TOPIC AREA:
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VALUE CHAIN ANALYSIS OF SEAWEED IN ACEH, INDONESIA

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FINAL INVESTIGATION REPORT

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ABSTRACT

This study analyzed the value chain of seaweeds (particularly *Gracilaria*) for Banda Aceh, Indonesia, including the roles of key players, logistical issues, external influences, and transaction flows among market levels. The study identified areas for improvement and provided recommendations for the Indonesian seaweed industry, in general, and the Banda Aceh seaweed farmers, in particular.

Key players of the seaweeds industry are the seaweed farmers, collectors (or assemblers), interregional shippers/traders, and provincial/regional processors and exporters. Jakarta, Sulawesi, and Surabaya are the major transshipment points of tradable seaweed products either in dried or derivative forms. Dried seaweeds (about 80%) are exported for further processing into agar and carrageenan and imported back to meet its domestic demand for food, pharmaceutical, industrial, and energy sectors. Domestic demand for seaweed derivatives is fast growing in many seaweed raw material sources such as Indonesia, the

Philippines, and other Southeast Asian countries, thus, putting downward pressure on the availability of raw material supply in the global markets.

The technological advances of the seaweed derivatives market (downstream subsector) had clearly outpaced those in the upstream subsector including the reliability and quality of planting materials, and cultural and post-production practices of dried seaweeds, among others. Hence, the mismatch of information on grades and standards is one of the major reasons for disparities of growth among the key players in the seaweed industry.

Because of the geographic locations and state of marketing infrastructures in rural Indonesia, the major problem of the seaweed industry is the very weak linkage of the raw material subsector to the seaweed derivatives and end-user subsectors. These problems include high logistics and transaction costs across the value chain, lack of seaweed laboratories and nurseries, lack of postharvest technologies and facilities at the farm level, irregular supply of desired quality, and volume of dried seaweed.

The levels of public and private investment in research and extension coupled by the geographic distribution of seaweed farming communities should require a shift in business and/or marketing strategies. The traditional marketing modes should now be replaced by more strategic ones, like the value (or supply) chain management schemes, joint ventures, and/or other coordinating mechanisms.

Some recommendations to address the issues and concerns are: encourage the establishment of more seaweed laboratories, nurseries or multiplier farms; establish more cluster-based post-harvest facilities; institutionalize an accreditation program for seaweed derivatives processors and manufacturers of end-products, etc.; and provide capital windows to improve facilities and enhance the entire management of value chains of the seaweed industry.

INTRODUCTION

Seaweed is one of the most dynamic fishery products in Indonesia. It continually provides livelihood and employment activities to small fishing folks in coastal areas. It attracts new investors while some established ones improve their products and processes to meet increasing demand of global markets. Likewise, it is a stable source of export earnings of the country. Finally, it opens up new niches in the food, pharmaceutical, industrial and energy markets.

Seaweeds (or sea plants) are salt-water algae that grow in shallow coastal areas and ponds near waterways. They are classified as Green, Brown or Red and each classification has a number of Genera and Species. Red seaweeds (e.g. *Gracilaria*) are the major varieties farmed in Indonesia and Southeast Asian countries, hence the interest of the study.

Seaweeds are the major sources of agar and carrageenan. Both are large, highly flexible molecules with curl forming helical structures, thus, enabling them to form a variety of different gels at room temperature. Carrageenan and agar are widely used in food and other industries as thickening, stabilizing and/or emulsifying agents for making primary products such as chocolate milk drinks, ice cream, dessert gels and flans; sauces and dressings; beef patty, luncheon meat, poultry and ham; beer, wine and vinegar; toothpaste, shampoo and cosmetic creams; pharmaceuticals, shoe polish, pulp and paper, ceramic coatings, carpet printing, and other products.

The demand for agar and carrageenan is derived from the demand for the above-cited primary products. However, the sluggish performance in the value-adding subsector of the Indonesian seaweeds industry and the relative inefficiencies in the marketing system remain vital challenges of the industry, by and large. To be a strong contender in the global market of seaweeds given its geographic features and

comparative advantages, Indonesia should capitalize more in the value-adding aspect of the industry and translate the gains to the smallholder farming communities, thus alleviating poverty in the process through a more responsive value (or supply) chain.

OBJECTIVE

The goal of the study is to foster the successful participation of small-scale Aceh seaweed polyculture producers in the Indonesian seaweed production/marketing system. The objectives are as follows:

1. Describe and evaluate the existing value chain of seaweed production in Aceh Indonesia.
2. Develop recommendations to improve local system efficiency and participation of small-scale seaweed polyculture producers in Aceh Indonesia.

METHODS

Seaweed value chain maps were traced for each market level, e.g., producer, assembler/collector, transporter, wholesaler and exporter, to identify specific activities and services, key players, logistical issues, external influences, and flow of product, information and payment. Seaweed value chain performance in Indonesia will be evaluated for efficiency, flexibility, and overall responsiveness. This method is guided by the framework of McHugh (2003), Tveras and Kvaloy (2004), and Neish (2008).

Study Areas and Coverage

In-country data collection was accomplished and interviews conducted from May to August 2012, by Jamandre with the assistance of Hasanuddin and Kokarkin. The focus of this in-country effort was Ujung Batee Aquaculture Center (UBAC) in Banda Aceh, Samalanga demonstration site in Bireun District, Lancang in Pidie District, Trengadring Multi Species Hatchery in Pidie Jaya District, Bayu in Aceh Utara District, Banda Aceh local markets, and Tangerang, East Jakarta, Cikarang, Medan and Jakarta regional markets.

Data Collection and Requirements

Primary data were obtained through survey, key informant interviews and focus group discussions (FGD). FGDs were also conducted to validate secondary information and to answer more specific questions related to value chain mapping.

The following primary data were collected: the key players and their respective roles, activities and services provided at each step in the value chain; product requirements (especially quality standards); information and money flow; critical logistics issues (including problems in production and marketing); and extension services and external influences.

Secondary data series on seaweed statistics were obtained from various Indonesian agencies, especially Ministry of Marine Affairs and Fisheries. Previous studies on the production and marketing of seaweed served as sources of secondary information. Likewise, UBAC and in-country collaborators served as sources of secondary information. Officers and staff of appropriate government agencies and other industry personalities were additional sources of information.

Data Processing and Analysis

The method of analysis of data and information for each objective is listed in Table 1.

Table 1. *Objectives and methods of analysis*

Objectives	Method of Analysis
• Develop the value chain maps • Identify improvement areas	• Flowchart analysis • Gross margin analysis

RESULTS AND DISCUSSION

Overview of the Indonesian Seaweed Industry

Production of Seaweeds

The major producing provinces of seaweeds in Indonesia are shown in Table 2 where South Sulawesi, Central Sulawesi and East Nusa Tenggara dominated the top three spots for the years 2007-09. During the same periods, the average annual growth rate of seaweed production rose to 32.46% across all provinces in Indonesia, with Gorontalo and Central Sulawesi as leaders with their respective growth rates.

Smallholder farmers or fisher folks undertake *Gracilaria* and *Cottonii* seaweed production, but the farming systems are distinct for the two crops. *Gracilaria* cultivation is in ponds while *Cottonii* culture is undertaken in shallow ocean water along the shoreline.

Cultivation of *Gracilaria* takes place in ponds that are located close to waterways that can be supplied with seawater. It is grown as a monoculture or in polyculture with milkfish and prawns. Most ponds are located relatively near to the coastline for both access to seawater and transportation. Production cycles are around 45 days or about 7 cycles/year. But because of water shortages during July to November in some locations, 4 cycles/year are more common.

Seaweeds Harvesting and Handling Operations

Gracilaria are grown to about 1 kg or more before they are harvested. Farmers harvest their crop by uprooting the full-grown seaweeds and taking the harvests out in pond paddies using small rafts. Seaweeds are sometimes packed in nylon sacks and transported to a farmer's shed or working area for subsequent operations.

With good and stable sunlight, seaweeds could be thoroughly dried down to about 30-35% moisture content (MC) in three to four days. This is the ideal MC for packing seaweeds. Indicators for well-dried seaweeds with about 30-35% MC include seaweeds covered with salt crystals with rubber-like texture and have no dripping water when squeezed. About 7kg to 10 kg of fresh seaweeds yield 1 kg of dry seaweeds.

Production of Agar

About 25% of the weight of dried seaweed is agar. Agar is a marine colloid extracted from certain algae of the class Rhodophyceae. It is insoluble in cold water but soluble in boiling water to make a liquid which, when cooled, forms a firm, clear, resilient gel possessing suspending, stabilizing and thickening properties. Agar can be extracted through an industrial process (Figure 1).

The processing of agar involves washing the seaweed, heating it in water and treating it with alkali (to increase the gel strength). The hot liquid is then filtered and the filtrate is cooled to form a gel. The water is then removed from the gel by squeezing and then the gel is dried. The gel is then milled to produce a fine agar powder or sometimes extruded as agar strips (see McHugh, 2003 for a detailed description). About 90% of agar is used for human consumption.

Apparently, *Gracilaria* became an important source for agar production because it is easily harvested and cultivated. Recent estimates place the annual world production of agar at about 8,000 tons. Nowadays, about 60% of agarophytes collected for agar production are attributed to *Gracilaria* spp., 35% to *Gelidium* sp. and 3% to others.

Some countries have abundant agarophyte resources, such as Chile, the Philippines, Brazil, Portugal, and Indonesia, and they export agarophytes to other regions. Japan imports a large amount of *Gracilaria* every year from these regions. Table 3 indicates the quantity of agarophytes imported by Japan.

Various studies have shown that seaweed farming is a growing agribusiness sector of Indonesia with bright prospect as a major source of income of fishing communities of the country. However, in order to realize the potential of the industry, there is a need to step up the provision of support services along with polyculture research and extension to enhance the fishermen's capability to produce and handle larger volumes of high quality seaweeds (Hatch, 2010; Jamandre et al., 2010).

Trade Performance of Indonesian Seaweeds

Seaweeds are traded globally both in raw and processed derivatives in the form of agar and carrageenan. The continued growth of the global seaweed production (Table 4) is indicative of the increasing market demand for the above primary products. In terms of wet volume equivalent, the Philippines is the world's top producer, with a share of around 32%, while Indonesia is fourth with about 10% contribution. But in terms of growth rate, Indonesia ranked first with 18%, followed by China with 15%, and the Philippines with 10%. Japan and others posted negative growth rates during 1999-2003.

Indonesia had taken the lead in the production and exports of dried seaweed from the Philippines (Table 5). The exports volume of dried seaweeds of Indonesia had grown by about 19% with an average value of US$33 million during 2000-05 while the Philippines registered a decline of around 6%. However, the Philippines has gained more in the exports of agar and carrageenan, in terms of volume and value. Hence, there is about US$40 million advantage of the Philippine over Indonesia on total value of exports.

Moreover, the world's major producers of carrageenan are the Philippines, Indonesia and China, with a combined share of about 70% (Table 6). The Philippines carries a lion's share of about 40%, which is around two to threefold higher than Indonesia and China, respectively. These gains could be attributed to the improved technologies and standards adapted in the value-adding activities of the Philippines through investment in research and extension, and strong market linkages and alliances at the various levels of the industry. These efforts should be emulated by Indonesia.

The major regional destinations of Indonesian dried seaweed are China, Europe and Asia Pacific, with a combined market shares of 40% (Table 7). Although these markets produce dried seaweeds too, Indonesian supply will certainly serve as buffer to ensure sustainable operations for their domestic requirements. For instance, the domestic markets for food, pharmaceutical and industrial grades of seaweeds absorb almost 95% of their local production. Other seaweeds are thinly distributed in America, Africa and Middle East regions. However, Asia Pacific and America are buying more aggressively than China and Middle East regional markets with respective growth rates of 45% and 39% for the same periods.

For the seaweed derivative markets, the total value of agar exports from Indonesia is almost twofold higher than that for carrageenan exports from 2000 – 2005 (Table 8). This is because *Gracilaria* as a major source of agar in Indonesia is becoming more attractive and a preferred variety. Albeit the price/tonne of carraagenan is relatively higher than agar, this may not be true for some regional markets

such as Asia Pacific and Europe, where agar is more expensive than carrageenan. There is no clear pattern of prices across the regional markets but in aggregate, carrageenan remained more expensive than agar.

Recently, the Indonesian export earnings from dried seaweeds (88%) and gelatin/agar (12%) amounted to an annual average of around US$96M during 2007-09 (Table 9). The variance of the unit values of the two commodities may be translated as export opportunities with improved processing technology by the seaweed-producing sector.

Table 10 corroborates further the advantages of undertaking downstream processing activities. The price differential across grades of processed carrageenan and dried seaweeds indicate premium for quality standards. Since Indonesia is exporting 80% of its dried seaweeds it is clearly missing this opportunity.

The shipping cost schedules of dried and processed seaweed derivatives to domestic and foreign destinations show the presence of cost savings by complying with the product grades and packaging requirements (Table 11). The gross margin per kilogram of dried *Gracilaria* is shown in Table 12. There is a premium of improving quality even within product grades. In this case, three classes of dried *Gracilaria* are compared with assorted ones and the gross margin or profit per kilogram increases to about two to tenfold more than the assorted ones. Due to the clear economic benefits of engaging in the value adding activities, more domestic processors are expanding and/or improving their outfits to conform with the world standards (Table 13).

Value Chain of Dried Seaweeds and Derivatives

There are three major segments or subsectors of the entire value chain of the Indonesian seaweeds industry: the raw (dried) seaweed, the seaweed derivatives (agar and carrageenan), and the end-users such as the food, pharmaceutical, industrial and energy subsectors. The first subsector is the focus of this study. Generally, the chain is characterized by the interdependence of the sources of planting and other farm inputs, smallholder farm production, collection or consolidation, and transport of products to local ports for either domestic or international customers.

Key Players, Major Roles, and Activities

The major players of the Indonesian agar value chain are the *Gracilaria* farmers, producers (or processors) of dried seaweeds and seaweed derivatives, collectors, traders (or interregional shippers), and exporters. Figure 2 presents the key players together with the product flow of dried seaweeds and its derivatives.

Seaweed Farmers

Families engaged in seaweed farming consider the following factors for better yield:

Location of the farm, which has the foremost bearing on the salinity of the water. The ideal salinity is between 32 and 38 ppt. Location also influences the water temperature, which is an important factor in seaweed farming. The ideal temperature is between 27 and 30^{o}C. Location also implies that water depth should not be less than 30 cm during the low tide in order to avoid exposing the plants to direct sunlight and air. On the other hand, seaweed should be "planted" high enough to allow sunlight to penetrate the water, providing the most crucial element for photosynthesis.

Secondly, the water current should not be too rough or too gentle. The recommended water current is one that could sway the seaweeds to about 45^{o}C. This is roughly about 20-40 meters/minute. Other

considerations in seaweed farming include: availability of planting materials and good marketing environment (prices and outlets).

Production Practices

Seedlings

Seaweeds are grown from seedlings that usually come from a mature harvested plant. Farmers either buy or produce their own planting materials. For those who produce their own planting materials, the shoots from the newly harvested crop are cut off to become the seedlings for the next cropping cycle. Other farmers opt to buy their planting materials from neighboring seaweed growers, especially if they want to have new stocks for better plant growth.

Planting

Seaweeds are grown and harvested in around 45 days, which typically results in 4 production cycles per year, depending on water availability. Seaweed seedlings are carefully tied to a rope using soft plastic straw before planting directly in ponds.

Postproduction Practices

Harvesting

Seaweeds are allowed to grow to 1 kg or more before they are harvested. Whole plants of *Gracilaria* are harvested or uprooted directly from ponds.

Drying

With good sunlight, seaweeds could be thoroughly dried down to about 30% moisture content in three to four days. It was cited by farmers that seven kilograms of fresh seaweed yields 1 kg of dry material. Different drying practices are enumerated, as follow:

1 Harvested seaweeds are laid and spread on finely braided nylon mesh sheets or nylon sacks sewn together, on the ground to dry under the sun.

2 Others dry their harvest on bamboo or wooden racks lined with nylon mesh or sacks as protective sheet. These bamboo or wooden slats serve as “drying pavements”.

3 Seaweeds are directly spread on uncovered pavement, along pond aisles or roads and/or soil, as observed in some parts of Tangerang. This practice results in heavily soiled seaweeds.

To facilitate drying, the seaweeds are regularly turned over. However, Seaweeds that are dried under direct sunlight, without cover during drying results in very dark seaweeds.

Packing and storing

Seaweeds of about 30-35% moisture content are ready for packing. Seaweeds are tightly packed in jute or nylon sacks.

Farmers do not store their produce; instead, these are immediately collected by local collectors or village-based collectors of traders and are brought to storage or warehouses. Before packing, a certain degree of cleaning is practiced, where pebbles, stones twigs, and other foreign materials are separated from the

dried seaweeds. However, fine soil materials and sand that adhere to the seaweeds are most often not removed. Contaminated seaweeds are especially observed in areas where drying is done directly on the soil surface without the use of protective sheets.

Most traders have facilities for storing their purchased seaweeds, for economies of scale and better future price consideration.

At the trader's level, properly dried seaweeds can be stored up to six months without quality deterioration; however, traders do not usually store the crop for a long period of time due to price considerations.

Marketing Practices

Farmer's level

As earlier cited, farmers do not store their produce; right after drying, seaweeds are compressed, packed in jute or nylon sacks, collected and brought to the traders' warehouses. Most farmers have some form of contractual arrangements with collectors and/or traders, as well as domestic processors. Hence, marketing schemes on price, payments, deliveries and product qualities were predetermined prior to actual production.

Some independent farmers sell freshly harvested seafood as wet seaweed. These farmers claim that the price of wet and dry seaweeds, when computed based on the price for dry seaweeds, is the same. However, the farmers who dry their produce claim that the price increment is so much higher, which gives them incentive to go through the drying process.

Traders' Level

The seaweed-trading sector has at least two "major" layers. The first layer is composed of those that move the commodity from the production site to the bigger assembly/consolidation centers. This layer of the trading sector may involve seaweed farmers, who have enough resources to provide services (and in turn obtain additional income) by purchasing the dried seaweeds directly from farmers. Some of these traders, who have enough space, would perform further drying, if and when necessary. This is performed to minimize price deductions when the seaweeds are finally brought to the bigger trading centers, such as those in Surabaya and Jakarta.

The second layer is composed of the big trading centers, which provide the link between the agar processing plants and the first level traders or sources of raw materials. Likewise, further drying is performed by these traders, if and when necessary. Seaweeds are unloaded, moisture content is determined, further cleaning is performed (e.g. removal of plastic straw, twigs, pebbles, sand, soil and other contaminants). These processes are carried out to minimize price deductions when the seaweeds are sold to the processing plants. Moreover, the big-interregional traders are the same exporters of agar and dried seaweeds as well.

Processing

Processing of agar is commercially done by factories across Indonesia but the biggest factories are found in Surabaya and Jakarta. About 22 processors are located across Indonesia, which are accessible to ports and production sites (Table 14).

Information Flow

Figure 3 describes the information flow among the players for the dried seaweed and derivatives segment. The type and quality of information exchange become more complicated as one moves down the chain. The common information among the players is price, volume or quantity of products, quality grades and class of products. However, controlling the quality of raw materials at the farm level requires a lot of efforts from the collectors and traders. In most cases, they train farmer leaders or representatives of the farming communities on the technical aspect of the seaweed trade with reference to price differences across product grades and the like. Likewise, the big/interregional traders who handle both exports of agar and dried seaweed should inform domestic traders and processors on the quality grades and international standards, including accreditation requirements.

Payment Flow

Due to the nature of seaweed production and marketing, collectors, traders (or exporters) and domestic processors usually make some form of contracts with the seaweed farmers. To avoid risks of price deduction, the full payment of the commodities are done after the assay results are available (Figure 4). Although all players prefer cash transactions, the practice of partial payments serve as hedge for poorly valued commodities. The role of mutual trust and confidence between the farmers and traders is crucial to establish strong interdependence in the process.

External Influences

1. Production and market support programs of the government

Recognizing the potential and crucial role of the seaweed industry in rural poverty alleviation and sustainable development efforts of Indonesia, the seaweed industry cluster as an agribusiness approach of controlling quality at cultivation and marketing levels within an integrated management system commenced implementation in 2008. This approach is a variant of the Nucleus Estate Management approach which was successful on the development of plantation crops. Details of the implementation concept and status of implementation are outlined in MOMAF (2011).

2. Transport services, transaction costs and availability

Transport services affect the competitiveness of seaweed value chain both directly and indirectly. Transport costs have a direct effect in that they influence the price of delivered products. However, quality of transport services regarding schedules, arrival at destination, and the frequency and reliability of service rotations (e.g., once a month, once a week, etc.) can affect the cost of maintaining large safety stocks of inventory. The complexity of shipping documentation contributes to the high transaction costs as well. For instance, there are too many certification requirements from various agencies just to ship seaweeds in Australia.

3. Socio-cultural factors as marketing constraints

Some socio-cultural factors (including citizenship, ethnicity, religion, etc.) may serve as market access constraint. For example, without a local partner, Japanese markets are extremely difficult to access due to multiple delivery documentation requirements.

Production Concerns

1. Low productivity, due to the following:
    a. incidence of “ice-ice”, characterized whitish blemish that gradually dissolves portions of the seaweed; the disease is contagious (e.g., it attacks the entire seaweed, spreading to adjacent

seaweeds, if left unchecked). Farmers quickly prune out portions that are attacked by "ice-ice" to prevent the spread of the disease.

b. practices of early harvesting of seaweeds (e.g., the seaweeds can grow to even heavier weights if left to grow for longer periods of time).

2. Increasing cost of inputs (e.g. ropes, straw lines, Styrofoam floaters, fuel for water pumps and small boat)
3. Inadequate credit access

Post-Production Concerns

1. Low quality produce due to malpractice of adding salt, sand or other debris. This is done in order to attain heavier seaweeds, which directly influences the price; however, this practice is to the detriment and disadvantage of the farmers.
2. Lack of drying facilities that could facilitate drying of cleaner seaweeds.
3. Lack of clear-cut industry-wide quality standards for dried seaweeds, hence, having no basis for determining fair prices.

General concerns

1. Increasing competition with neighboring countries such as the Philippines and Malaysia.
2. Limited technical assistance on production and post-production provided to the farmers.
3. There seems to be a "disinformation" among and between the players of the industry, especially about real value of the seaweeds at farm level and processor's levels.

Value Chain Synthesis

The chain starts with *Gracilaria* hatcheries or seedling farms which are not well established, hence, smallholder farmers either recycle their own seedlings or source them from nearby co-farmers. Farmers employ simple implements and materials for planting seaweeds in shallow and open seas as well as in ponds.

After harvesting, farmers will dry the seaweeds along pond paddies or any available ground spaces. In some cases, farmers use drying racks. Dried seaweeds should reach a moisture content of 30-35% before marketing. Although farmers do not have any moisture tester to ascertain the moisture contents of the seaweeds, most rely on their sensory judgment.

Dried seaweeds are then compressed and packed in a 50 kg bag using a simple compressor (like a baler) before local or village-based collectors collect them. Sometimes collectors collect directly from farmers then compress and bag the seaweeds into full container lots and transport the seaweed to the port. Some intermediary collectors or agents first collect the dried seaweed directly from farmer groups or cooperatives and pass it on to another collector who bags, compresses and consolidates for full container loads before transporting the seaweeds to the port.

To expedite collection efficiency of traders and local processors, they usually put up storage or warehouses that are spread strategically across the production areas with better access to ports and transportation facilities as well. All seaweed is shipped through the ports of Surabaya and Jakarta before either being processed or exported as raw, dried seaweed. More than 90% of the processed products are exported while very little is absorbed domestically. Interestingly, however, a good number of Indonesian processors import agar and carrageenan already graded for food, pharmaceutical, industrial and energy uses.

As implied earlier, the markets for seaweed products are highly segmented and differentiated by quality, final application or use, and channel specific price discovery schemes. Hence, product pricing varies widely for what appears to be homogenous products.

At the end of the seaweed derivatives segment, where the raw materials (agar and carrageenan) are perfectly substitutable for each other, price differences depend on several factors. Mutual trust and confidence between the farm gate collectors and the seaweed farmers with respect to the uniformity of product quality must exist since results of assay will be only be available after the final sale is made. Differences in availability and charges of transport services, and differences in transaction mechanisms in terms of intermediation, dried seaweed collection, and value added/processing undertaken will also affect pricing and cost.

As one moves down the chain, knowledge content on the product sale progressively increases while the characteristics of the seaweed derivatives decline. End-users (e.g., food manufacturers) of these products buy solutions to food chemistry problems more than buying food additives. Therefore, the profit margins are wider down the chain but competition is very thin due to intellectual property rights content.

RECOMMENDATIONS

Some recommendations to address the issues and concerns are to encourage the establishment of more seaweed laboratories, nurseries or multiplier farms; establish more cluster-based post-harvest facilities; institutionalize an accreditation program for seaweed derivatives processors and manufacturers of end-products, etc.; intensify techno-transfer and capacity building; and provide capital windows to improve facilities and enhance the entire management of value chains of the seaweed industry. The goals are to sustain the implementation of the seaweed industry cluster program while promoting more private-public partnership to boost investment in the industry in general.

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Table 2. *Seaweed production in Indonesia by province.*

Rank	Province	Production volume (fresh weight in MT)			
		2007	2008	2009	Growth rate
4	Bali	152,226	170,860	135,811	-4.14%
6	West Nusa Tenggara	75,509	84,750	147,251	42.99%
2	East Nusa Tenggara	504,699	566,495	498,422	0.11%
11	South Kalimantan	6,058	6,850	1,832	-30.09%
9	East Kalimantan	17,562	19,820	7,541	-24.55%
10	North Sulawesi	4,241	4,640	7,933	40.19%
8	Gorontalo	7,117	7,790	48,280	264.61%
3	Central Sulawesi	190,073	208,040	713,562	126.22%
1	South Sulawesi	630,441	690,385	774,026	10.81%
5	Southeast Sulawesi	81,787	89,510	185,229	58.19%
7	Mollucas	16,830	37,590	47,783	75.23%
	Other provinces	41,632	58,070	395,890	310.62%
	Total	1,728,175	1,944,800	2,963,560	32.46%
	Philippines	1,505,008	1,666,497	1,739,992	7.57%

Source: Aquaculture Statistics MOMAF, 2011

Table 3. *Quantity of agarophyte imported by Japan in 1984.*

Country and region	Gelidium spp. (ton)	Gracilaria spp. (ton)
People's Republic of Korea	112	47
Taiwan	4	77
The Philippines	3	1,470
Indonesia	62	69
Chile	303	6,128
Brazil	20	607
Argentina	--	58
Madagascar	74	--
South Africa	100	895
Sri Lanka	--	45
Thailand	--	3
Vietnam	--	15
South Korea	--	48
Total	678	9,462

Source: **http://www.fao.org/docrep/field/003/AB730E/AB730E03.htm** (Training manual on *Gracilaria* culture and seaweed processing in China)

Table 4. *World production of Red Seaweed (wet, metric ton), 1999-2003.*

Country	1999	2000	2001	2002	2003	Mean	Share	Growth Rate
Philippines	673.80	679.20	761.00	884.50	985.20	796.74	31.95%	10.11%
China	426.70	494.10	599.60	687.50	740.00	589.58	23.64%	14.86%
Japan	413.10	394.50	376.30	438.60	339.50	392.40	15.73%	-3.79%
Indonesia	156.90	247.90	246.90	278.80	288.20	243.74	9.77%	18.47%
Chile	133.20	192.60	182.00	181.20	187.20	175.24	7.03%	10.49%
Korean Republic	208.60	133.40	171.70	212.60	194.90	184.24	7.39%	2.04%
Others	118.70	123.50	121.30	93.10	103.00	111.92	4.49%	-2.59%
Total	2131.0	2265.2	2458.8	2776.3	2838.0	2493.9	100.00%	7.49%

Source: FAOSTAT

Table 5. *Dried and processed seaweed exports from Indonesia and the Philippines.*

	2000	2001	2002	2003	2004	2005	Mean	Growth rate
Indonesia								
Dried Seaweed Exports (x1000 tonnes)	22.70	27.90	28.30	39.90	51.00	69.30	43.28	18.63%
Agar and carrageenan Exports (x 1000 tonnes)	5.00	5.60	7.20	8.10	4.90	4.00	5.96	2.71%
Total Exports expressed as dried seaweed (35%MC)	40.10	43.40	43.60	57.10	64.60	87.20	59.18	10.56%
% of exports as dried seaweed	57%	64%	65%	70%	79%	79%	71%	7.03%
Value of all exports (US$$ million)	27.90	26.70	24.50	29.70	34.50	50.50	33.18	4.97%
Philippines								
Dried Seaweed Exports (x 1000 tonnes)	48.30	31.60	35.50	31.20	32.00	21.20	30.30	-6.36%
Agar and carrageenan Exports (x1000 tonnes)	7.70	8.70	7.90	10.10	12.00	9.40	9.62	10.09%
Total Exports expressed as dried seaweed (35%MC)	105.0	86.7	89.0	94.2	101.6	80.6	90.4	-0.22%
% of exports as dried seaweed	46%	36%	40%	33%	31%	26%	33%	-6.64%
Value of all exports (US$ million)	84.80	71.20	74.88	80.50	86.90	71.50	77.00	0.92%

Source: FAOSTAT

Table 6. *Major world producers of carrageenan (2010).*

Source	**Production (MT/year)**	**Rank**	**%**
World	84,700		100.00
Philippines	34,500	1	40.73
Indonesia	17,000	2	20.07
China	9,000	3	10.63
USA	4,500	4	5.31
South America	4,500	5	5.31
France Spain	3,500	6	4.13
Denmark	3,300	7	3.90
South Korea	3,000	8	3.54
Japan	2,000	9	2.36
Malaysia	1,700	10	2.01
	1,700	11	2.01

Source: Dakay, 2010

Table 7. *Indonesian dried seaweed exports by region, 2000-2005.*

Region	2000	2001	2002	2003	2004	2005	Mean	Growth rate
China (including Hong Kong)								
Dried Seaweed Exports (x1000 tonnes)	10	9	11	17	23	33	19	19%
Value of all exports (US$ million)	4	4	5	6	7	10	6	14%
US$/tonne	350	415	412	360	291	297	355	-3%
Total Exports expressed as dried seaweed (35%MC)	12	13	17	22	25	34	22	16%
Asia Pacific (excluding China and HK)								
Dried Seaweed Exports (x1000 tonnes)	2	4	3	7	9	16	8	45%
Value of all exports (US$ million)	5	5	4	6	8	12	7	16%
US$/tonne	2300	1421	1129	824	894	744	1002	-15%
Total Exports expressed as dried seaweed (35%MC)	7	7	5	12	12	23	12	24%
Europe								
Dried Seaweed Exports (x1000 tonnes)	9	12	12	11	14	14	13	11%
Value of all exports (US$ million)	7	6	6	6	8	10	7	6%
US$/tonne	759	530	525	545	585	698	577	-4%
Total Exports expressed as dried seaweed (35%MC)	15	17	19	19	21	21	20	7%
Americas								
Dried Seaweed Exports (x1000 tonnes)	2	3	2	4	5	5	4	39%
Value of all exports (US$ million)	1	2	1	2	3	3	2	36%
US$/tonne	533	548	619	500	519	611	560	0%
Total Exports expressed as dried seaweed (35%MC)	6	5	3	4	6	7	5	11%
Africa and Mid-East								
Dried Seaweed Exports (x1000 tonnes)	0	0	0	0	0	1	0	
Value of all exports (US$ million)	0	0	0	0	0	1	0	
US$/tonne	6000	0	0	600	1000	909	502	
Total Exports expressed as dried seaweed (35%MC)	0	0	0	0	0	1	0	13%
Total								
Dried Seaweed Exports (x1000 tonnes)	23	28	28	40	51	69	43	19%
Value of all exports (US$ million)	16	17	16	20	25	36	23	11%
US$/tonne	696	615	553	513	498	512	538	-6%
Total Exports expressed as dried seaweed (35%MC)	40	43	44	57	65	87	59	
11%								

Source: FAO

Table 8. *Indonesian agar and carrageenan exports by region.*

	2000	2001	2002	2003	2004	2005	Mean	Growth rate
China (including Hong Kong)								
Agar Exports (x1000 tonnes)	1.8	2.9	4.7	3.7	1.9	1	2.8	11%
Value of exports (US$ million)	0.8	0.9	1.9	1.1	0.6	0.4	1.0	7%
US$/tonne	444	310	404	297	316	400	345.5	-4%
Carrageenan Exports (x1000 tonnes)	0.2	0.06	0.2	0.5	0.4	0.04	0.2	59%
Value of exports (US$ million)	0.1	0.04	0.05	0.3	0.3	0.1	0.2	93%
US$/tonne	500	667	250	600	750	2500	953.3	27%
Asia Pacific (excluding China and HK)								
Agar Exports (x1000 tonnes)	0.6	0.5	0.2	0.5	0.5	0.8	0.5	15%
Value of exports (US$ million)	1.7	2	1.3	1.5	1.9	4.9	2.3	5%
US$/tonne	2833	4000	6500	3000	3800	6125	4685	15%
Carrageenan Exports (x1000 tonnes)	0.2	0.4	0.1	0.5	0.3	0.5	0.4	77%
Value of exports (US$ million)	0.2	0.2	0.06	0.8	0.3	1.7	0.6	220%
US$/tonne	1000	500	600	1600	1000	3400	1420	20%
Europe								
Agar Exports (x1000 tonnes)	1	0.8	1.1	1	0.9	0.7	0.9	0%
Value of exports (US$ million)	4.5	2.9	3.3	3.3	3.3	2.9	3.1	-4%
US$/tonne	4500	3625	3000	3300	3667	4143	3547	-3%
Carrageenan Exports (000 tonnes)	0.2	0.2	0.5	1.4	0.6	0.7	0.7	55%
Value of exports (US$ million)	0.5	0.8	1.5	1.7	1.8	4.1	2.0	33%
US$/tonne	2500	4000	3000	1214	3000	5857	3414	25%
Americas								
Agar Exports (x1000 tonnes)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	-10%
Value of exports (US$ million)	0.6	0.4	0.4	0.4	0.4	0.6	0.4	-7%
US$/tonne	3000	2000	4000	4000	4000	6000	4000	13%
Carrageenan Exports (x1000 tonnes)	0.7	0.3	0	0	0.1	0.03	0.1	
Value of exports (US$ million)	3.7	1.4	0	0	0.6	0.2	0.4	
US$/tonne	5286	4667	0.00	0.00	6000	6667	3467	
Total								
Agar Exports (x1000 tonnes)	3.7	4.5	6.2	5.6	3.5	2.7	4.5	2%
Value of exports (US$ million)	7.7	6.3	7.7	6.5	6.23	8.85	7.1	-3%
US$/tonne	2081	1400	1242	1161	1780	3278	1772	1%
Carrageenan Exports (x1000 tonnes)	1.3	0.96	0.86	2.43	1.4	1.28	1.4	21%
Value of exports (US$ million)	4.5	2.44	1.61	2.8	3	6.1	3.2	0%
US$/tonne	3462	2542	1872	1153	2143	4766	2495	-1%

Source: FAO

Table 9. *Export volume and value of Indonesian seaweeds.*

Commodities	2007			2008			2009		
	Volume (kg)	Value (US$)	Unit value	Volume (kg)	Value (US$)	Unit value	Volume (kg)	Value (US$)	Unit value
Seaweed (dried)	94,073,398	57,522,350	0.61	99,948,576	110,153,291	1.10	94,002,964	87,773,297	0.93
Gelatin/agar	2,117,712	9,436,751	4.46	2,467,355	14,206,160	5.76	1,794,858	10,309,814	5.74
Total		66,959,101			124,359,451			98,083,111	

Source: Fisheries Trade Statistics, MOMAF, 2010

Table 10. *Seaweed derivatives and selling prices, Indonesia.*

Price	*Cottonii*		*Gracilaria*	
	IDR/kg	US$/tonne	IDR/kg	US$/tonne
Farm gate (assorted)	4,500.00	500.00	3,500.00	389.00
Dried Seaweeds::				
Class A			10,000.00	1,111.11
Class B			6,000.00	666.67
Class C			5,000.00	555.56
Processed (carrageenan) grades:				
ATC		2,700.00		
SRC Technical grade		3,750.00		
SRC food grade		6,500.00		
Clarified RC		10,000.00		
Processed (agar) grades:				
Agar food grade		not available		
Blended food additives		16,500.00		

Exchange rate: US$1:IDR 9,000.00

Source: Based on personal communications with key informants.

Table 11. *Cost of shipping dried and processed seaweed products.*

Product	Sulawesi to Surabaya/Jakarta	Indonesia to	
		China	Europe
Pressed dried seaweed (20 tonne/container)	IDR540/kg	not available	not available
Not pressed dried seaweed (12 tonne/container)	IDR430/kg		
Processed powder (21 tonne container capacity)		IDR 900/kg	IDR 1200/kg
Processed chips (12 tonne container caapacity)		IDR 1600/kg	IDR 2000/kg

Exchange rate: US$1:IDR 9,000.00

Table 12. *Gross margins of dried Gracilaria across product class (per kilogram).*

	Assorted		Class A		Class B		Class C
Particu	IDR/kg	US$/kg	IDR/kg	US$/kg	IDR/kg	US$/kg	IDR/kg
Farm gate of dried gracilaria	4,500.00	0.50	10,000.0(	1.11	6,000.00	0.67	5,000.00
Cost of production							
Seedlings	1,500.00	0.17	1,500.00	0.17	1,500.00	0.17	1,500.00
Other maj inputs	1,800.00	0.20	1,800.00	0.20	1,800.00	0.20	1,800.00
Shipping c for presse dried grac	540.00	0.06	540.00	0.06	540.00	0.06	540.00
Total cost	3,840.00	0.43	3,840.00	0.43	3,840.00	0.43	3,840.00
Gross mar	660.00	0.07	6,160.00	0.68	2,160.00	0.24	1,160.00

Exchange rate: US$1:IDR 9,000.00
Based on personal communication with key informants (2012).

Table 13. *Indonesian seaweed processors.*

			Capacity (metric ton/year)			
Company	Factory Location	Product type	Rated	RM Needed	Actual	RM Needed
Pt. Galic Artha Bahari	Cikarang	ATC & SRC	2,040	8,568	1,224	5,141
Pt. Gumindo Perkasa Industri	Banten	SRC Food grade	1,200	6,000	720	3,600
Pt. Giwang Cintra Laut	Takalar	ATC & SRC	960	4,032	576	2,419
Pt. Cahaya Cemerlang	Makasar	ATC & SRC	720	3,024	432	1,812
Pt. Bantimurung Indah	Makasar	ATC & SRC	3,000	12,600	1,800	7,560
Primkopin	Janeponto, Sulsel	ATC	720	2,880	-	-
Pt. Algalindo Perdana	Pasuruan	RC	1,560	7,956	936	4,774
Pt. Centram Pasuruan	Pasuruan	RC	432	6,480	259	3,888
Pt. Indonusa Algaenas Prima	Malang	ATCC	4,800	19,200	2,880	10,520
Pt. Amarta Carragenan	Gempol & Pasuruan	SRC	480	7,800	288	8,640
Pt. Azwa Utama	Gorontalo	ATC	360	1,440	216	864
Pt. Langit Laut Biru	Maumere-NTT	ATC	180	720	108	432
Pt. Algae Sumba Timur	Waingapu-Sumba Timur-NTT	ATC	2,160	8,640	1,296	5,184
Pt. Agar Swallow	Citerep-Bogor	Agar	480	2,880	288	1,728
Pt Agarindo Bogatama	Tangerang	Agar	3,000	18,000	1,800	10,800
Pt. Surya Indo Algas	Jimbaran Wetan	Agar	240	1,440	144	864
PT. Satelit Sriti	Surabaya	Agar	480	2,880	288	1,728
CV. AGAR Sari jaya	Malang	Agar	240	1,440	144	864
PT. Samudera Agar Indonesia	Solo	Agar	360	2,160	216	1,296
PT. Indoking Aneka Agar-agar	Medan	Agar	360	2,160	216	1,296
PT. Biliton Sejahtera Mandiri	Balitung	ATCC	360	2,160	216	1,296
PT. Phonix Mas	Mataram	Agar	240	3,600	144	2,160
TOTAL			24,372	126,060	14,191	76,866

Source: Aquaculture Statistics MOMAF, 2011

Table 14. *Indonesian importers of seaweed derivatives.*

Company	Location	Product type
PT. Galic Bina Mada	Cikarang Barat Bekasi	Carrageenan
PT. Frisian Flag	Jakarta Timur	Carrageenan
PT. Halim Sakti Pratama	Jakarta Indonesia	Carrageenan
PT. Lion Wings	Jakarta Timur	Carrageenan
PT. Sinar Permata Halim Swadaya	Surabaya	Carrageenan
PT. Ki Antaka Rasa	Tangerang	Carrageenan
PT. Nestle Indonesia	Jakarta Indonesia	Carrageenan
PT. Behn Meyer Kimia	Tangerang	Carrageenan
PT. Satelit Sriti	Surabaya	Carrageenan
PT. Multi Kimia Inti Pelangi	Cikarang Barat Bekasi	Carrageenan
PT. Centram	Pasuruan Jawa Timur	Carrageenan
PT. Brataco	Bandung Jawa Barat	Carrageenan
PT. Galic Arthabahari	Cibitung Bekasi	Carrageenan
PT. Pafa Mandiri Sakti	Jakarta Barat	Carrageenan
PT. Alvia Tri Mandiri	Jakarta Barat	Carrageenan
PT. Agar Sehat Makmur Lestari	Pasuruan	Agar-agar
CV. Sinar Kejayaan Brothers	Sungai	Agar-agar
PT. Segera Jaya Perkasa	Jakarta Utara	Agar-agar
PT. Buana Jaya Perkasa	Jakarta Utara	Agar-agar
PT. Petrona Inti Chemindo	Cengkareng Barat	Agar-agar
PT. Alam Subur Tirta Kencana	Jakarta Barat	Agar-agar
PT. Merck TBK	Jakarta Timur	Agar-agar
PT. Trimulti Maha Barata	Tanjung Priok	Agar-agar
PT. Sari Coffee Indonesia	Karet, Tengsin, Tanah Abwisma	Agar-agar
CV. Anugerah Jaya Abadi	Jakarta Barat	Agar-agar
CV. Agar Sari Jaya	Pasuruan	Agar-agar
PT. Petrakemindo Pratama Mandiri	Cipandah	Agar-agar
PT. Sindo Makmur Sentosa	Nagoya Centre Block 8 Batam	Agar-agar
PT. Abilindo Lintas Persada	Jakarta Utara	Agar-agar
CV. Inti Karya Cemerlang	Jakarta Barat	Agar-agar
mur Sentosa	Jaksel	Agar-agar
PT. Agarindo Bogatama	Jakarta	Agar-agar
PT. Chitra Adhi Perkasa	Graha Samudera	Agar-agar
PT. Catur Harapan	Batam	Agar-agar
PT. Exim Tuna Indonesia	Pluit	Agar-agar
PT. Aneka Tuna Indonesia	Jawa Timur	Agar-agar
PT. Sindo Makmur Sentosa	Batam	Agar-agar
PT. Rajawali Prima Sakti	KEL	Agar-agar

Source: Aquaculture Statistics MOMAF, 2011