seaweed farmer	2011	Persons	16.776	14.645	87.30
	2012	Persons	16.776	14.823	88.36
	2013	Persons	17.456	16.500	94.52
	2009	Tons	150.000	147.251	98.17
	2010	Tons	250.000	221.046	88.42
Production	2011	Tons	500.000	457.914	91.58
	2012	Tons	750.000	657.700	87.69
	2013	Tons	1.000.000	765,335	75.64
Productivity					
Bamboo raft	-	Tons/Ha	45	43,50	96.67
Longline	-	Tons/Ha	20	17.00	85.00
Patok	-	Tons/Ha	80	70.00	87.50
Average income	-	IDR/Yr	40.000.000	47.700.000	119.25

Source: DKP NTB (2013).

Table 4. Cost component for making drying rack or *"para-para"*.

Components	Cost
Lumber (1 M^3)	IDR. 4.000.000
Bamboo (25 sticks) @ IDR. 50.000	IDR. 1.250.000
Operational cost and etc	IDR. 1.000.000

Remarks: 1 USD = IDR 13,294.
Source: Primary data (2015).

farming was used since 2011 though it was introduced by the DKP of East Lombok District with individual ownership status. Materials for manufacturing cages consist of nylon rope, weights, large and small buoys. The longline and raft methods are generally applied to areas with the following characteristics: the depth of the waters ≥ 3m at low tide, quite sheltered from the waves / big waves, away from areas with high sedimentation, areas of water with good visibility (≥ 2 m) and not in a shipping line (ships or boats). While the stakes method is applied to tidal regions with a minimum depth of 0.5 m at the lowest tide, has a sandy sea floor or sand mixed with corals. The longline and raft methods were most widely used in Central Lombok District (Teluk Gerupuk, Teluk Bumbang and Teluk Awang) and East Lombok District (Ekas Bay and Serewe Bay) (Purnomo, et al. 2014). In the longline method, the required seeds for one plot are 1 ton with a price of IDR. 2000/Kg (Table 7).

There are 2 (two) wage systems for harvesting seaweed: the contract and rope systems. A total of 94.7% of farmers in Serewe Village use the rope calculation system, while the remaining 5.3% or as many as 25 people still use the contract system. Seaweed farming in East Lombok District was still not balanced between dried seaweed and processed products. Developing product diversifications or combination of two types of product diversification could be as an alternative livelihood. The role of livelihood diversification through the development of value-added seaweed has been able to lift the fishermen economy, even replacing fishing as the main source of livelihood (Zamroni and Yamao, 2011).

Supporting production and services

Seaweed farming in Serewe requires boats and fuel (gasoline). Those facility is used by fishermen to transport seaweed from the beach to farm area for daily control and cleaning of seaweed from dirts and mosses. The fishermen need 1 to 2 L of gasoline every day,

Table 5. Price comparison between two types of seaweed in Serewe village.

S/N	Seaweed	Wet (IDR/Kg)	Dry (IDR/Kg)
1	*E. Cottonii*	2000 to 2500	6.000
2	Spinosum	1.500	5.000

Remarks: 1 USD = IDR 13,294.
Source: Primary data (2015).

Table 6. Comparison of investment cost between two farming methods.

S/N	Investment components	Longline method	Bamboo raft method
1	Initial Investment	IDR. 5.000.000/Unit (*Petak*)	IDR. 500.000/Unit (Raft)
2	Technical life	5 Yrs	2 Months
3	Number of line	200 units	40 Units
4	Line space	40 cm	20-25 cm
5	Space between seed points	25-30 cm	25-30 cm
6	Number of main buoy	20 units	-
7	Number of small buoy	800 unit (4 btl/line x 200 line)	-
8	Number of bamboo	-	6 units (@ IDR 20.000)

Remarks: 1 USD = IDR 13.294.
Source: Primary Data (processed) (2015).

given its location not far to the beach. Planting sites are located on 1 to 2 km from the beach. Fishermen select the seaweed farm area by following two main considerations;

(1) Location should be protected from large waves
(2) Rich nutrients
(3) Pollution-free, and
(4) Location is not far from the beach to reduce operating costs for fuel.

Several post-harvest facilities are needed to develop the seaweed in Serewe; for example, drying racks or drying floors and warehouse. Seaweed production facilities such as ropes and buoys are still insufficient due to limited financial capital; some farmers are still having an average of 30 lines which in turn causes low income.

Characteristics of seaweed market

According to interview with market players of seaweed in Central Lombok and East Lombok, the profit of each market channels is described in Table 9. Marketing network for value-added products needs an advanced strategy. This strategy can take advantage of the role of middlemen to reduce frictions in seaweed market (Masters, 2007). Production diversification and marketing opportunities can open up more job opportunities. In order to maximize the seaweed for fishermen's livelihood, Smith and Renard (2002) suggest that the integration of technology, ecology, sociology and economics is an appropriate strategy approach. Seaweed market in Serewe is still dominated by middlemen who buy dried seaweed. Seaweed farming cycles in Serewe Bay is divided into three seasons a year. In terms of peak season, farmers can harvest the seaweed 4 to 5 times, with an average yield of 3 to 4 tons/harvest/unit. It usually occurs from June to September. In low season, they harvest at least 4-5 times and it usually occurs during the rainy season or from January to May with average production of 1 ton/unit/crop. The season with moderate production occurs from October-December, with average yield of 1.5 ton/cycle/unit (figure 2). The problem of low prices has become a "trademark" of seaweed from Serewe. In addition, the factors affecting low price of seaweed are as follows;

(1) Seaweed under 45 days or mainly from 25 to 30 days
(2) Dry method does not pay attention to hygiene standards, that is, they are dry on the ground which is likely the mixing of dirt or debris with seaweed.
(3) The seed quality slowly declines. The *thallus* growth is slow and easily broken.
(4) Low quality of post-harvest handling by seaweed farmers.

Bonded system (*ijon*) between seaweed farmers and middleman is affected by the seaweed price (Table 5). The existence of bonded system is driven by farmers' expenditure. In other words, the debts of farmers to collectors are not mostly used for business matter (Table 9 and Figure 3).

Table 7. Cost component for seaweed farming in Serewe village.

S/N	Cost components	Quality	Unit	Price per unit (IDR)	Total (IDR)
1	Rope (5 mm)	150	Kg	42.000	6.300.000
2	Main rope (14 mm)	30	Kg	42.000	1.260.000
3	Anchor rope (8 mm)	50	Kg	42.000	2.100.000
4	Raffia rope	200	Kg	450	90.000
5	Anchor	48	Units	5.000	240.000
6	Seedling workers	200	Lines	1.000	200.000
7	Open raffia workers	200	Lines	1.000	200.000
8	Longline setting workers	200	Lines	750	150.000
9	Maintenance workers	1	crops	100.000	100.000
10	Harvest	30	persons	75.000	2.250.000
11	Remove seaweed from line (post-harvest)	200	Lines	1.000	200.000

Remarks: 1 USD = IDR 13.294.
Source: Primary data (processed) (2015).

Table 8. Profit and/or value-added (absolute or % contribution to total).

Profit	(P) IDR (.000)/kg	Own sales (%)	Collector sales (%)	Value added (%)
Seaweed farmer	2	20	80	20
Seaweed collectors	2	10	90	5
Seaweed processors				
Sweets	10	85	15	75
Tortilla	10	85	15	70
Crackers	10	85	15	73
Sticks	10	85	15	66
Rengginang	10	85	15	71
Wholesaler	4	90	10	30

Source: DKP NTB (2014) and Primary data (2015) (Processed).

Table 9. Market characteristics of seaweed in Serewe.

Components	East Lombok
Volumes	74.953.60 Tons
Values	IDR. 524.7 M
Prices	IDR. 7000/Kg
Products and product development	Dry and food processed products
Competitors	Local collectors and wholesalers
Demand characteristics	Good quality of dry seaweed for food product processing Local market (West Nusa Tenggara Province)
Regulation and policy	Improving quality of dry seaweed, improving added value products
Key institutions	DKP of East Lombok and West Nusa Tenggara Province, Mariculture institute at Lombok, Buyers, Ministry of Marine Affairs and Fisheries and other local government offices

Remarks: 1 USD = IDR 13.294.
Source: Primary data (2015).

Low season					3-4 ton (*E. cottonii*)				*Moderate*			
					Peak season				1,5 ton (*E. cottonii*)			
Prod: 1 ton (*E. cottonii* (green) atau *sakul*)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

Figure 2. Seasonal production of seaweed farming.

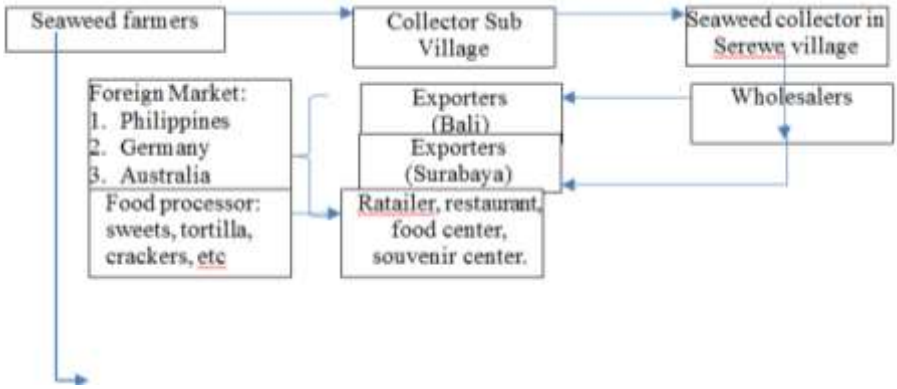

Figure 3. Marketing map of seaweed in Serewe.
Source: Primary data (2015).

The challenges and opportunity of Seaweed Business

Seaweed is one of the top priorities of fisheries commodity in West Nusa Tenggara with a relatively high and stable production; it has a wide potential area. Seaweed has a good prospect, because it is supported by several factors:

(1) Extensive farming area
(2) High demand
(3) Low cost
(4) Jobs opportunity
(5) As an alternative livelihood, particularly for coral-miner, mangrove loggers.

Bindu and Levine (2011) predicted that the seaweed cultivation in tropical countries will continue due to the high production values realized, coastal villages need for alternative livelihood, and increased demand of carrageenan in global market (Table 10). However, the problem/barriers obtained based on the field interviews are as follows:

(1) Pests and diseases are affecting the aquaculture communities.
(2) Harvesting of young seaweed and drying the seaweed with unrequired water content would deteriorate during storage and transportation.
(3) The seaweed price determined by buyers.
(4) Lack of financial sources.
(6) Small number of instructors and inequality in the growth of expanded farming area.
(7) Climate change impacts on farming activities.

In the future, there will be the opportunity to use good quality seeds or commonly referred to tissue culture method from *E cotonii* in East Lombok. The advantages of using tissue culture seeds are;

(1) They are tougher in terms of disease resistance
(2) Withstand strong wave
(3) Have more *thallus* and
(4) Look fatter compared to the existing seeds
(5) Harvest yields are greater than ordinary seeds.

However, provision of tissue culture seedlings is still limited, and it has not been widely distributed to seaweed centre, especially in the area of East Lombok. Therefore, it is necessary to develop a strategy and technology for the provision of tissue culture seedlings as a solution to overcome the problem of seed quality. Scoones et al. (2007) argued that sustainability of seaweed has been examined with several considerations, namely; durability under internal value chain stress, stability in the face of internal value chain shocks, robustness under external

Table 10. Factors influence to seaweed industry in East Lombok.

Factors	Internal	External
Factors affecting sourcing	Price is fluctuation, availability is depending on climate situation→5 times production per years	Seasonal is unpredictable Water pollution in certain months/seasons
	Productivity is slowly decrease because of seeds quality	Drying in the rainy season
	Business management is poor	Low ability of seaweed farmers for re-investment
Factors affecting making/producing	Value added product is need to develop	-
	Quality is under standard (under 45 days harvest)	-
	Altering type of farming technology from raft to longline	-
	Dirty Drying method	-
Factors affecting delivery/sales	Delivery: 2 Ton per 2 weeks (dry seaweed)	No storage system No Business consorsium
	Long distribution channels.	Only ± 30% of raw material utilized by SMEs

Source: Primary data processed (2016).

Table 11. Infrastructures needs for farming activities.

S/N	Activities	Type of Infrastructure
1	Fisheries business	Research institute→ Producing high quality seeds Farming technology and processing technology Cold storage
2	Mariculture	Handling space for mariculture product Landing place and parking area for boats
3	Processing	Drying place (*para-para*) for seaweed Storage and other post-harvest handling
4	Marketing	Marketing and promotion

value chains stress and resilience in the face of external value chain shocks.

Intervention toward seaweed industry development in West Nusa Tenggara

At present, the obstacles of seaweed farming development are as follows;

(1) “Ice-ice” (white spot syndrome virus) disease
(2) Low quality of seeds
(3) Lack of post-harvest management
(4) Less of optimal harvest time (that is, 30 days in average)
(5) One price for all quality of dried seaweed
(6) Limitation of freshwater resource
(7) Zoning and carrying capacity is not established yet.

In order to improve quality and productivity, post-harvest management and supporting infrastructure facilities should be top priority for seaweed development in the future (Table 11). The Marine Affairs and Fisheries Minister Decree *No. KEP.02/MEN/2007* regarding Good Fisheries Practices, and the Director General of Aquaculture Decree *No. KEP.44/DJ-PB/2008* regarding Implementation Guidelines for *CBIB* (Best aquaculture practices) Certification are the strong commitments from central government or Ministry of Marine Affairs and Fisheries in developing aquaculture industry. Based on the results of analysis, the actions can be divided into 3 aspects;

(1) Aquaculture
(2) Product processing and
(3) Social and economics.

In terms of aquaculture, the actions that need to be taken by government consist of;

(1) Supporting the production infrastructures, that is, drying racks and line

(2) New variety of seaweed introduced by *BBL* in Lombok
(3) Water monitoring for farming activities related to water environment, desease and standard of operation for mariculture.
(4) Farming license for mariculture development
(5) Integrated spacial planning for coastal area
(6) Training for desease prevention to seaweed farmers
(7) Empowering fisheries cooperative, and
(8) Seaweed seeds-park.

Improving value added and price, central government might collaborate with provincial government to provide low-power food processing equipment. Socially and economically, the following actions can be taken;

(1) Provide scholarship program for fishermen's children
(2) Trainning and education for main fisheries players actors
(3) Marine and fisheries advocation, and
(4) Improving particiption level of farmers and seaweed processor groups.

Seaweed Industry development in East Lombok might focus on post harvest management. Post harvest management can start from improving the quality of seeds, wet seaweed, and dry seaweed. Seed of seaweed could be developed using tissue culture method.

Barrios (2005) reported that vegetative tissues have high growth rates, asexual reproduction capacity through fragmentation, resistance to grazing and colonization by fouling organisms make seaweed-*Kappaphycus* a potential invader to new environments. Therefore, local government should make collabotaration work with other related institutions to develop non-food products using seaweed as a raw material. Establishing seaweed storage and good management could protect seaweed farmers from speculators' act and improve the dry seawed quality. Provincial government could support local companies to produce non-food products using seaweed as a raw material.

Based on the development plan of the West Nusa Tenggara Province, increased productivity and added value is a major concern. Improving connectivity in the regions is the best follow up action to optimize local resource and minimize the problems of seaweed farming in East Lombok. However, the strategy should focus on the following actions:

(1) Farming area development. It is a priority to manage the coastal zone, conserve the coastal area, and enhance community based management.
(2) Optimizing mariculture resources through integrating activities in research and development encourage government to collaborate with related public and private sectors toward competitiveness improvement of fisheries resources and their products.
(3) Improving adaptation to climate change impacts through implementation appropriate aquaculture technologies and using high-quality seeds.
(4) Social and economic empowerment of farmers through enhancing the role of local communities, improving effective procedure for resource utilization, improving community participation, improving small economics activity.
(5) Infrastructure and facilities for the utilization of mariculture fishery resources, including a guidance and improving data and information for farmer's group.

Valderrama et al. (2015) suggest that minimum farm lines are still necessary to ensure adequate economics returns, and greater farming plots to improve the potential economy of under-performing systems. Finally, there should be colloboration work among cross sectors and different levels of institutions. This means that the central and local government collaboration is absolutly required for developing seaweed industry in East Lombok.

Conclusions

Small-scale entrepreneurs of seaweed in Serewe are dominant in production activity (farming) by using floating longline. In average, each farmer can harvest the wet seaweed of about 10-15 ton per crop and sell dry seaweed (95%) to wholesaler through collectors at Sewere Village. Seaweed farmers are mostly trapped on tie system with collectors as well as wholesalers at local level. As consequence, farmers are helpless about price determination. Food products made from seaweed are potentially alternative income sources for household, but people still do this job and consumers depend on their orders. Developing seaweed industry in East Lombok has some obstacles: low seeds quality, *ice-ice* disease attack, post-harvest quality, high dependency of farmers on traders, unsustainable financial capital, less advocacy from extension service, and natural impact of climate change. In food processing, the obstacles faced by food processors are:

(1) Marketing of processed products depends on consumers' order
(2) Low quality of post-harvest handling for seaweed
(3) Low quality of manpower on products processing
(4) Low financial capital, and
(5) Small-scale entrepreneurs develop slowly.

There are 3 (three) issues in socio- economic aspects: traditional knowledge in East Lombok, *awig-awig* need of improvement in their roles as a community based natural resource management; creativity of fish farmers and seaweed farmers to diversify the products to be developed; horizontal conflict among stakeholders in fisheries activities due to coastal uses problem. However, there are several opportunities why seaweed industry

needs to develop. First, tissue culture method has found the new generation of *Eucheuma cottonii L* that has an advantage compared with elder generation. Second, dry seaweed can produce *Alkali Treatment Chips* (ATC) that could improve value-added. Third, farming area is located close to the beach, which could save the operational cost. The actions need to be implemented by collaboration between central government and local government, which includes several activities; supporting post-harvest infrastructures, dissemination of new generation seaweed, arranging coastal utilization, and capacity building for farmers and institution. Value added can be improved by producing seaweed-chips to supply food and non-food industries. Finally, government should provide scholarship program for fishermen's children, training and education for main fisheries actors, advocating for farmers, and improving participation level of groups

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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