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## The global status of seaweed production, trade and utilization

Volume 124



## **The global status of seaweed production, trade and utilization**

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### **ABSTRACT**

This report is an update of the status of the global seaweed market: production figures from culture and capture, the size of the international market for seaweed and its commercially important extracts, the leading nations by region, developments in processing and utilization technology, and innovations in the industry, as well as the challenges and outlook for the industry.

As it is not possible to feature all individual countries of importance in the seaweed sector, several have been selected as being representative of the different regions of the world: Asia [China, Indonesia, the Republic of Korea, Malaysia, the Philippines, Singapore and Thailand]; South America (Chile); Europe (Denmark, the European Union); and Africa (Morocco, South Africa and Zanzibar (Tanzania)]. The sections on Chile, China, Denmark and South Africa are based largely on previous studies commissioned by the Food and Agriculture Organization (FAO).

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# 1. OVERVIEW

## 1.1 INTRODUCTION

Seaweed, or marine algae, comes in various shades of red, brown and green, and may be shaped in the form of broad leaves, delicate fingers, spheres or may resemble fruit. Although a few genera are free-floating, most are anchored in littoral zones. Some tuft-forming, blue-green algae (*Cyanobacteria*), at times, may be considered seaweed.

Seaweed has been utilized throughout the world for centuries, and was considered only as a food source for coastal communities in the earliest times. Apart from its wide-ranging use in many industries (as will be elaborated upon later), seaweed contributes greatly to the nutritional status of communities due to its rich composition of macronutrients such as sodium, calcium, magnesium, potassium, chlorine, sulphur and phosphorus; micronutrients (iodine, iron, zinc, copper, selenium, molybdenum, fluoride, manganese, boron, nickel and cobalt); and vitamins (B12, A, K). In taking iodine, for example, the daily adult requirement of 150 µg/day is easily met by small quantities of seaweed, particularly brown algae such as kelp, which has an iodine content that ranges from 1 500–8 000 parts per million. According to the World Health Organization, iodine deficiency is the most prevalent and easily preventable cause in the world of impaired cognitive development in children.

Some 221 species of seaweed are of commercial value. About ten species are intensively cultivated, such as brown seaweed (*Saccharina japonica*, *Undaria pinnatifid* and *Sargassum fusiforme*); red seaweed (*Porphyra* spp., *Eucheuma* spp., *Kappaphycus alvarezii* and *Gracilaria* spp.); and green seaweed (*Enteromorpha clathrata*, *Monostroma nitidum* and *Caulerpa* spp.). Japanese kelp (*Saccharina japonica*, formerly classified as *Laminaria japonica*) accounts for over 33 percent of global cultivated seaweed production, followed by *Eucheuma* spp. at 17 percent of total *Kappaphycus alvarezii* (Elkhorn sea moss), *Undaria pinnatifida* (Japanese *wakame*) and *Porphyra* spp. (Japanese *nori*). Microalgae (*Spirulina* spp.) also is cultivated, although it tends to be much under-reported; hence, the reported statistics are a small proportion of existing production. Australia, India, Israel, Japan, Malaysia and Myanmar are known producers of *Spirulina*.

Red seaweed, such as *Gelidium*, *Gracilaria* and *Pterocladis*, are important for human consumption and other uses, mainly as a binder in food products as well as a bacterial substrate in laboratories. *Eucheuma* and *Kappaphycus* are essential for the manufacture of carrageenan, used in cosmetics, food processing and industrial usage.

Brown seaweed (*Saccharina japonica* (Japanese *kombu*), *Undaria pinnatifid* (Japanese *wakame*), and *Sargassum fusiforme* (Japanese *hiziki*)) and green species (*Ulva* sp., *Enteromorpha* sp., *Monostroma* sp., *Caulerpa* sp. and *Codium* sp.) are important food resources in Asia, and are most commonly eaten raw, dried or boiled in soups and stews. They are considered to be a good source of food fibre, protein and minerals for human consumption.

Today, the global seaweed industry is worth more than USD 6 billion per annum (approximately 12 million tonnes per annum in volume) of which some 85 percent

comprises food products for human consumption. Seaweed-derived extracts (carrageenan, agar and alginates) make up almost 40 percent of the world's hydrocolloid market in terms of foods; the rest come from certain animals, microbes and land plants.

The most important extract, carrageenan, is named after the red seaweed, 'carrageen moss/Irish moss', found in Carraigin, Ireland, which has been used as a gelatin as well as for traditional healing for more than 1 000 years. Carrageenan is used in the pet food, dairy and meat industries and, to a lesser extent, the pharmaceutical industry. There are three main types of carrageenan: kappa, iota and lambda, which come mainly from *E.cotonii*, *E. spinosum* and *Chondrus crispus*, respectively. Kappa carrageenan is widely used in food additives and produces strong rigid gels; iota carrageenan are more elastic and soft; and lambda carrageenan provides the creamy sensation in dairy products. The carrageenan concentration is usually from 0.005 percent to 2 percent by weight in food products.

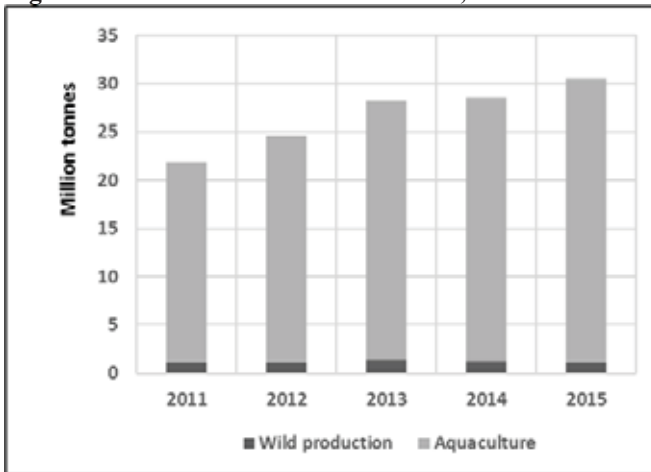
Agar, or agar agar, has had a strong demand in most Asian countries as a foodstuff since more than 300 years ago, and alginates have been used in the textile printing industry since approximately 1020. Agar agar is mainly produced from the *Gracilaria* seaweed, with China as the world leader with a reported harvest of 2.7 million tonnes of farmed *Gracilaria* in 2015. Though domestic consumption is high, China's share in the international trade of alginates is also significant, including for agar agar. Currently, Chile and China are the largest producers and exporters of agar agar. Supplies to the international trade also have increased from Indonesia, Morocco and Thailand in response to rising global demand.

## 1.2 GLOBAL PRODUCTION OF SEAWEED

In 2005, world seaweed production totalled 14.7 million tonnes, of which the culture sector contributed 13.5 million tonnes (freshwater culture: 53 157 tonnes; brackishwater culture: 46 729 tonnes; and marine culture: 13.4 million tonnes), while the harvest from the wild was slightly over 1.2 million tonnes in the same year. Ten years later, by 2015, the total production had doubled to 30.4 million tonnes, with the culture and capture sectors responsible for 29.4 million tonnes and 1.1 million tonnes, respectively (Figure 1).

The leading producers by country (in order of decreasing rank) were Chile, China and Norway for wild species (mainly brown and red) and Chilean kelp; and China, Indonesia, the Republic of Korea and the Philippines for cultured species (mainly *Euclima*, Japanese kelp, *Gracilaria* and *Undaria pinnatifid*). The detailed global production data for the capture and culture sectors, by country and species (Q = tonnes; V = USD '000) are appended in Annexes 1–6.

**Figure 1. World: Production of seaweed, 2011–2015**



Source: FAO.

### 1.2.1 Harvested from the wild

In contrast to the farming sector, wild harvests have remained almost level from approximately 1.06 million tonnes in 2006 to a peak of 1.29 million tonnes in 2013, and settling at about 1.09 million tonnes (wet weight) in 2015, according to FAO statistics (Annex 1). The top four producers of wild seaweed in 2015 were Chile (345 704 tonnes), followed by China (261 770 tonnes), Norway (147 391 tonnes) and Japan (93 300 tonnes) (Annex 2).

The dominant species harvested from the wild are Chilean kelp (*Lessonia nigrescens*) at 22 percent of the harvested total, followed by *huiro palo* (*Lessonia trabeculata*) at 7 percent, *Gracilaria* spp. at 5 percent and the rest – tangle (*Laminaria digitata*), *luga negra* (*Sarcothalia crispata*), kelp (*Macrocystis* spp.), Japanese kelp (*Saccharina japonica*), North Atlantic rockweed (*Ascophyllum nodosum*) and *Gigartina skottsbergii* – accounting for less than 5 percent. Farmed and wild *Gracilaria* species are a major source of agar agar for human consumption.

A significant issue with wild seaweed is the possibility of contamination by heavy metals such as arsenic and mercury. These act as a restraint on market expansion, especially in countries which place a high premium on food safety and sustainability. Consumers will be more willing to pay for seaweed that originates from countries with a strictly enforced integrated coastal zone management policy.

### 1.2.2 Farmed seaweeds

The most important farmed seaweed species is *Eucheuma* (10.2 million tonnes in 2015), followed by Japanese kelp (8 million tonnes), *Gracilaria* spp. (3.9 million tonnes), *Undaria pinnatifid* (Japanese *wakame*) (2.3 million tonnes), *Kappaphycus* (1.8 million tonnes), and *Porphyra* spp. (Japanese *nori*) (1.2 million tonnes). The

production volumes of other seaweed species fall below the one-million-tonne mark (Annex 3).

Seaweed cultivation takes place in about 50 countries, with the top ten producers in value being (in descending order) China, Indonesia, Japan, the Republic of Korea, the Philippines, the Democratic People's Republic of Korea, Malaysia, Chile, Sri Lanka and Madagascar (Annex 4). In volume terms, the ranking changes (in descending order) to China, Indonesia, the Philippines, the Republic of Korea, the Democratic People's Republic of Korea, Japan, Malaysia, Zanzibar, Madagascar and the Solomon Islands (Annex 5). While Chinese output accounts for approximately 60 percent of the global volume, Japan ranks third in value due to its production of *nori*. Globally, *Undaria pinnatifid* (Japanese *wakame*) and *Gracilaria* seaweed are the two other highly valued seaweed species (Annex 6). Annexes 4 and 5 clearly indicate that countries in East Asia and Southeast Asia contribute the major share of the world's farmed seaweed in terms of volume and value.

In Southeast Asia, seaweed is widely cultivated in response to rising demand for its use, primarily as raw material for the hydrocolloid industry (agar agar, alginate and carrageenan extracts). This industry is estimated to be growing at 2–3 percent per annum, mainly in the Asia and the Pacific region. Outside of Asia, cultured seaweed is exported mainly from Madagascar and Zanzibar (Tanzania) in Africa and Chile in South America.



*Nori is a staple in Japanese cuisine.*  
© FAO/Fatima Ferdouse

A major advantage in the cultivation of seaweed is the fact that feeds, the cost and availability of which are often limiting factors in the aquaculture of fish and fishery species, are generally not needed in this regard. It also does not require elaborate setups and causes little harm to the seabed and fishery resources. Consequently, it is often promoted in developing countries as a sustainable activity that is capable of providing alternative livelihoods for small-scale fishing communities. In some countries, seaweed culture is integrated with intensive fish farming, functioning as nursery grounds for fingerlings. Meanwhile, researchers are moving towards finding greener techniques in cultivation and utilization, as well as towards promoting the genetic diversity of seaweed stocks. The latter point is especially important in preventing large-scale losses due to

disease, as has occurred in the case of genetically identical seaweed stocks in the Philippines during the 2011–2013 period.

In many parts of the world, seaweed is grown together with fish and fishery species, although it often tends to be because the seaweed happens to grow in the vicinity compared to its planned presence in integrated multi-trophic aquaculture (IMTA) systems. Leading exceptions in Asia are China and the Republic of Korea where IMTA (not limited to seaweed) has been practised for many years.

In a report compiled by the United Nations University (UNU) in 2016, it was reported that in China's Sungo Bay (Shandong Peninsula), these culture systems – based on the integrated culture of kelp (*Saccharina japonica*), abalone and sea cucumber – have been in existence for more than two decades. Interestingly, the abalone feed on the kelp and generate organic waste which, together with uneaten feeds, is eaten by the sea cucumbers. The waste products from the sea cucumbers and abalone are then assimilated by the kelp which increases its own productivity. The kelp, in turn, is used as food by the abalone or may be harvested for human consumption. In Sansha Bay (Fujian Province), the culture system includes fish, abalone, oyster and seaweed. In Zhejiang Province, the co-cultured seaweed species are *Saccharina japonica*, *P. haitanensis*, *Gracilaria* spp. and *Sargassum* spp., and the total seaweed production each year is approximately 60 000 tonnes.

In Brazil, culturing seaweed within shrimp cages has resulted in improved economic returns for both species; in Chile, with *Gracilaria* and salmon farms, the seaweed has grown well and has removed a large amount of the ammonium excreted by the fish. In France, *Gracilaria* growing in the effluents from oyster farms has removed almost all the ammonia in the water. *Porphyra* spp. and salmon farming trials have taken place off the east coast of Canada and the United States of America.

### 1.3 SAFEGUARDING THE INDUSTRY

Within the context of a global boom in seaweed production and processing, a 2016 policy brief of the UNU called for stricter policies to ensure the sustainability of the industry. Pointing to the “unabated exponential growth in the last 50 years”, the UNU stated that “There is increasing need to address new challenges imposed by trade and market demand. Case studies clearly show that valuable lessons can be drawn from the major seaweed-producing nations and other aqua and agriculture sectors.” (Cottier-Cook *et al.*, 2016).

Some of the issues that the UNU has highlighted are the need to have efficient resource management in coastal areas, establish disease-free seed banks to reduce over-reliance on limited genetic stocks; and poor biosecurity guidelines that may allow the introduction of non-indigenous pests and pathogens into culture areas. Displacement of wild stocks due to competition with farmed seaweed and potential conflict with other users in the same area are also among issues identified.



Seaweed farmer in the Philippines regaining her livelihood after typhoon Haiyan.

© FAO

#### **1.4 SOCIO-ECONOMIC BENEFITS FOR COASTAL COMMUNITIES**

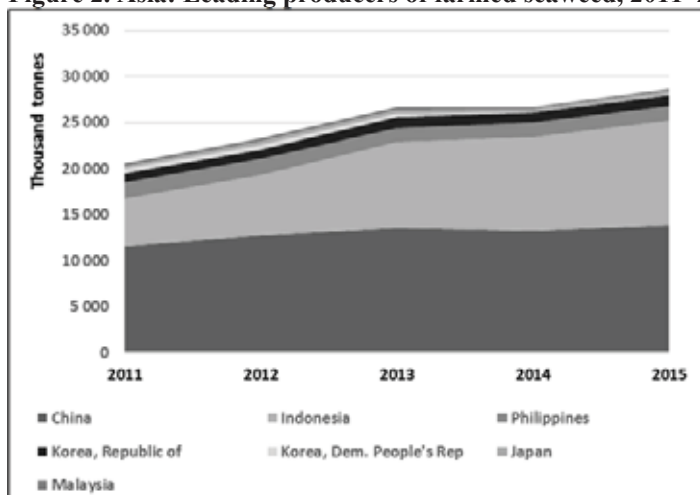
What makes seaweed harvesting from the wild and farming attractive to coastal communities is that the technology is relatively simple, requires low initial capital investment, the crop can be harvested in about six weeks and it can be dried on mats, grass, or on the beach sand. Furthermore, as the farming areas are in intertidal zones, women and children can safely access seaweed plots. These factors allow women, in particular, an important opportunity to earn some income for themselves and their families while the men work as fishermen and in other sectors. Several studies also have mentioned that women tend to be more patient and more willing to learn about sustainably managing local seaweed resources. This trend is seen in every region, particularly so in the Asia and the Pacific region (China, Indonesia, Malaysia, the Philippines) and Africa (Ghana, Morocco, Zanzibar (Tanzania)).

## 2. MAIN REGIONAL PRODUCERS AND MARKETS

### 2.1 ASIA

In Asia, China remains the largest producer, followed by Indonesia, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Malaysia and the Philippines. The bulk of the production comes from the culture sector (Figure 2).

**Figure 2. Asia: Leading producers of farmed seaweed, 2011–2015**



Source: FAO.

Japanese farms along the coastal areas are able to provide more than 90 percent of the demand for *Porphyra* spp., *Saccharina japonica* and *Undaria* spp locally called *nori*, *kombu* and *wakame*, respectively. *Nori* is used for making sushi, *kombu* is generally used as seasoning in bean curd soups and *wakame* (slightly more upmarket than *kombu*) is used for bean curd soups and salads. At the same time, Japan is a leading importer of raw seaweed, with much of its supply coming from the Republic of Korea. A significant portion is processed into such products as agar, *nori* sheets and seasoned snacks which are consumed in the country and exported. Some 21 seaweed species are used daily in food preparation in Japan, with the average annual consumption per capita estimated at 4 kilograms (kg).

There is a large industry in Japan that is built around the agar, alginate, and carrageenan used in food products and other sectors. Alginate extraction is carried out using imported *Ecklonia* and *Durvillea antarctica*, and the material is then used for specific biotechnology applications. The carrageenan industry uses *Eucheuma* and *Kappaphycus* imported from Southeast Asian farms, as well as *Chondrus* and *Gigartina* wild stocks from the Americas and Europe.

Indonesia reported an output from 1.2 million tonnes in 2006 to 11.3 million tonnes in 2015 (Annex 5). The sector in that country has expanded at 8 percent per annum in the past decade, up from 6.2 percent in the previous decade, with output more than doubling in this period.

In Thailand, *Gracilaria* is the most commercially important species, followed by *Hypnea*, *Porphyra Acanthophora* and *Caulerpa*. *Gracilaria* is used for human consumption and as a source of agar. Production is in limited volume (almost all wild harvests), resulting in imports of raw and processed products, generally *Porphyra* spp., *Saccharina japonica* and *Undaria spp* from China, Japan and the Republic of Korea. Of the imported products, food grade agar (from Chile, Japan, the Republic of Korea and Taiwan Province of China) ranks first in volume. In the Republic of Korea, brown species (*Saccharina japonica* and *Undaria spp.*) and red species (*Porphyra* spp.) make up almost all the country's seaweed production.

*Gracilaria* and to a smaller extent, *Sargassum*, are the two main seaweed species of importance in Viet Nam. Agar and alginates have a steady demand, and since the local farming and processing sectors are still developing, imports of *Gracilaria* are needed. Processing units for agar and sodium alginate have been established in Haiphong, Ho Chi Minh City and Danang. *Sargassum* is used as a fertilizer.

### 2.1.1 China

As mentioned in Section 1.2.2, Chinese output accounts for approximately 60 percent of the global volume of seaweed. Wild harvests make up less than 2 percent of this total volume, albeit production from aquaculture increased sharply from 9.7 million tonnes in 2006 to 13.9 million tonnes in 2015 (Annex 7). This indicates the absolutely vital role played by the culture sector.

Seaweed farming in China officially began in the 1950s, with the development of technology in the cultivation of kelp (*Saccharina japonica*); that is, new commercial varieties, including disease-resistant strains. From then on, the seaweed farming industry developed very fast and, by 2015, total seaweed production had escalated to nearly 14 million tonnes (Table 1).

**Table 1. China: Farmed seaweed production, 2009–2015**

|                              | Weight in tonnes  |                   |                   |                   |                   |                   |                   |
|------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|                              | 2009              | 2010              | 2011              | 2012              | 2013              | 2014              | 2015              |
| Brown seaweeds               | 5 543 485         | 5 587 550         | 5 994 165         | 6 758 500         | 6 941 315         | 9 011 595         | 9 170 515         |
| Red seaweeds                 | 2 395 370         | 2 285 030         | 2 602 840         | 3 191 070         | 3 692 680         | 3 806 890         | 3 910 290         |
| Miscellaneous aquatic plants | 2 546 300         | 3 208 390         | 2 943 250         | 2 873 390         | 2 922 860         | 506 630           | 842 530           |
| Green seaweeds               | 10 750            | 11 300            | 9 300             | 9 100             | 4 590             | 1 200             | 1 200             |
| <b>Total</b>                 | <b>10 495 905</b> | <b>11 092 270</b> | <b>11 549 555</b> | <b>12 832 060</b> | <b>13 561 445</b> | <b>13 326 315</b> | <b>13 924 535</b> |

Source: FAO.

As shown in fishery statistics collected by FAO, China is the largest producer of cultivated algae around the globe. Estimated by protein content, the total production of China's eight species of farmed seaweeds in 2014 was equal to 3.0 million tonnes of rice,

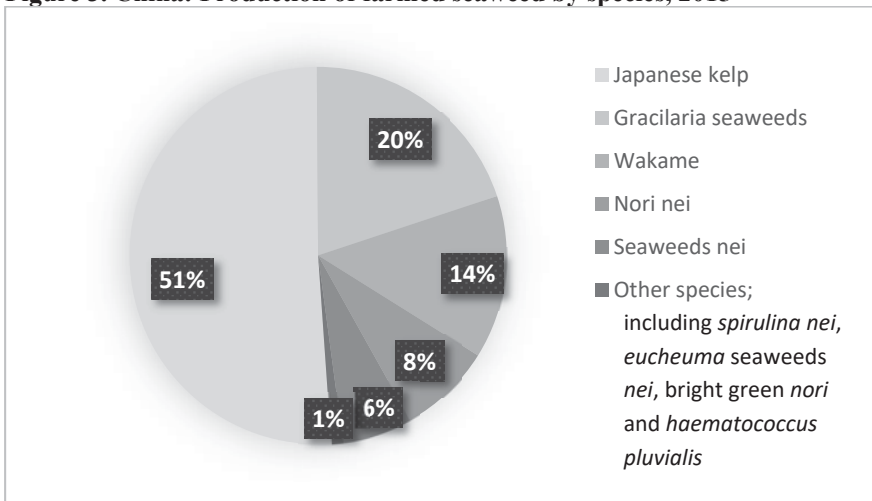


10.54 million tonnes of spinach, 14.13 million tonnes of potato and 1.35 million tonnes of pork (Yang, 2016). Seaweed in China is measured in dry weight.

**Main commercial seaweed species in China**

Japanese kelp (*Saccharina japonica*) comprises close to 51 percent of the total amount of cultured seaweed; *Gracilaria* is in second place, followed by *Undaria* spp. (*wakame*) and *Porphyra* spp. (Japanese *nori*) (Figure 3). These four main species contributed 92 percent of total production in 2015 (Annex 7). *Saccharina japonica* is now the main commercial seaweed crop in China, with cultivation covering more than 40 000 per hectare and an annual production of approximately 1 million tonnes (dry weight). *Euचेuma* sp, *Hizikia fusiforme* and *Enteromorpha* sp are other major seaweeds in China.

**Figure 3. China: Production of farmed seaweed by species, 2015**



Source: FAO.

Three provinces (Fujian, Liaoning and Shandong) produced over 91 percent of total farmed seaweeds in 2014, particularly Fujian and Shandong provinces where the output is significant, at 40.56 percent and 33.06 percent, respectively (BFDA, 2015). Other provinces, including Jiangsu, Guangdong, Hainan and Zhejiang also produce some seaweed, but their production volumes are smaller than those of the three ‘giants’.

It also is worth mentioning, however, that the ranking of provinces in terms of farmed seaweed production is changing. For example, Shandong topped the list in 2002, followed by Liaoning and Fujian. By 2014, output from Fujian had increased by 147.28 percent from 2002, pushing it to first position. Shandong (though with a rise of 39.55 percent in the same period) fell to second place, with Liaoning (+6.98 percent) third.

For wild harvested seaweed, Hainan was the largest contributor from 2003 to 2014 (despite a general declining trend). The volume remains much smaller than farmed output.

### Japanese kelp (*Saccharina japonica*)

Known also as sea tangle, Japanese kelp is known in China by its local name, *Hai Dai* (production volume in 2015: 7.06 million tonnes). It is served as a component in many food dishes and processed products. While it is found naturally only in the Liaodong and Shandong peninsulas, its main farming areas are along the coast from Liaoning to Guangdong province. Most of the *Saccharina japonica* produced in China is consumed as part of a ‘healthy vegetable’ diet. It is generally sold dried, although in recent years, small packages of seasoned seaweed have entered the snack food market. It is also important as a raw material for alginate, mannitol and iodine.

During the Three Kingdoms period, kelp was described as ‘sour, salty, cold, non-toxic, edible’, and as the ‘Therapeutic *Materia Medica*’ (written by Meng Shen in the Tang Dynasty) says, “kelps can help one to cure flatulence”. In addition, kelp is low in calories and is high in resin and minerals; it can be easily digested and absorbed.

### Sea mustard (*Undaria pinnatifida*)

Natural populations of sea mustard in China are mainly distributed in Zhejiang province. In addition to natural reproduction, sea mustard is extensively farmed in the Dalian region and its products are mainly exported to Japan. Sea mustard is said to play an important role in the metabolism and development of the body, maintaining a balance of the cardiovascular, immune, blood and nervous systems.

### Laver (*Porphyra* spp.)

There are as many as 134 sub-species of this seaweed, although only two of them are farmed: *Porphyra haitanensis* in the south of China (Fujian, Zhejiang and other locations) and *Porphyra yezoensis* in the northern provinces of China (Jiangsu, Shandong and other provinces).

### *Gracilaria* sp

There are almost 100 kinds of *Gracilaria* that grow in a wide range of water temperatures in the South China Sea and East China Sea. It is the main feed ingredient for abalone and the key raw material for the extraction of agar. It has also been used in bioremediation to reduce eutrophication in mariculture areas.

### Other species

*Eucheuma* is mainly found in the coastal areas of Hainan, Guangdong and Guangxi. Almost 90 percent of the global total yield of carrageenan is supplied by China, Indonesia and the Philippines.

*Gelidium* is served as a salad or processed into jelly. In addition to being edible, it is the main raw material for extracting agar, which is used to make cold foods or as a microbial culture medium. In addition, traditional Chinese doctors believe that *Gelidium* is sweet-salty and has a detoxification effect; thus it can be used for curing enteritis, anal

swelling, and pyelonephritis. It is also used as a folk medicine to cure silicosis, tinea corporis and thyromegaly.

*Sargassum* is widely distributed in Fujian, Liaoning, Shandong, Zhejiang and other coastal provinces, and is cultivated in Zhejiang province. As an antioxidant, *Sargassum* not only enhances the immune function and helps in the anti-aging and anti-inflammatory processes; it also inhibits tumour growth and reduces blood fat and sugar levels, among others.

### ***Processing of seaweed***

China's seaweed processing industry began in the 1960s, with one of the earliest ventures being the production of iodine, mannitol and alginate from kelp. China also has *spirulina* and green algae food processing industries, although the quantities are small. Some 50 years on, seaweed processing technologies have improved tremendously, with many seaweed processing enterprises having been established and the total output from the seaweed processing industry having escalated to approximately 1.08 million tonnes by 2014 (more than three times the volume in 2013). Almost 95 percent of the total processed seaweed products were from Fujian, Liaoning and Shandong provinces in 2014.

### **Japanese kelp**



*Instant sea tangle (brand: Guanwu Kelp).*  
© Yoycart

Processed Japanese kelp ranges from simple dried, salted items to more complex products such as food additives, beverages and other foods (e.g. seasoning and instant seaweed foods). Sometimes, it is added into traditional fermented items, resulting in products such as sea tangle soybean juice, lacto-fermented beverages with sea tangle flavour, sea tangle cakes, sea tangle milk, and sea tangle peanut jams.

There are more than 100 enterprises that process laver in China. In Fujian and Zhejiang, *Porphyra haitanensis* is the predominant laver that is farmed, from which dried laver is produced. In Jiangsu, with the introduction of equipment and technology from Japan, *Porphyra yezoensis* is the main species. It is processed principally into standard laver sheets and roasted laver.

Laver (*Porphyra spp.*)



*Dried sea tangle.*



*Sea tangle knots.*

Key processed laver products are as follows:

- (i) Dried laver and salted laver from preliminary processing, which involves cleaning, cutting, pressing, pickling, dewatering, drying and separating (usually by automated machines), followed by classifying, re-drying and packaging.
- (ii) Laver seasoning, laver sauce, laver drinks, laver puffed food, among others, from refined processing. The technology involved includes dehydration, freezing, expansion, slicing and seasoning, among others.
- (iii) Beverages, peptone, agar, concentrated juices, nutrients, among others, from deep processing. These items contain substances extracted from the laver.



*Dried and pressed laver.*  
© Yang



*Seasoned laver soup.*  
© Yang

*Sargassum fusiforme*

Currently, dried *Sargassum fusiforme* dominates China's domestic market. Because it is dried, it is convenient for storage, selling and transportation, and can help to balance the supply of *Sargassum fusiforme* throughout the year. The product is popular with consumers because it is convenient to use and has a unique taste. The processing technology is as follows: cleaning, cutting, hot pressing, removing arsenic and sand, seasoning, weighing and packaging, sterilizing, cooling and drying.

## Sea mustard (*Undaria pinnatifida*) and other species



Dried *Undaria*.

© Yang

Dried and salted sea mustard are the main products in the domestic market. Similar to *Sargassum fusiforme*, it is an 'instant' food product and thus has good market potential.

Besides consumption as a food item, seaweed is commonly used in Chinese medicine. According to the *Oriental Materia Medica*, *Saccharina japonica* and *Ecklonia* (local name: *kunbu*), as well as *Sargassum* (*haizo*), enter the body through the liver, stomach and kidney, working to 'soften hardness, disperse accumulation, resolve phlegm, and cleanse heat', thereby helping persons with tumours, goitre, pains and swelling. *Porphyra* (*zicai*) enters the body through the lung, where it 'resolves phlegm, softens hardness, dispels heat, promotes diuresis', making it useful in cases of goitre, beriberi, oedema, urinary infections and sore throats.

### ***Marketing and trade of seaweed and seaweed products***

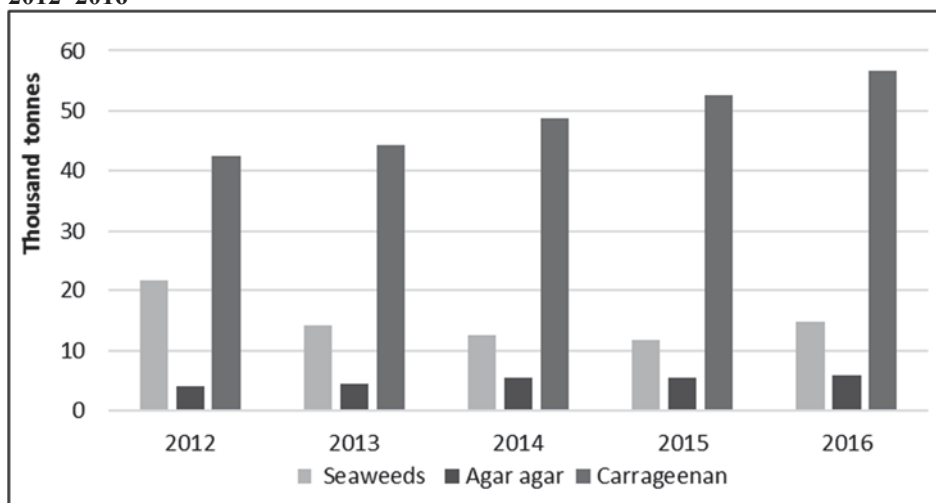
#### Exports

With regard to Chinese exports of seaweed and other algae fit for human consumption (Annex 8a), 14 721 tonnes was recorded in 2016 compared to 11 654 tonnes the previous year; however, this represented a drop from 21 595 tonnes in 2012. The top five markets (in descending order) for this category in the year 2016 were Japan (7 177 tonnes), Russia (1 861 tonnes), Portugal (1 187 tonnes), Taiwan Province of China (952 tonnes) and Spain (699 tonnes). Laver products, including flavoured laver and (the less expensive) dried laver, are one of the main export items. Besides Taiwan Province of China and the Hong Kong Special Administrative Region, the main target markets for laver exports are the Australia, Japan, Thailand and the United States of America. The flavoured laver is mainly exported to Australia, Thailand and the United States of America, while the dried laver is exported to Japan, Thailand and the United States of America.

Meanwhile, Chinese exports of the seaweed and other algae *not* fit for human consumption (Annex 8b) indicated a total of 1 477 tonnes in 2016 compared to 1 007 tonnes in 2012. The top five markets (in descending order) for this category in 2016 were Viet Nam (411 tonnes), the Republic of Korea (380 tonnes), the United States of America (272 tonnes) and Malaysia (252 tonnes).

Agar agar was also exported in appreciable quantities from China in 2016, with a total of 5 846 tonnes, valued at USD 86 024 million compared to 4 146 tonnes (USD 58 803 million) in 2012 ( Figure 4). The leading markets were Italy (775 tonnes), Spain (663 tonnes), Malaysia (612 tonnes), Thailand (598 tonnes), Russia (569 tonnes), and Germany (521 tonnes) (Annex 8c). China has emerged as the world’s largest exporter of carrageenan, with nearly 60 000 tonnes of products in the international trade in 2016, valued at USD 360 million. The main markets were the European Union and the United States of America (Annex 8d and Annex 8e).

**Figure 4. China: Exports of dried edible seaweed and other processed products, 2012–2016**

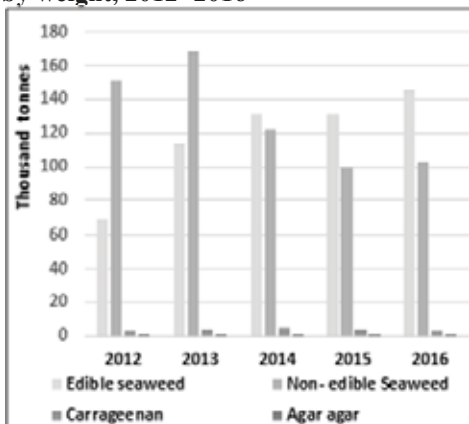


Source: China Customs.

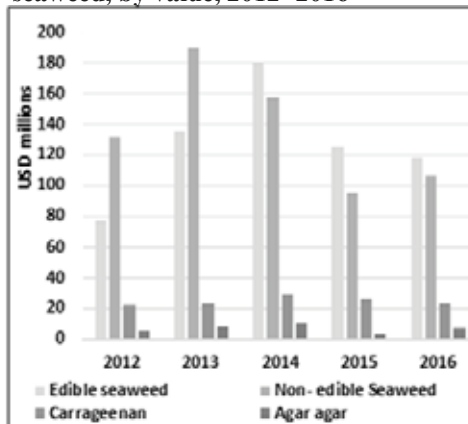
### Imports

Chinese imports of seaweed and other algae in 2016 were 146 028 tonnes (USD 118 544 000) in the ‘fit for human consumption’ category (Annexes 9a, 17 and 18), slightly higher than 103 222 tonnes (USD 106 485 000) in the ‘not fit for human consumption’ category (Annex 9b). Noteworthy is the fact that only four years prior, in 2012, the figures were 68 812 tonnes (USD 77 271) and 151 209 tonnes (USD 131 937) for the two categories, respectively (Figure 5 and Figure 6). Imports of seaweed and algae for human consumption have clearly more than doubled within the space of four years; in contrast, there has been a small decline in the import of seaweed not for human consumption.

**Figure 5. China: Imports of seaweed, by weight, 2012–2016**



**Figure 6. China: Imports of seaweed, by value, 2012–2016**



Source: China Customs.

In 2016, seaweed and other algae for human consumption were imported (in descending order) mainly from Indonesia (137 450 tonnes), the Republic of Korea (3 266 tonnes), the Philippines (2 662 tonnes), Malaysia (1 279 tonnes) and Chile (921 tonnes) (Annex 9a). It should be noted that in 2012, Indonesia supplied 62 283 tonnes, marking an increase of 120 percent in the space of four years. Imports of agar agar by contrast, were much lower, with a total of 418 tonnes in 2016, supplied mostly by Italy (314 tonnes), with smaller amounts from the Republic of Korea and Morocco, among others (Annex 9c).

In summary, besides being the top seaweed producer in the world, China is a major exporter and importer of raw seaweed and seaweed products. In 2016, in the ‘fit for human consumption’ category, 14 721 tonnes were exported mainly to Australia, the Hong Kong Special Administrative Region, Japan, Taiwan Province of China, Thailand and the United States of America. Imports in the same year and in the same category, however, were much higher, at 146 028 tonnes originating from the Indonesia, the Republic of Korea Malaysia and the Philippines, among others. China, therefore, represents a huge (and still expanding) market for seaweed fit for human consumption, where it is eaten in soups, snacks, salads, as *nori* sheets and is manufactured into products such as seaweed noodles.

### 2.1.3 Indonesia

With more than 61 000 km of coastline spread over 17 000 islands, Indonesia has emerged as the second largest producer of cultured seaweed in the world following China. Of the global production of farmed aquatic plants (largely seaweeds) at around 29.4 million tonnes in 2015, recorded by FAO, Indonesia contributed almost 38 percent (11.3 million tonnes) compared to China’s 47 percent (14 million tonnes) (Table 2 and Annex 5).

**Table 2. Indonesia: Seaweed production, 2010–2015**

|  | Weight in tonnes |                  |                  |                  |                   |                   |
|--|------------------|------------------|------------------|------------------|-------------------|-------------------|
|  | 2010             | 2011             | 2012             | 2013             | 2014              | 2015              |
| <b>Aquaculture</b>                     |                  |                  |                  |                  |                   |                   |
| <i>Eucheuma</i><br>seaweeds <i>nei</i> | 3 399 436        | 4 539 413        | 5 738 688        | 8 323 263        | 8 971 463         | 10 112 107        |
| <i>Gracilaria</i><br>seaweeds          | 515 581          | 630 788          | 776 166          | 975 211          | 1 105 528.6       | 1 157 234         |
| <b>Total aquaculture</b>               | <b>3 915 017</b> | <b>5 170 201</b> | <b>6 514 854</b> | <b>9 298 474</b> | <b>10 076 992</b> | <b>11 269 341</b> |
| <b>Wild production</b>                 | <b>2 697</b>     | <b>5 479</b>     | <b>7 641</b>     | <b>17 136</b>    | <b>70 514</b>     | <b>78 230</b>     |
| <b>Total</b>                           | <b>3 917 714</b> | <b>5 175 680</b> | <b>6 522 495</b> | <b>9 315 610</b> | <b>10 147 560</b> | <b>11 347 571</b> |

Source: FAO.

In contrast to China's production of seaweed and algae, primarily for human consumption, seaweed farming in Indonesia focuses on species such as *Eucheuma spp*, *Kappaphycus spp* and *Gracilaria spp* from which carrageenan and agar can be extracted. In recent years, demand for the food and non-food carrageenan quality, produced from *Eucheuma* and *Kappaphycus* seaweed, has increased rapidly in developed and developing markets alike worldwide. Indonesia is, in fact, the world's largest producer of these species. Farms are located mainly in Sulawesi, Maluku, West and East Nusa Tenggara, Northern Kalimantan and East Java.

### *Processing of seaweed extracts*

The Indonesian hydrocolloid industry is relatively young, with most processing companies having been founded within the last 20 years. More than 30 seaweed processing companies engaged in producing semi-processed and processed seaweed (carrageenan and agar) are now active; however, according to industry estimates, the factory utilization for SRC production in Indonesia is 60–70 percent. They produce mainly SRC (food and non-food grades) and agar as well as RC. Other extracts include Alkali Treated Carrageenan, SRC and RC.

According to the Indonesian Seaweed Industry Association, the output of carrageenan products in 2013 totalled 12 500 tonnes (around 40 percent of total capacity), consisting of 1 720 tonnes of RC; 8 770 tonnes of SRC and 2 010 tonnes of Alkali Treated Carrageenan. Seven companies produce agar agar, while two companies produce food-based seaweed products with installed capacities of 6 240 tonnes/year and 480 tonnes/year, respectively according to the DG of Fishery Products Marketing and Processing, MMAF. Much of the technology has been imported and this has met with varying degrees of success. Most of these companies are in technical partnerships with overseas concerns, particularly Japanese corporate companies and trading houses. Some have successfully optimized their processes whereas others have struggled to bring their factories up to a good standard of operation.

Indonesia's current production of agar is estimated at over 12 000 tonnes, an increase from 8 000–9 000 tonnes produced during early 2002. Almost 60–70 percent of the production is diverted to the export market and the rest is consumed in the domestic food



market, although this ratio is likely to fluctuate in the future due to rising national incomes and greater domestic demand for agar agar.

### *Trade in raw and processed seaweed*

Indonesia is the second largest producer of farmed seaweed. Domestic consumption is relatively low, and the bulk of exports consists of dried seaweed, particularly the edible varieties that are exported to Chile, China (85 percent), the Philippines and other Asian markets.

During 2012–2016, Indonesian exports of seaweed peaked in 2015 at 207 055 tonnes, valued at USD 170.3 million. There was a decline in 2016 to 183 257 tonnes, valued at USD 132 million (Table 3) due to lower exports to Chile, China and markets in the European Union in that year (Annex 10a). Exports of carrageenan, however, recovered during 2015 and 2016 (Figure 7 and Figure 8). The European Union, Japan and the United States of America are the top markets for carrageenan originating in Indonesia. Meanwhile, good domestic demand for agar agar has taken away the product from the export market in recent years.

**Table 3. Indonesia: Exports of seaweed, 2012–2016**

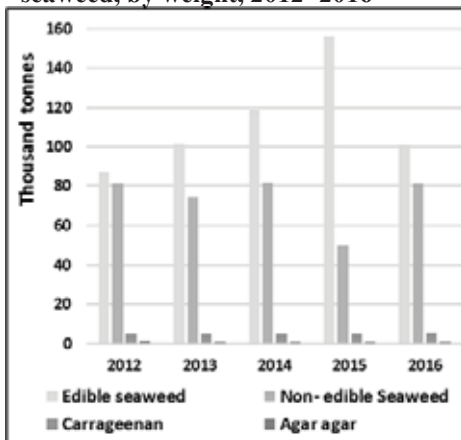
|   |                      | 2012           | 2013           | 2014           | 2015           | 2016           |
|---|----------------------|----------------|----------------|----------------|----------------|----------------|
| Seaweed & other algae, for human consumption            | Tonnes               | 86 817         | 101 547        | 118 759        | 156 390        | 100 972        |
|   | USD thousands        | 62 631         | 89 904         | 136 450        | 127 361        | 70 195         |
| Seaweed & other algae, <u>not</u> for human consumption | Tonnes               | 81 463         | 74 564         | 81 947         | 49 915         | 81 339         |
|   | USD thousands        | 71 524         | 72 552         | 89 778         | 33 048         | 53 818         |
| Agar agar   | Tonnes               | 1 292          | 1 056          | 933            | 750            | 946            |
|   | USD thousands        | 2 861          | 13 084         | 14 811         | 9 932          | 8 908          |
| Carrageenan   | Tonnes               | 5 266          | 5 299          | 4 933          | 5 190          | 5 503          |
|   | USD thousands        | 31 791         | 34 660         | 38 848         | 35 840         | 29 698         |
| <b>Total</b>  | <b>Tonnes</b>        | <b>169 572</b> | <b>177 167</b> | <b>201 635</b> | <b>207 055</b> | <b>183 257</b> |
|   | <b>USD thousands</b> | <b>137 119</b> | <b>175 540</b> | <b>241 039</b> | <b>170 341</b> | <b>132 921</b> |

Source: Statistics Indonesia.

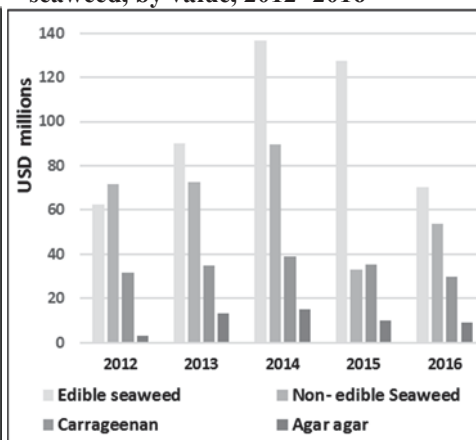
In 2015, 5 190 tonnes of carrageenan were exported, valued at nearly USD 30 million (Annexes 10b and 10c). The agar processing industry (mainly using *Gracilaria*) – although currently showing a lower output than carrageenan – is considered to have huge market potential, as the former has a strong foothold in the domestic market and is able to compete in the global market. Moreover, carrageenan companies are worried about the prospect of the delisting of carrageenan as an organic product in the U.S. market. The U.S. National Organic Standards Board has recommended to the United States Department of Agriculture that it delist carrageenan as an organic product; if this proceeds, carrageenan will no longer be qualified to be described as an organic product. Although the organic market share is relatively small, some food producers in the United

States of America have begun declaring their products as ‘carrageenan-free’, regardless of whether the product is organic or not.

**Figure 7. Indonesia: Exports of seaweed, by weight, 2012–2016**



**Figure 8. Indonesia: Exports of seaweed, by value, 2012–2016**



Source: Statistics Indonesia.

Indonesia’s dried seaweed exports are dominated by *Eucheuma* spp. Unprocessed seaweed is categorized into two types in the export trade: food type, fit for human consumption (HS 121221), and non-food type, not fit for human consumption (HS 121229). While exports to Asian markets and Chile are dominated by food-category seaweed, the European Union and the United States of America import nonfood-category seaweed from Indonesia. Exports of food-quality seaweed have increased over the years although in general, both types presently hold almost the same share in the export trade. Nevertheless, it is worth noting that exports of agar agar have dwindled within 1 000 tonnes (+/-) although its average export value has increased to USD 10/kg in 2015 (Table 4).

Until the late 1990s, the dried seaweed exporters in Indonesia were largely dependent on the reprocessing sector, specifically in Denmark. The average FOB export price of Indonesian dried seaweed, however, increased from USD 400/tonne during the late 1990s to USD 800/tonne in early 2000 as a result of strong and stable demand from China.

**Table 4. Indonesia: Export price of *E cottonii*, 2015**

| Dried seaweed ( <i>E. cottonii</i> ), raw material | Seaweed chips | Semi refined carrageenan | Refined carrageenan (non-food grade) | Refined carrageenan (food grade) |
|--|---------------|--------------------------|--------------------------------------|----------------------------------|
| USD0.30/kg   | USD2.00/kg    | USD3.60/kg               | USD12.60/kg                          | USD14.00/kg                      |

Source: Seaweed Export Industry, Indonesia.

Indonesia also imports seaweed and colloids for use in the local food industry, such as the beverage, food and pharmaceutical sectors. Carrageenan, in particular, is sought by the domestic industry for the manufacture of food jellies, toothpaste, ice cream, canned meat and fish. None of the domestically produced carrageenan or semi-refined carrageenan (SRC), however, is used in the country.

### ***New market trends***

In the past few years, there has been a growing trend in the use of seaweed as direct food products in Indonesia. Though a relatively small sector at present, the rising domestic demand is driving the processing of *cottonii* or *Gracilaria* into various food products such as noodles, drinks, crackers, cookies, sweets and tidbits, among others. Throughout the country, these items are produced mainly by small family businesses.



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### ***Potential and challenges***

Indonesia has a vast potential for seaweed farming and export, which is not fully realized as yet. Cognisant of this fact, the government has renewed its intent to modernise and further develop the industry. Among the initiatives being taken is the notion of collective partnerships between local producers and processors; communities; non-government organizations; public- and private-sector representatives; and international organizations.

The Government of Indonesia also has prioritized seaweed in the country's national development plan, not only due to its export earnings but also because its farming has obviously assisted in improving the livelihoods of coastal communities. Various programmes have been launched to increase seaweed production, such as providing better quality seed, improving farming techniques, zonation and enhancing post-harvest and processing technologies. As a result, small fishermen in many areas of Indonesia have changed their profession from fishing to the farming of seaweed to increase their incomes.

Since 2014, Switzerland's State Secretariat for Economic Affairs has funded the SMART-Fish Indonesia programme, implemented by the United Nations Industrial Development Organization together with the Indonesia's Ministry of Marine Affairs and Fisheries. The programme aims to improve the productivity of the seaweed value chain in Indonesia, as well as the competitiveness of the Indonesian seaweed industry

### 2.1.3 Malaysia

#### *Production of seaweed (farmed)*

A coastline of over 3 500 kilometres, with an extensive continental shelf area, has provided opportunities during the last decade to increase seaweed farming in Malaysia. Mariculture activities for seaweed centre around Sabah, particularly in Kudat and Semporna where the agro-climatic environment is ideal for farming seaweed. The main species of seaweed cultured is *E spinosum* in Kudat and *E cottonii* (*Kappaphycus*) in Semporna.

Production increased significantly, from 60 000 tonnes in 2006 to 261 000 tonnes in 2015 (Table 5), supported by the local Government of Sabah's initiatives through technical collaboration between the Department of Fisheries, research institutes (University of Malaya, Sabah Unit) and the aquaculture industry in Malaysia – particularly in Sabah, where seaweed farming has become a major activity during the last seven to eight years. Malaysian seaweed production reached the highest level at over 330 000 tonnes in 2012. However, disease and low-quality seed problems affected the aquaculture sector during the subsequent years.

**Table 5. Malaysia: Aquaculture production of seaweed, 2008–2015**

|                      | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    | 2015    |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| <b>Tonnes</b>        | 111 298 | 138 857 | 207 892 | 239 450 | 331 490 | 269 431 | 245 332 | 260 760 |
| <b>USD thousands</b> | 6 686   | 7 884   | 17 444  | 21 919  | 23 616  | 25 672  | 63 752  | 33 577  |

Source: FAO.

The farming technique engaged in Malaysia is the monoline method, similar to that practised in Indonesia and the Philippines. The common seaweeds in national waters are green seaweed (*Caulerpa* and *Ulva*), brown sea weed (*Sargassum*, *Tubinaria*, *Dictyota* and *Padina*), and red seaweed (*Gracilaria*, *Euclidean* and *Laurencia*) according to the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asian and Pacific Region (INFOFISH).



*Monoline culture of seaweed.*  
© Fatima Ferdouse



© INFOFISH

Coastal farmers in the Semporna area have largely benefited from seaweed aquaculture. Increased demand from China, as well as from the local seaweed processing industry, has boosted the FOB price of dried seaweed from USD 400/tonne during the late 1990s to USD 800/tonne in the early 2000s. The carrageenan processing industry in Sabah, mostly Tawau, has been the main customer for local dried seaweed.



*Seaweed mariculture and drying facilities in Semporna, Malaysia.*  
© Fatima Ferdouse.

Dried seaweed in Malaysia is used as food for human consumption, animal feed, fertilizer and in traditional Chinese medicine. The seaweed-producing industries generally use *Eucheuma* as the main raw material for manufacturing semi-refined carrageenan (SRC) and refined carrageenan (RC). Species such as *Gelidium* and *Gracilaria* are also used to make agar on a small-scale basis. Agar agar, however, is imported for direct usage as food.



*Agar agar is popular as a dessert item and as a content of drinks in Malaysia.*  
© Fatima Ferdouse

Major seaweed processing industries/factories, established in Sabah, produce food and nonfood-grade SRC and RC. While most of the products are exported, there is an increasing demand for grades of carrageenan from the domestic industries in Malaysia. Tacara Sdn. Bhd, based in Tawau (Sabah) is one of the leading producers of carrageenan in the country.



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### ***Import-export trade***

Until 2014, the main component of Malaysia's seaweed exports has been dried carrageenophyte, and the country is one of the producers in Southeast Asia of high-grade carrageenophytes. The trend changed, however, during 2015 and 2016 when carrageenan exports declined significantly and dried seaweed exports increased, particularly to China (1 588 tonnes in 2016) (Table 6). In 2016, the export value of seaweed, including

carrageenan, totalled USD 8.45 million, and the leading markets for carrageenan were the European Union, Thailand, Viet Nam and the United States of America.

**Table 6. Malaysia: Exports and imports of dried seaweed, carrageenan and agar agar, 2014–2016**

|               | Weight in tonnes |              |              |              |            |              |
|---------------|------------------|--------------|--------------|--------------|------------|--------------|
|               | 2014             |              | 2015         |              | 2016       |              |
|               | Exports          | Imports      | Exports      | Imports      | Exports    | Imports      |
| Dried Seaweed | 709              | 1 106        | 2 378        | 1 121        | 2 226      | 1 295        |
| Carrageenan   | 1 018            | 997          | 798          | 1 019        | 573        | 977          |
| Agar agar     | 11               | 680          | 126          | 531          | 42         | 532          |
| <b>Total</b>  | <b>1 738</b>     | <b>2 783</b> | <b>3 303</b> | <b>2 671</b> | <b>841</b> | <b>2 804</b> |

Source: Department of Statistics Malaysia.

In the category of seaweed and other algae fit for human consumption, Malaysia exported 2 224 tonnes valued at USD 1.8 million in 2016. Except for the peak in 2015, this figure represented a significant increase over preceding years (Table 7).

**Table 7. Malaysia: Exports of seaweed and other algae HS 121221, fit for human consumption, 2013–2016**

|                                 | Weight in tonnes; value in USD thousands |                |            |                  |              |                  |              |                  |
|---------------------------------|--|----------------|------------|------------------|--------------|------------------|--------------|------------------|
|                                 | 2013                                     |                | 2014       |                  | 2015         |                  | 2016         |                  |
|                                 | Weight                                   | Value          | Weight     | Value            | Weight       | Value            | Weight       | Value            |
| China                           | 388                                      | 465 288        | 586        | 984 102          | 1 502        | 146 6753         | 1 588        | 1 156 297        |
| Philippines                     | 0  | 0              | 21         | 9 060            | 723          | 315 550          | 558          | 219 987          |
| Indonesia                       | 25                                       | 34 739         | 27         | 31 114           | 1            | 5 681            | 40           | 10 7973          |
| Japan                           | 0  | 0              | 8          | 56 411           | 8            | 52 529           | 16           | 112 074          |
| United Kingdom                  | 44                                       | 92 851         | 44         | 195 535          | 0            | 0                | 15           | 71 600           |
| Singapore                       | 44                                       | 257 230        | 1          | 40 384           | 3            | 4 677            | 3            | 20 769           |
| Hong Kong SAR                   | 6  | 24 782         | 0          | 0                | 1            | 10 471           | 3            | 63 560           |
| <b>Total (including others)</b> | <b>550</b>                               | <b>921 353</b> | <b>687</b> | <b>1 326 223</b> | <b>2 261</b> | <b>1 871 361</b> | <b>2 224</b> | <b>1 763 940</b> |

Source: Department of Statistics Malaysia.

It is important to note that imports of seaweed raw materials and refined products were at a record high in Malaysia, exceeding 2 800 tonnes in 2016, with an import value of USD 27.1 million. This made Malaysia a net importer of seaweed in terms of quantity as well as in value. The previous year saw a similar trend.

One of the reasons behind the rising imports of seaweed into Malaysia could relate to the increasing usage of carrageenan in the domestic food industry (e.g. ice cream, meat binders) and the chemical/pharmaceutical industries (e.g. toiletries). Agar agar is popular for the preparation of desserts at home and in the catering sector; its usage is also on the rise in the ready-meal processing industries. Companies dealing in chemicals and food additives are the main buyers of carrageenan in Malaysia. In addition, they import supplies via Singapore and directly from sources such as China, as well as of late Indonesia.

## Outlook for the seaweed sector

According to Malaysia's Department of Fisheries, the aquaculture production forecast for the country in 2017 is 1.44 million tonnes, of which approximately 730 000 tonnes will comprise seaweed. In line with this expected volume, farming of *Gracilaria* is likely to increase due to the rising consumer demand for agar, which is currently being met through imported supplies. Demand for carrageenan is also expected to increase with the rising utilization of phycocolloids in the food and non-food sectors in Malaysia.

### 2.1.4 Thailand

The domestic production of seaweed is relatively low in Thailand. Because the consumption or usage within the country is high in the food and non-food sectors, however, Thailand is a net importer of seaweed and hydrocolloids.

Generally, Thailand imports edible seaweed such as dried *wakame*, *nori* and agar agar strips and powder for direct consumption. China and Republic of Korea are the principal sources of dried edible seaweed (Table 8).

Imported dried edible seaweed from Chile is used to produce agar powder for direct consumption. Besides marketing the agar agar locally, Thailand exported nearly 200 tonnes of the product in 2016, mainly to Australia, the Republic of Korea and the United States of America (Table 9).

Hydrocolloids (carrageenan, agar agar and alginic acid) are imported for the large food processing sector in the country, which manufactures a wide range of 'ready to cook' and 'ready to eat food' for local and export markets. The import of carrageenan has increased over the years (Table 10). Besides food for human consumption, there is a large export-oriented pet food industry in Thailand that uses seaweed products as a binder.

**Table 8. Thailand: Imports of seaweed and other algae HS 121221, fit for human consumption (by origin), in tonnes, 2012–2016**

|   | Weight in tonnes |               |               |               |               |
|---|------------------|---------------|---------------|---------------|---------------|
|   | 2012             | 2013          | 2014          | 2015          | 2016          |
| Korea, Republic of                                    | 515              | 1 404         | 2 020         | 2 556         | 3 066         |
| China   | 1 230            | 1 053         | 1 099         | 921           | 1 206         |
| Chile   | 189              | 160           | 108           | 133           | 128           |
| Indonesia   | 106              | 56            | 109           | 163           | 54            |
| Norway  | 0                | 1             | 0             | 0             | 51            |
| Japan   | 31               | 42            | 51            | 59            | 45            |
| <b>Total weight (including other minor suppliers)</b> | <b>2 121</b>     | <b>2 759</b>  | <b>3 408</b>  | <b>3 837</b>  | <b>4 554</b>  |
| <b>Total value in USD thousands</b>                   | <b>15 417</b>    | <b>25 900</b> | <b>36 334</b> | <b>40 690</b> | <b>56 450</b> |

Source: Customs Department, Thailand.

**Table 9. Thailand: Imports of agar agar (HS 130231), 2012–2016**

|   | Weight in tonnes |               |               |               |               |
|---|------------------|---------------|---------------|---------------|---------------|
|   | 2012             | 2013          | 2014          | 2015          | 2016          |
| China   | 587              | 527           | 639           | 581           | 612           |
| Chile   | 122              | 96            | 90            | 99            | 85            |
| Taiwan, Province of China                             | 0                | 0             | 31            | 15            | 16            |
| Indonesia   | 4                | 8             | 6             | 12            | 10            |
| India   | 8                | 46            | 48            | 72            | 5             |
| <b>Total weight (including other minor suppliers)</b> | <b>724</b>       | <b>695</b>    | <b>818</b>    | <b>812</b>    | <b>731</b>    |
| <b>Total value in USD thousands</b>                   | <b>9 264</b>     | <b>10 119</b> | <b>11 241</b> | <b>11 800</b> | <b>11 595</b> |

Source: Customs Department, Thailand.

**Table 10. Thailand: Imports of carrageenan (HS 130239), in tonnes, 2012–2016**

|   | Weight in tonnes |               |               |               |               |
|---|------------------|---------------|---------------|---------------|---------------|
|   | 2012             | 2013          | 2014          | 2015          | 2016          |
| Philippines   | 988              | 801           | 1 040         | 894           | 1 136         |
| United Kingdom  | 801              | 656           | 660           | 759           | 870           |
| Canada  | 17               | 246           | 520           | 552           | 707           |
| United States of America                              | 145              | 183           | 194           | 161           | 216           |
| China   | 90               | 101           | 118           | 149           | 155           |
| Denmark   | 122              | 110           | 91            | 120           | 96            |
| India   | 73               | 50            | 61            | 58            | 72            |
| Indonesia   | 20               | 46            | 53            | 45            | 70            |
| Korea, Republic of                                    | 125              | 143           | 57            | 58            | 64            |
| Malaysia  | 39               | 35            | 34            | 46            | 45            |
| Peru  | 0                | 0             | 24            | 21            | 31            |
| Japan   | 15               | 17            | 27            | 21            | 30            |
| Australia   | 12               | 10            | 13            | 10            | 13            |
| <b>Total weight (including other minor suppliers)</b> | <b>2 549</b>     | <b>2 629</b>  | <b>2 918</b>  | <b>2 940</b>  | <b>3 517</b>  |
| <b>Total value in USD thousands</b>                   | <b>21 645</b>    | <b>24 090</b> | <b>22 475</b> | <b>21 113</b> | <b>23 954</b> |

Source: Customs Department, Thailand.

### 2.1.5 Philippines

#### *Seaweed from aquaculture*

The Philippines is the world's third largest producer of seaweed, following China and Indonesia. There are some 800 species of seaweed in national waters of which *Eucheuma spp* is the most commercially significant, followed by *Caulerpa*, *Gracilaria* and *Sargassum*. In 2015, about 90 percent of the farmed output from the Philippines comprised *Eucheuma spp*, namely, *E. cottonii* (*Kappaphycus*) and *E. denticulatum*, and the rest was green seaweed. In fact, nearly 80 percent of the world's total *E cottonii* (*Kappaphycus*) production originates from the Philippines (777 963 tonnes), roughly 30 percent of which is traded in dried form.



The farming of these seaweed species, particularly in the southern part of the country, generates income for more than 500 000 people from over 100 000 families living along coastlines and on the many islands. In addition, at least 10 000 job opportunities have been created through processing and other related activities. Wild harvests are insignificant by comparison; the species involved are mainly *Sargassum*, *Gracilaria*, *Gelidium* and *Porphyra* spp.

The major producing areas are Tawi-Tawi, the reef areas of Sulu, Zamboanga del Norte, Sacol and Cuyo Islands of Palawan, Dawajon of Central Visayas, Pangasinan, Mindoro, Negros, Panay, Leyte and Camarines Sur. Mindanao island is the leading region, producing more than 50 percent of the country's seaweed volume.

During 2016–2015, aquaculture production of seaweed in the Philippines reached its highest point in 2011, at 1.8 million tonnes, but dwindled during the next three years because of the highly intensified nature of the farming system and subsequent disease-related issues. By 2013–2015, the annual production stabilized at around 1.55 million tonnes, with a marginal rise in 2015 (Table 11).

**Table 11. The Philippines: Production of seaweed (by species), in tonnes, 2011–2015**

| ASFIS Species                        | Weight in tonnes |                  |                  |                  |                  |
|--------------------------------------|------------------|------------------|------------------|------------------|------------------|
|                                      | 2011             | 2012             | 2013             | 2014             | 2015             |
| Elkhorn seamoss                      | 1 697 682        | 1 608 401        | 1 428 707        | 1 434 714        | 1 457 865        |
| Spiny <i>Eucheuma</i>                | 136 183          | 137 603          | 124 218          | 113 127          | 106 950          |
| <i>Caulerpa</i> seaweeds             | 5 145            | 3 928            | 3 029            | 1 199            | 1 219            |
| <i>Gracilaria</i> seaweeds           | 1 823            | 1 139            | 2 424            | 536              | 327              |
| <b>Total (farmed)</b>                | <b>1 840 833</b> | <b>1 751 071</b> | <b>1 558 378</b> | <b>1 549 576</b> | <b>1 566 361</b> |
| <b>Total (capture &amp; culture)</b> | <b>1 841 291</b> | <b>1 751 476</b> | <b>1 558 778</b> | <b>1 549 943</b> | <b>1 566 728</b> |

Source: FAO.

In addition to being the world's third largest producer of seaweed (approximately 14 percent of global output), the Philippines is also the second largest exporter of SRC to the international market. It lost its top ranking to China during the mid-2000s.

*C. crispus* and *Gigartina*, which grow naturally in their habitat, continue to be harvested as raw material for carrageenan extraction, although currently around 70 percent of the carrageenan production in the country is derived from cultured seaweed (mainly *Eucheuma*). In the late 1960s, some experiments were initiated in the Philippines on the culture of *Eucheuma* by Maxwell Doty of the University of Hawaii under the sponsorship of FMC Corporation. The trials eventually became so successful that today the Philippines supplies approximately 80 percent of the world's *Eucheuma* requirements for the production of carrageenan.

### *International trade*

The seaweed aquaculture sector in the Philippines is highly export-oriented. According to the Philippine Statistics Authority, exports of seaweed (and other algae) and carrageenan in 2016 totalled nearly 43 000 tonnes at a customs declared value of USD 200 million (Annexes 11a, 11b and 11c; Table 12).

**Table 12. The Philippines: Exports of dried seaweed, carrageenan, and agar agar, 2013–2016**

|               | Weight in tonnes; value in USD thousands |                |               |                |               |                |               |                |
|---------------|--|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
|               | 2013                                     |                | 2014          |                | 2015          |                | 2016          |                |
|               | Weight                                   | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          |
| Dried seaweed | 37 063                                   | 34 356         | 18 493        | 49 300         | 14 910        | 21 739         | 11 052        | 8 539          |
| Carrageenan   | 23 503                                   | 195 242        | 26 633        | 213 239        | 27 181        | 185 461        | 31 813        | 190 171        |
| Agar agar     | 2  | 11             | 1             | 10             | 2             | 6              | 1             | 1              |
| <b>Total</b>  | <b>60 568</b>                            | <b>241 012</b> | <b>45 675</b> | <b>272 306</b> | <b>42 093</b> | <b>213 508</b> | <b>42 866</b> | <b>199 973</b> |

*Source:* Philippine Statistics Authority.

During the 2013–2016 period, there was an overall marked decline in the exports of seaweed and other fresh or dried algae, despite individual fluctuations by country (Annex 11a). China, Denmark, France, Hong Kong Special Administrative Region, the Republic of Korea, Spain, the United Kingdom and the United States of America were the top destination markets for this product from the Philippines. Unlike the top seaweed exporter, Indonesia, where the products consist mainly of dried seaweed, exports from the Philippines are increasingly dominated by SRC and RC (Annexes 11b and 11c). In other words, dried seaweed exports from the Philippines have declined gradually as more raw materials are being processed into carrageenan products in response to the increasing demand for that product worldwide. During the last six years, the processing industry in the Philippines imported 8 000–10 000 tonnes of dried seaweed annually to supplement supplies of raw material. China, Indonesia and the Republic of Korea have been the main supply sources.

In the same year (2016), the export of value-added seaweed or carrageenan from the Philippines consisted of 74 percent of the country's total seaweed exports, and was at a record high of 31 813 tonnes, valued at USD 190 million. The share of refined carrageenan also increased by 55 percent during the 2012–2016 period.

Processed and semi-processed carrageenan exports were exported to 80 countries worldwide, with the top destinations being the United States of America (9 760 tonnes) and the European Union (7 620 tonnes). In the common market of the European Union, the large importing countries were Belgium, Denmark and the United Kingdom. Other leading markets, in descending order, were Mexico (2 346 tonnes), Thailand (1 928 tonnes) and Indonesia (1 186 tonnes). Compared with 2015, exports to the European Union, Indonesia, Thailand and the United States of America in 2016 had increased (Table 13).

The major markets for raw/minimally processed seaweeds are Brazil, China, France, Thailand and the United States of America. For seaweeds and carrageenan, the composition of the major markets changes to Belgium, Denmark Mexico, Spain, Thailand and the United States of America. The limiting factor in the production of refined carrageenan is a lack of sufficient facilities with the appropriate technology.

**Table 13. The Philippines: Exports of processed and semi-processed carrageenan (HS 130239), 2012–2016**

|                                 | Weight in tonnes |               |               |               |               |
|---------------------------------|------------------|---------------|---------------|---------------|---------------|
|                                 | 2012             | 2013          | 2014          | 2015          | 2016          |
| United States of America        | 7 495            | 7 498         | 7 387         | 8 431         | 9 762         |
| Mexico                          | 1 146            | 1 704         | 1 621         | 2 821         | 2 346         |
| Thailand                        | 832              | 891           | 1 202         | 1 066         | 1 928         |
| Belgium                         | 1 753            | 1 500         | 1 592         | 1 504         | 1 897         |
| Denmark                         | 1 302            | 1 221         | 1 090         | 1 265         | 1 366         |
| United Kingdom                  | 791              | 1 293         | 805           | 1 082         | 1 187         |
| Indonesia                       | 304              | 298           | 528           | 357           | 1 186         |
| Brazil                          | 924              | 776           | 720           | 777           | 931           |
| China                           | 524              | 507           | 475           | 476           | 918           |
| Australia                       | 735              | 772           | 974           | 902           | 913           |
| Russian Federation              | 883              | 618           | 765           | 853           | 823           |
| Germany                         | 990              | 739           | 1 337         | 591           | 803           |
| Spain                           | 655              | 480           | 396           | 415           | 759           |
| Argentina                       | 488              | 446           | 768           | 621           | 598           |
| Japan                           | 260              | 401           | 463           | 532           | 543           |
| Viet Nam                        | 92               | 122           | 321           | 169           | 531           |
| Malaysia                        | 146              | 197           | 384           | 300           | 525           |
| <b>Total (including others)</b> | <b>24 035</b>    | <b>23 503</b> | <b>26 633</b> | <b>27 181</b> | <b>31 813</b> |

Source: Philippine Statistics Authority.

### **Domestic market**

Annual imports of agar agar into the Philippines range between 20 tonnes and 25 tonnes, of which 60 percent is used by the food industry, followed by biotechnological applications and the pharmaceutical industry. Although demand appears to be increasing from several industries (meat and poultry processing, food and pet food), the local market for SRC and RC remains relatively small.

Agar strips, referred to as ‘gulaman’ bars made from *Gracilaria spp*, are sold on the domestic market. These are produced by small- to medium-scale manufacturers in Manila and Bulacan. In the northern coastal communities in Luzon and Central Visayas, seaweed has long been used as a part of vegetable salads. Several types of seaweed are easily available in Manila and other local markets, and there is slow albeit increasing demand from consumers throughout the country. *Gracilaria*, *Codium*, *Caulerpa*, *Porphyra spp.*, *Hydroclathrus*, *Hypnea*, *Laurencia* and *Eucheuma* are consumed fresh in salads while

species, such as *Porphyra*, *Ulva*, *Laurencia*, *Colpomenia*, *Acanthophora* and *Halymenia*, are sold in dried form and then soaked in water to recover its fresh state before preparation into salads. Some species are first boiled before they are added to salads or made into gelatine or jelly desserts. The young shoots of *Sargassum* are used in soups or mixed with coconut milk to make vegetable dishes according to INFOFISH.



*Caulerpa* spp. makes a colourful and crunchy addition to salads.

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A positive point about the seaweed industry in the Philippines is the fact that there is an effective collaborative network between the local authorities, such as the Bureau of Fisheries and Aquatic Resources (BFAR) and other stakeholders (non-government organizations, cooperatives and research institutions) that aim to strengthen farming, processing and trade activities relating to seaweed.

BFAR has identified several challenges in the sector at the local level: pollution in production areas, inadequate supply of dried seaweed for processing, the security situation in the producing areas in the southern part of the country, diseases such as ice-ice (between 2011–2013, for example, the Philippines lost a potential seaweed harvest worth USD 300 million as a result of ice-ice), and inconsistency in the quality of the seaweed produced. Internationally, BFAR warns of increasing competition in the production of *Eucheuma* vis-à-vis countries such as Indonesia and Malaysia.

## Republic of Korea

According to FAO, the Republic of Korea is the fourth largest producer of farmed seaweed. Production has remained relatively stable over the last decade, with a marginal rise in 2015 at 1.2 million tonnes compared to 1.1 million tonnes harvested in 2014.

While a major part of the production is consumed locally, the country is also a net exporter in the seaweed trade in terms of quantity and value. In 2016, exports totalled 34 500 tonnes at a value of USD 222 million, largely dominated by edible seaweed (32 000 tonnes) which was 15 percent more than the quantity exported in 2012. The main markets were China, Japan and Thailand. The other important exportable in this product group was carrageenan, for which exports fluctuated between 2 200 tonnes in 2012 to 2 500 tonnes in 2016, valued at USD 22 million. Notably, the market also imported 15 000 tonnes of seaweed in 2016, valued at USD 31 million. The main products were edible seaweed (12 000 tonnes) and carrageenan (1 300 tonnes).

Dried seaweed is a favourite addition in many dishes in the Republic of Korea. It can be a part of traditional rice rolls (*kimbap*); roasted with sesame oil and eaten together with rice and *kimchi*; pressed into a dark green sheet known as *kim*; enjoyed as a crispy, flavoured seaweed snack; prepared as an addition to salads and soups; among others. In 2015, dried seaweed exports were valued at USD 300 million, almost three times higher than the figure in 2010. Dried seaweed is now in second place in export rankings, following that for tuna. The main market was the United States of America followed by Japan, Thailand, China and the Middle East.

Dongwon F&B Co. Ltd., the nation's largest dried seaweed producer, created a product called 'Sea Veggies' for the U.S. market. Once this company has received its halal food certification, it is expected to make a significant push into Middle Eastern markets. While sales in the United States of America have risen due to the perception that these products are healthy non-sugar snacks, its popularity in China and Southeast Asia is considered a result of the Korean pop culture craze.

Where the Republic of Korea seeks to differentiate itself from Thailand's successful snack industry is to offer more flavours, such as barbecue, wasabi and squid, and to introduce innovative products. An example is a snack that consists of dried laver and brown rice chips, marketed by CJ Cheiljedang, the country's largest food company. Apart from the United States of America, seaweed snacks in the Republic of Korea are sold under the brandname 'Bibigo' in 20 other nations. The authorities also are trying to promote Korean dried seaweed as *kim* in an effort to create a different market niche from Japanese *nori*.

## 2.2 EUROPE

### 2.2.1 European Union

Several market studies indicate that seaweed product innovation is at its highest rate in the Asia and the Pacific region (more than 80 percent), with Europe second, followed by North America.

In Europe, the single most important reason is the expanding consumer view of seaweed as a type of healthy ‘superfood’. A walk through major supermarkets in Europe will reveal a large number of foods, seasonings and drink items containing seaweed and/or its flavor. Furthermore, if they carry an organic label – as many do – they can be sold at a premium.

**Table 14. European Union: Exports of seaweed, 2012–2016**

|                                   | Weight in tonnes |               |                |                |                |
|-----------------------------------|------------------|---------------|----------------|----------------|----------------|
|                                   | 2012             | 2013          | 2014           | 2015           | 2016           |
| Seaweed for human consumption     | 3 733            | 4 691         | 5 041          | 5 219          | 4 607          |
| Seaweed not for human consumption | 35 138           | 42 910        | 48 833         | 55 974         | 53 723         |
| Agar agar                         | 2 897            | 2 431         | 2 634          | 2 766          | 2 462          |
| Carrageenan                       | 40 403           | 45 379        | 46 939         | 37 587         | 40 802         |
| <b>Total</b>                      | <b>82 171</b>    | <b>95 411</b> | <b>10 3447</b> | <b>101 546</b> | <b>101 594</b> |

Source: Eurostat.

**Table 15. European Union: Imports of seaweed, 2012–2016**

|                                   | Weight in tonnes |                |                |                |               |
|-----------------------------------|------------------|----------------|----------------|----------------|---------------|
|                                   | 2012             | 2013           | 2014           | 2015           | 2016          |
| Seaweed for human consumption     | 15 0631          | 31 768         | 22 953         | 1 7175         | 15 184        |
| Seaweed not for human consumption | 21 717           | 65 882         | 65 310         | 89 103         | 88 485        |
| Agar agar                         | 3 117            | 4 396          | 3 359          | 3 734          | 4 171         |
| Carrageenan                       | 61 146           | 72 113         | 63 302         | 57 158         | 70 627        |
| <b>Total</b>                      | <b>136 611</b>   | <b>174 159</b> | <b>159 924</b> | <b>167 170</b> | <b>17 846</b> |

Source: Eurostat.

Research into new processing technologies is a clear focus in the European Union. Taking France as an example and provided they meet safety regulations, seaweed is commonly used as a vegetable and condiment in many interesting food products. According to the Center for Study and Promotion of Algae in France, several companies in the region specialize in developing innovative uses for seaweed. Two such companies mentioned in a center’s report are C-Weed Aquaculture (which has its own culture and processing facilities, and produces a range of items that include dried and powdered seaweed); and Algues Services, which produces items for culinary use (e.g. seaweed tartare). C-Weed Aquaculture products have Bureau Veritas (FR BIO 10) organic certification.



Some of the many innovative seaweed products manufactured and sold in Europe.

Such innovation is not limited, of course, to European Union countries within Europe. In Norway, for example, the Norwegian Seaweed Technology Center is described as a knowledge platform for technology development within the industrial cultivation, harvesting, processing and application of seaweed in that country.

### 2.2.2 Denmark

Denmark has a broad range of industries, ongoing research projects and other activities that involve seaweed, as well as a long history with industrial extraction of seaweed and seaweed research. The company Litex A/S (later FMC Corporation), which was founded in Denmark in 1942, began extracting 'Danish agar' from locally available *Furcellaria lumbricalis* seaweed. Later, in 1960, Copenhagen Pectin (today CP Kelco ApS) began to extract carrageenan from imported seaweed; today, this company continues to be one of the world's leading carrageenan producers, with factories in Denmark and the Philippines. This was not least because of the work of the former director of CP Kelco ApS, Hans Porse who, in the 1970s and 1980s, initiated the cultivation of *Kappaphycus* and *Euclima* seaweeds in Indonesia and Zanzibar (Tanzania). Commercial carrageenan seaweed cultivation and its extraction now involves approximately 150 000–200 000 people worldwide. Another example is Danisco A/S (today, DuPont™ Danisco®), which is perceived to be the world's largest food ingredients joint company. Based in Denmark and with factories in Chile and France, it has for many years also been involved with the manufacture of alginate and carrageenan.

While Denmark has been a leader for hundreds of years in the field of seaweed research, its industry and academia have maintained a profound interest in seaweed. Currently, several research groups from the six national universities in Denmark are involved in seaweed research in terms of the screening of biochemical and bioactive compounds; gastronomy; feed; multi-extraction/biorefineries, where residuals are utilized as fertilizer and/or bioenergy; and cultivation and crop improvement. Meanwhile, Danish companies are involved in the extraction of biochemical; product development, including inclusion of seaweed; modeling of farms and extractive potential; and cultivation and crop improvement of seaweed, among others. The use of the local, sustainable, palatable 'new' resource continues to be of interest to the media and new customers, and the demand for these products is increasing.

Private investments are driving the expansion of small- and medium-sized businesses in the production of seaweed food products. A recently significant example is the funding that has been provided by the Karl Pedersen and Wife's Industrial Foundation (founder

of Copenhagen Pectin) to support the Danish Seaweed Organisation's initiative to gather the local players in the seaweed industry and create a marketing platform for companies to enhance visibility and export, as well as to support each other. Applied research funding is also offered, in particular for proposals based on collaboration between research bodies and companies on all aspects of the cultivation and utilization of seaweed. Companies also are able to apply for investment or shared funding for innovative ideas.

Denmark's National Strategic Plan for the Development of Sustainable Aquaculture 2014-2020 forecasts an increase of at least 25 percent of fish and shellfish (from 44 000 tonnes to 55 000 tonnes). Seaweed is referred to therein as an initiative to bioremediate waste nutrients in water environments (MEF, 2016), and its use as feed also is stated to reduce the import of vegetable protein sources. In 2016, the Government of Denmark explored the potential for creating aquaculture zones to include fish, shellfish and seaweed, as well as possible areas to combine these species.

The Danish AgriFish Agency of the Ministry of Environment and Food has a report that examines the potential for and challenges to the cultivation of mussels and seaweed. The most significant barrier to development was identified as financing (Petersen *et al.*, 2016)). A couple of the points to be considered are the (i) identification and documentation of the potential for, and costs related to, seaweed cultivation in Danish waters; and (ii) development of cost-effective technologies for species that have significant volume and value prospects.

Another recent report, "Growth within the blue biomasses", released by Innovation Network for Biomass, Danish Food Network, and others (Andersen *et al.*, 2016) is also worth reading. It focuses on the potential, challenges and recommendations in the cultivation of seaweed and shellfish.

### ***Main commercial seaweed species***

Denmark is a small country with a long coastline of 7 300 kilometres with a salinity gradient from the northern part (~35 practical salinity unit) to the southern waters (~10 practical salinity unit), towards the brackish Baltic Sea. This causes a significant decline in the number and size of seaweed species – from between 350 and 500 species in the north down to less than 50 species in the south. Exploitation of various seaweed species in Denmark's waters has been challenging, although with further research, the low, saline areas necessary for the cultivation of seaweed could be found. For now, however, there are only more or less ten species that are of commercial interest from wild and cultivatable sources.

The establishment of seaweed farms can take place once the Danish Coastal Authority has carried out an initial review of the impact on the surrounding nature and the potential for an environmental impact assessment. A license is typically valid for five years with the option for extension. Seaweed also can be cultivated organically based on certification from the Ministry of Environment and Food. In brief, neither non-organic fertilizers nor nutrient additions can be used in the initial stages of cultivation; the location should be classified as a suitable area for organic aquaculture; boats that work in the area should be free of anti-fouling on the hull, among other conditions. The gathering of seaweed for private consumption or sale is not legally prohibited.



The species cultivated commercially at present on a large scale is the brown sugarkelp (*Saccharina latissima*). This species is also collected from the wild for commercial purposes (i.e. human consumption) as are the bladderwrack (*Fucus vesiculosus*), serrated wrack (*Fucus serratus*) and smaller amounts of dulse (*Palmaria palmate*). Research is being carried out on the cultivation of *Palmaria palmate* and, to some extent, *F. vesiculosus* and *Laminaria digitata*.

Farming was carried out in seven licensed areas over the 2011–2015 period, with the largest being 1 square kilometre. These areas are mainly used for commercial cultivation of *Saccharina latissima* as well as for pilot trials relating to *Palmaria palmata* and *Fucus vesiculosus*. Production volume has increased from 1 tonne in 2009 to 10 tonnes (wet weight) in 2014. An unexpectedly high volume was reported in 2013; however, this figure is questionable and has not been verified.

Approximately 20 companies harvest local and natural populations of seaweed, with most manufacturing products for the niche and local markets, such as snacks, pesto, pickled seaweed and mustard. When evaluating the use of seaweed as a food, the chemical risk assessment must take into account all regulations that relate to heavy metals, inorganic arsenic and iodine. Table 16 indicates the thresholds for seaweed as a food in France and the United States of America, as well as a dietary supplement in the European Union. It should be noted that European Union regulation does not include inorganic arsenic and iodine, and that the regulations of France and the United States of America differ in iodine threshold concentrations.

**Table 16. Threshold levels for minerals and heavy metals in edible seaweed sold in France, the European Union and the United States of America**

| Toxic minerals    | Limit (mg kg <sup>-1</sup> dry matter, ppm) |        |               |
|-------------------|---|--------|---------------|
|                   | France                                      | USA    | EU regulation |
| Inorganic arsenic | <3.0  | <3.0   | No regulation |
| Lead              | <5.0  | <10    | <3.0          |
| Cadmium           | <0.5  |        | <3.0          |
| Tin               | <5.0  |        |               |
| Mercury           | <0.1  |        | <0.1          |
| Iodine            | <0.5  | <5,000 |               |
| Heavy metals      |   | <40    |               |

Source: “Other References” in Holdt and Kraan, 2011.

Analyses of Danish seaweed species indicate that, in general, inorganic arsenic concentrations (and non-harmful species of arsenic) are below the standards set by France and the United States of America. For food use, however, the standard is based on total arsenic, with a threshold level of 40 parts per million. This concentration is reached by *Saccharina latissima* several months a year. Lead and mercury concentrations are also below threshold values, whereby cadmium (up to 1.22 milligram (mg)/kg for *S. latissima*) is below European Union regulation (<3.0 mg/kg), but not at the threshold value set for France (<0.3 mg/kg) for a certain period in the year. Iodine concentrations in some large

brown kelps are extremely high and this also applies to the Danish specimen of *S. latissima*, which has concentrations up to 6 110 mg/kg. There is no standard with regard to iodine in food supplements in the European Union, although the concentration threshold is more than ten times higher than that set by France (<0.5 mg/kg) and above that of the United States of America (<5 000 mg/kg). Conclusively, therefore, iodine is the element that limits the recommended daily consumption of seaweed. Little is known, however, of the bioavailability and uptake of iodine, which also applies to the other seaweed heavy metals.

### ***Processing***

The major commercial seaweed-based product for human consumption in Denmark is dried seaweed. This is sold as flakes or powder, or is mixed as a sea salt, pesto, mustard and oil.

The processing technique for dried seaweed involves the collection of natural or cultivated seaweed. This is then washed in seawater or fresh water and hung to dry in a closed room with a dehumidifier. Once it is of a crispy texture, the seaweed is homogenized and sealed in a plastic pack or plastic/glass jar, mixed with some sea salt and/or spices. Seaweed pesto has become considerably popular and is sold as normal pesto or as a dried version that has a longer shelf life and requires the addition of oil and water before use. The pesto is made mainly of *Fucus* sp. and *Saccharina latissima* (47 percent), freshly collected from wild populations, washed in fresh water, boiled and finely cut, and later mixed with other ingredients. Seaweed oil is made by homogenizing rapeseed oil with an entire piece of dried *Fucus serratus* (2 percent); the freshness from the seaweed complements the lipids in the oil. Other products that include seaweed are many and are used fresh, fresh frozen, or dried.

Any company venturing into seaweed farming must register at the Ministry of Environment and Food, undertake a risk evaluation process of activities in the water area, provide an analysis of the species and their composition, and demonstrate the know-how of handling seaweed. The Ministry sets and implements the seaweed product standards for Denmark, which include food safety regulations, company responsibilities, among others.

More specifically, the following applies:

- Food safety: Food cannot be marketed if considered dangerous, marketing cannot be misleading, and the food company has the responsibility to comply with the relevant regulations, ensure product traceability, and ensure the withdrawal of potentially dangerous foods.
- Hygiene at the source: The regulation regarding the cultivation and harvest of natural populations includes protection against contamination, surveillance of zoonosis, assurance that the environment (e.g. equipment) and products are kept clean, assurance that drinking water or clean water is used, employee health issues, securing against possible pests and waste handling, among others.

- Hygiene in processing: These standards address facilities such as toilets, sinks, ventilation, building cleanliness, transport, equipment, food waste, water supply, personal hygiene and packaging;
- Novel food: Food and food ingredients must be approved in the European Union if they have not yet been consumed in notable amounts before May 15, 1997. Species such as *Saccharina latissima*, certain *Laminaria spp* and *Porphyra purpurea* are well recognized and do not require further approval. *Palmaria palmate*, however, is labeled “Any other food uses of this product (other than as food supplement) have to be authorised pursuant to the Novel Food Regulation”, given that the European Union views it only as a food supplement.
- Chemical contamination: Generally relates to compounds such as iodine, cadmium and arsenic (inorganic arsenic);
- Natural toxic compounds: Possible natural toxic compounds also should be taken into account; for example, kainic acid in *Palmaria palmata*;
- Labelling and claim: Prepackaged food should be labelled with product information. Statements, logos, pictures, symbols and trademarks that indicate nutritional or health properties about a given product or the effect on one’s health are considered nutritional or health claims;
- Materials that come into contact with foods: In general, the materials that come into contact with food should not release compounds in concentrations that may affect one’s health.

More details on seaweed as a food and its relevant standards are found on the website of the Ministry of Environment and Food of Denmark (MEF, 2016b).

### ***Marketing and trade of seaweed and seaweed products***

#### Exports

Exports of seaweed for human consumption reached a peak in 2012 at 609 tonnes (USD 4.7 million) and, thereafter, steadily declined to 361 tonnes (USD 2.9 million) in 2016 (Table 17).

#### Imports

Records indicate that except for a peak of 191 tonnes in 2014, imports of seaweed for human consumption remained fairly stable in succeeding years. Imports included *nori* sheets for sushi; other dried seaweed; and *wakame* mixed salad. Imports not for human consumption, however, were much higher in comparison, peaking to 6 866 tonnes (USD 1.2 million) in 2013. Between 2014 and 2016, there was some fluctuation, settling at 5 400 tonnes in 2016 (Table 18). The latter imports were mainly used for hydrocolloid extraction.

Imported and exported seaweed were both recorded as ‘seaweed and other algae, fresh, refrigerated, frozen or dried, also grinded’ (i.e. combined nomenclature) until 2011. Microalgae imports into Denmark are included in the figures, albeit as minor contributors.

**Table 17. Denmark: Trade in seaweed, 2012–2016**

|   | 2012       | 2013       | 2014       | 2015       | 2016       |
|---|------------|------------|------------|------------|------------|
| <b>Exports of seaweed for human consumption (HS 121221)</b> |            |            |            |            |            |
| Tonnes  | 609        | 549        | 364        | 364        | 361        |
| USD   | 4 737 000  | 4 575 000  | 3 332 000  | 2 853 000  | 2 880 000  |
| <b>Exports of agar agar (HS 130231)</b>                     |            |            |            |            |            |
| Tonnes  | 1          | 7          | 16         | 27         | 23         |
| USD   | 79 000     | 632 000    | 594 000    | 633 000    | 491 000    |
| <b>Imports of seaweed for human consumption (HS 121221)</b> |            |            |            |            |            |
| Tonnes  | 145        | 117        | 191        | 184        | 175        |
| USD   | 1 767 000  | 2 207 000  | 1 963 000  | 1 632 000  | 1 760 000  |
| <b>Imports of carrageenan (HS 130239)</b>                   |            |            |            |            |            |
| Tonnes  | 4 647      | 5 198      | 4 714      | 5 601      | 5 009      |
| USD   | 52 262 000 | 57 970 000 | 59 974 000 | 62 750 000 | 48 360 000 |
| <b>Imports of agar agar (HS 130231)</b>                     |            |            |            |            |            |
| Tonnes  | 126        | 106        | 88         | 95         | 119        |
| USD   | 3 277 000  | 3 288 000  | 2 784 000  | 2 644 000  | 3 350 000  |

Source: Eurostat.

**Table 18. Denmark: Imports of seaweed not fit for human consumption (HS 121229), 2012–2016**

|                                    | Weight in tonnes |               |               |               |              |
|------------------------------------|------------------|---------------|---------------|---------------|--------------|
|                                    | 2012             | 2013          | 2014          | 2015          | 2016         |
| Tanzania                           | 2 881            | 2 652         | 1 794         | 2 658         | 1 883        |
| Indonesia                          | 878              | 1 278         | 722           | 1 152         | 1 581        |
| Chile                              | 1 376            | 1 679         | 1 755         | 1 820         | 1 459        |
| Canada                             | 862              | 703           | 769           | 167           | 191          |
| Netherlands                        | 20               | 11            | 48            | 108           | 73           |
| Norway                             | 25               | 40            | 46            | 26            | 57           |
| Italy                              | 0                | 0             | 2             | 8             | 50           |
| Lithuania                          | 0                | 0             | 1             | 0             | 29           |
| Philippines                        | 36               | 18            | 0             | 0             | 26           |
| Morocco                            | 0                | 237           | 283           | 123           | 26           |
| <b>Total weight (tonnes)</b>       | <b>6 924</b>     | <b>6 866</b>  | <b>5 533</b>  | <b>6 244</b>  | <b>5 401</b> |
| <b>Total value (USD thousands)</b> | <b>10 205</b>    | <b>12 197</b> | <b>11 708</b> | <b>10 308</b> | <b>6 400</b> |

Source: Eurostat.

### Domestic demand

The per capita consumption of seaweed in 2015 was estimated at 34.2 grams per annum (Statistics Denmark, 2016). Seaweed has received considerable attention from the media and is promoted as a healthy, sustainable ‘super’ food, substantiated by a Michelin-star restaurant. In addition, the sushi ‘wave’ has found ground in Denmark and, for this reason, seaweed has become popular on the menu or to be eaten by most Danes. This is due to the *nori* sheets that are wrapped around the rice and the *wakame* salad side dish that can be purchased or taken away at sushi restaurants and outlets, let alone sold frozen or fresh at fish stores. Several cookbooks in Denmark relating to seaweed have been launched or

are in the process of production. Nevertheless, seaweed has yet to find its way into normal, everyday or traditional Danish cooking.

## **2.3 AFRICA**

### **2.3.1 South Africa**

South Africa extends from the Orange River and the Mtamvuna River. It includes the coasts of the Northern Cape, Western Cape and Eastern Cape provinces. Overall, the area encompasses 23 individual seaweed concession areas (Seaweed Rights Area – SRA).

South Africa is believed to have a commercial seaweed industry that dates back to the 1950s that includes the collection of beach-cast materials and the cutting of living kelps for export, as well as the production of agar (jelly), alginate, powdered kelp, fish feed, plant growth stimulants and soil conditioners. To date, seaweed resources are considered under-exploited.

South Africa's wild seaweed industry is believed to be well protected under its Marine Living Resources Act, 1998, and the functional concessional protocols in place. For instance, the management and regulatory structure of the annual Recreational Fishing Permit allows individuals access to 10 kg a day of fresh seaweed. Permits are purchased from any local post office and the collection of fees is periodically monitored by fishery officers during beach patrol.

In 2010, approximately 7 602 tonnes (wet weight) of mixed seaweed species were collected from the wild and 2 015 tonnes (wet weight) were harvested from aquaculture systems (DAFF, 2011). There are indications, however, that cultured output could overtake wild harvests over time. This will implicate the country's abalone (*Haliotis midae*) industry which uses almost all collected and harvested seaweed as fresh feed material. In fact, the industry invests millions of rand, annually, in equipment, government dialogue and research in order to farm seaweed for use as natural feed for stocks.

Only a small amount of seaweed in South Africa goes towards human consumption and therefore, there is no relative subsistence or commercial seaweed fishery farming. There is, nevertheless, substantial evidence of a growing cottage industry that utilizes fishing permits within a recreational fishery context to collect beach-cast and forage for seaweeds for the preparation of various meals and drinks that are consumed locally. Some culinary delights made with seaweed range from soft seaweed couscous salad starters to *nori* chips and sustainable seaweed sushi, kelp lasagna main courses and kelp candy or kelp-cocoa ice cream deserts, as well as seaweed cocktails and beer. There also are some food businesses and restaurants (e.g. Cape Farmhouse and SexyFood South Africa) that forage for ingredients for their Fresh from the Sea range of dishes.



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As previously mentioned, the farming of seaweed for direct human consumption does not take place on a significant scale in South Africa in comparison to other countries in the region (e.g. Tanzania's Seaweed Community Cluster Initiative in Zanzibar). Improving an understanding and awareness of the use of seaweed in human nutrition within the country cannot be over-emphasized to stimulate the improved management of resources at sustainable levels when facilitating commercial development and promoting socio-economic benefits, such as nutritional security and poverty reduction.

### ***Main commercial seaweed species***

Around 900 species of seaweed were identified in 2012 within South Africa's concession and seaweed management areas, demonstrating the richness and diversity of its coastal marine flora. Of this flora, only 12 species, belonging to six genera, are understood to be commercially exploited, such as *Ecklonia* and, to a lesser extent, *Laminaria*, *Gracilaria*, *Gelidium*, *Gigartina* and *Porphyra*. Positive steps are being taken in the industry to cultivate the more favoured species within a more controlled and disease-free environment. For instance, aquaculture establishments focus primarily on the production of *Ulva* and *Gracilaria* spp. for use as feed in abalone farms and salt production. These two species, together with four others, are common seaweed species collected from shoreline habitats and beach-cast materials, and are used for direct human consumption within the recreational industry of South Africa.

Within this group, *Ulva*, *Porphyra*, and *Laminaria* are mostly consumed for their pleasant flavor. They are also adaptable in a variety of meal presentations.

### Farmed seaweed

Aquaculture sites for the production of seaweed in South Africa are located in proximity to the land-based abalone farming sector (e.g HagaHaga in the Eastern Cape). Seaweed species, such as *Ulva* and *Gracilaria*, are grown in ponds and raceways with aeration systems such as paddle wheels.



South Africa: Seaweed aquaculture production system.  
© Anderson and Rothman, 2013

Aquaculture production data are not protected, given the commerciality and competitive nature of the industry. In 2013, approximately 2 015 tonnes (wet weight) of *Ulva* were harvested for use as abalone feed. No data, however, were available with regard to the annual production and use of *Gracilaria* seaweed.

### Harvested from the wild

Seaweed collection on a commercial scale from the wild is recorded according to its use as feed in abalone farming or for use in the production of plant growth stimulants. In 2011, approximately 6 000 tonnes (wet weight) of *Ecklonia* (kelp) were harvested for use as abalone feed (Amosu *et al.*, 2013; Anderson & Rothman, 2013). A similar volume of kelp is believed to be harvested annually for use in the production of plant growth stimulants (Anderson & Rothman, 2013).



*Ecklonia maxima* (kelp) being harvested by boat.  
© Anderson & Rothman, 2013

## Processing

Raw (or minimally processed) seaweed contributes indirectly to the production and nutrient content of food for human consumption through its use in the industrial production of plant growth stimulants and as feed for the abalone industry. Value is added when the wet seaweed is collected and exported for the extraction of colloidal chemicals (e.g. gums, agar, carrageenan, salts and other food supplements) that are used in food production. This has implications for international trade.

## Marketing and trade of seaweed and seaweed products

Production and trade data are not available for *Porphyra spp*, *Plocamium corallorhiza* and *Laminaria pallid*, indicative perhaps of the historical and current low levels of commercial interest or value. Understandably, the scale of South African exports of seaweed is governed by the economic viability of the trade. From 2012 to 2016, the export volume of seaweed did not exceed 2 000 tonnes annually, peaking in 2013 and settling to 1 498 tonnes (USD 2.4 million) in 2016 (Table 19). Fresh kelp is processed locally into plant growth stimulants that are then exported to over 30 countries.

**Table 19. South Africa: Export of seaweed, 2012–2016**

|                                   |                      | 2012         | 2013         | 2014         | 2015         | 2016         |
|-----------------------------------|----------------------|--------------|--------------|--------------|--------------|--------------|
| Edible seaweed<br>(HS 121221)     | Tonnes               | 269          | 290          | 1 050        | 731          | 1 299        |
|                                   | USD thousands        | 670          | 649          | 1 357        | 1 064        | 1 690        |
| Non-edible seaweed<br>(HS 121229) | Tonnes               | 1 130        | 1 379        | 800          | 537          | 134          |
|                                   | USD thousands        | 937          | 1 144        | 1 000        | 567          | 402          |
| Carrageenan<br>(HS 130239)        | Tonnes               | 236          | 325          | 120          | 99           | 65           |
|                                   | USD thousands        | 1 290        | 1 808        | 603          | 354          | 265          |
| <b>Total weight</b>               | <b>Tonnes</b>        | <b>1 635</b> | <b>1 994</b> | <b>1 970</b> | <b>1 367</b> | <b>1 498</b> |
| <b>Total value</b>                | <b>USD thousands</b> | <b>2 897</b> | <b>3 601</b> | <b>2 060</b> | <b>1 985</b> | <b>2 357</b> |

Source: South African Revenue Service.



© Anderson & Rothman, 2013



The trade of freshly harvested *Ecklonia* for local use in abalone feed is valued at over ZAR 8 million per annum. On the other hand, *Gracilaria spp* – which are usually processed by simple drying – have a high content of the compounds needed to manufacture agar and gum as a thickener. Market prices, however, often are too low to support a commercial business.

Certain seaweed products – many from China, Japan and the Republic of Korea – are imported into South Africa for direct human consumption and are regularly available in various population clusters such as cities, hospitals and business offices. Imported seaweed products (e.g. Sea’s Gift, a Korean seaweed snack (*kim nori*); Mineralife’s Daily Multiple - Liquid Wholefood Multivitamin drink; Leafy Greens Nori Wands) also are available in the automated vending sector. Furthermore, seaweed snacks can be purchased online from websites such as [www.healthisland.co.za/seaweed-snack/](http://www.healthisland.co.za/seaweed-snack/). The actual trade data is not available due to commercial confidentiality. Official data also are unavailable for the small amounts consumed in specialized eateries such as Cape Farmhouse and SexyFood, where the consumption of seaweed (*Ulva*, *Porphyra*, *Gracilaria*, *Laminaria*, and *Ecklonia*) occurs on a national scale.

Overall, therefore, the dominant production and trade of seaweed in South Africa is recognized within the industrial and commercial sectors of abalone and plant growth stimulants. Less known and documented, however, are the production and export trade statistics of dried seaweed for extraction and further processing and – less so – the production, trade and consumption of seaweed in human food. A significantly positive scenario is that the import of seaweed products is regulated according to commodity policy, although volume and value remain undisclosed based on the vulnerability originating from market competition.

### **2.3.2 Zanzibar (Tanzania)**

Of the countries in the continent, Zanzibar(Tanzania) is second to South Africa in terms of seaweed culture and, between 2005 and 2015, the region has been included in the top ten countries listed as seaweed producers (Annex 5). During its peak, seaweed farming contributed about USD 8 million annually to Zanzibar’s economy and, in terms of value to the national economy, seaweed comes third following tourism and clove. Seaweed from Zanzibar is exported to China, Denmark, France, the Republic of Korea, Spain, Vietnam and the United States of America.

Currently, however, the industry struggles to remain a major player. Large swathes of seaweed are dying, attributed by researchers to high temperature conditions as a result of climate change. Deeper water culture is one solution, although about 90 percent of Zanzibar’s seaweed farmers are women and they traditionally do not swim.

Several remedial initiatives are being promoted by the regional Zanzibar government and various organizations. One company, funded by the Swedish-based Rylander Foundation, established the Seaweed Center in 2011 in the village of Paje on the southeastern coast of Unguja. Here, a team of women make high-quality value-added products such as seaweed powder soap, body oils, shampoos and spice for cakes. Meanwhile, other women are encouraged to farm seaweed in deeper waters with the use of a floating line system.

### 2.3.3 Morocco

Morocco is the world's fifth largest exporter of agar agar following Chile, China, Indonesia and Spain. Between 2012 and 2016, the annual export volume of agar agar has ranged from 905 tonnes to 1 066 tonnes (Annex 15), with the major markets in 2016 being Japan (240 tonnes) and the United States of America (184 tonnes) (Annexes 22c, 21a, 21b and 21c, respectively). Morocco also imports a small quantity of agar agar (171 tonnes in 2016) (Annex 19).

The source of agar is mainly *Gelidium sp* which grows in the wild, Strong global demand for high-grade agar, however, has resulted in its over-exploitation. Agar is particularly sought after by research institutions, where it is used to culture microbes, and by communities with religious exclusions (Jews, Muslims, Hindus) and vegetarians as a food thickener in place of gelatin (usually from animal sources).

In the 1990s and 2000s, harvesters reported that they were able to collect as much as 500 kg of the seaweed (which they referred to as 'red gold') a day; however, when the total volume collected rose to 14 000 tonnes in 2009, Morocco's marine research institute (Institut National de Recherche Halieutique) raised the alarm. In 2010, the Government of Morocco implemented emergency measures to revive stocks. By the following year, there were signs of a small revival.

In addition to seasonal bans and an annual harvest cap of 6 040 tonnes, the Moroccan government is collaborating in a new initiative, Blue Belt, a project with several African nations working together with FAO and other partners. Initiative objectives include a review of coastal surveillance; and sustainable fishing and aquaculture, particularly in terms of seaweed farming. The Blue Belt initiative also will reinforce the country's Halieutis 2020 strategy, implemented in 2009 to strengthen the Moroccan fishery sector's development and competitiveness.

## 2.4 SOUTH AMERICA

### 2.4.1 Chile

There are more than 157 marine resources commercially harvested along the coast of Chile, of which 16 species are seaweed constituting 11.3 percent of Chile's total fisheries production. In 2014, seaweed output amounted to 413 141 tonnes, positioning Chile as the top producer of algal commodities in South America. While the sectors of salmon aquaculture and anchovy/sardine fishery – the major marine products of Chile – have benefitted from significant investments, the production of seaweed essentially is carried out by local fishers.

Macroalgae production in the country has always been highly extractive. In the 1980s, for example, Chile reported seaweed landings of below 200 000 tonnes, all of which were harvested from natural beds (Sernap, 1990), a scenario that continues today. Less than 5 percent of total output in 2014 (Sernapesca, 2015) originated from the aquaculture of *Gracilaria*, which is the only species that has reached commercial level (12 808 tonnes). A few tonnes have been recorded for *Macrocystis pyrifera*, corresponding to pilot/pre-commercial experiences by companies interested in the giant kelp for either

abalone foraging, biofuel trials or as food to a limited extent. Some 3 percent of total production in that year originated from management areas (i.e. delimited marine areas where only fishers from that area can administer, and therefore collect, the biomass of certain resources (seaweed among them)). The remaining biomass corresponded to free access areas, where local fishers listed in the Registry of Artisanal Fisheries are able to collect available seaweed.

The need to increase production levels to meet the growing demand for algal commodities and processed products has led to the Government of Chile designating aquaculture-based systems as a top priority. Currently, at least 15 species are being farmed on an experimental basis, while three species have reached commercial maturity. The sector, however, is a long way from overall profitability, and it depends on many factors, such as production costs, availability of natural beds and market factors.

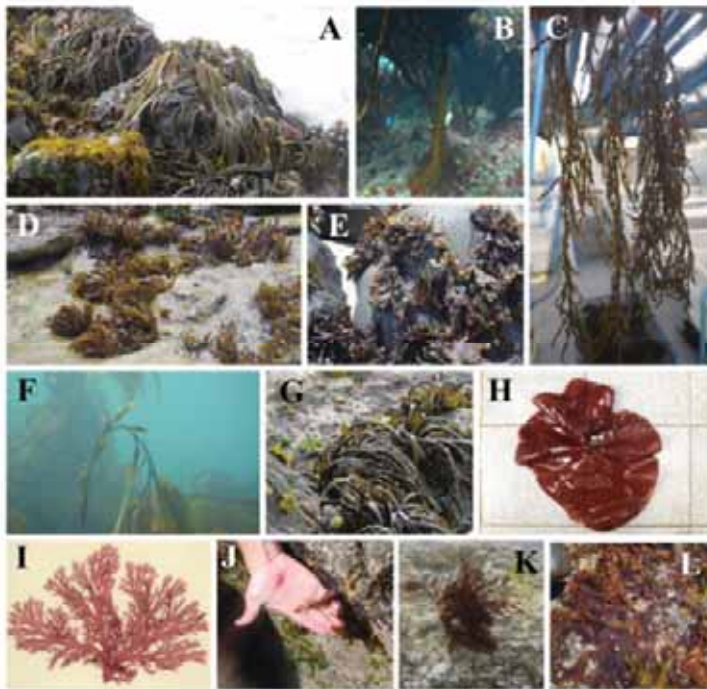
### ***Main commercial seaweed species***

*Durvillaea antarctica* (bull kelp, or *cochayuyo* in Spanish) and *Porphyra* (purple laver, or *luche* in Spanish) are the two seaweed species most commonly found at Chilean national markets for direct consumption. They grow along the entire Chilean shoreline in the high intertidal area (usually in the spray zone), occurring either on large rocks or boulders. They can be found in coastal markets, sold by local fishers, and in grocery and supermarket chains in inland cities and towns. *Durvillaea antarctica* landings surpassed 8 000 tonnes in 2014, a sharp rise of more than 400 percent in the past ten years. *Porphyra* landings, on the other hand, were only 132 tonnes in the same year which, nevertheless, was an increase of almost ten times in comparison to 2004. *Durvillaea antarctica* and *porphyra* fisheries are located mostly in Central Chile where approximately 75 percent of total landings originate.

Of the red algae, two species belonging to the *Gigartinales* family (and therefore valuable carragenophytes) are consumed primarily abroad as seasoning in Asian dishes.

*Chondracanthus chamissoi* is found in intertidal and subtidal environments along Peru and Chile (from northern Chile to Chiloé Island). This species has been harvested regularly over the last ten years, especially in Chilean Region III and Region VIII with 2 715 tonnes in 2014. It is the second most produced alga for human consumption in Chile, although this trend is declining.

*Callophyllis variegata* inhabits Chilean subtidals (up to 12 miles) along the entire coastline. Its production was very promising 15 years ago, with a growth rate of 300 percent annually (84 tonnes in 1999) (Sernapesca, 2006); however, following 2000, volume fell to only a few tonnes. Landings of *Callophyllis variegata* now do not exceed 1 tonne per annum.



A: *Durvillaea antarctica*. B: *Lessonia trabeculata*. C: *Gracilaria chilensis*. D: *Mazzaella laminarioides*. E: *Porphyra* sp. F: *Macrocystis pyrifera*. G: *Lessonia nigrescens*. H: *Gigartina skottsbergii*. I: *Callophyllis variegata*. J: *Chondracanthus chamissoi*. K: *Gelidium* sp. L: *Sarcothalia crispata*.  
 © R. Westermeier (Images A-H; L) & M.E. Ramirez (Images I-K)

The most important carragenophytes commercially exploited in Chile are red algae belonging to the *Gigartineae* family: (i) *Gigartina skottsbergii* (*luga roja* in Spanish), (ii) *Sarcothalia crispata* (*luga negra* in Spanish) and (iii) *Mazzaella laminarioides* (*luga cuchara* in Spanish). These are valuable resources, rich in Kappa II and Lambda carrageenan. *Gigartina skottsbergii* is a subtidal species (~12 miles), occurring in Chile from Niebla (40°S) to Cabo de Hornos. Previously collected in Region X and Region XI, it is now mostly harvested in Region XII (15 000 tonnes, equivalent to 55 percent of national production).

Because *Gigartina skottsbergii* began to reflect symptoms of an over-exploited species, its biomass is currently regulated by an area rotation system, with a ban imposed during the reproductive months (May to September). For a long period, *Gigartina skottsbergii* has been the key carragenophyte species exploited in Chile, and its decreasing yield has forced the industry to consider new alternatives to obtain carrageenan, such as *Sarcothalia crispata* and *Mazzaella laminarioides*.

*Sarcothalia crispata*, on the one hand, is an endemic species that occurs in subtidal areas from Valparaiso (33°S) to the Strait of Magellan (54°S) in Central and Southern Chile, respectively. It coexists with the giant kelp, *Macrocystis pyrifera*, *Gigartina skottsbergii* and the crust red alga, *Mesophyllum* sp. Currently, it is the most harvested carragenophyte

in Chile (34 600 tonnes), mostly extracted in Region X. *M. laminarioides*, on the other hand, is an intertidal red alga that does not exceed 5 000 tonnes per annum. Its biomass is mainly extracted from Region X (60 percent).

Agarophytes, such as *Gracilaria chilensis* and *Gelidium spp.*, also are produced on a commercial scale in Chile, used mainly as a source of agar. *Gracilaria chilensis*, known as *pelillo* or *lamella* in Spanish, is a floridophycean red alga in sheltered environments that attaches itself either to sandy and rocky substrata in the intertidal or is found in subtidal zones. *Gracilaria chilensis* is the third most farmed seaweed in the country, with landings above 45 000 tonnes in 2014, mostly in Region X. Its current production, however, is much lower in comparison with the output in the 1980s when landings easily reached 100 000 tonnes (Sernap, 1986). The dramatic drop is attributed to over-exploitation plus the appearance of new competitors for Chilean *Gracilaria* commodities.

Nevertheless, *Gracilaria chilensis* is today the most important seaweed crop cultivated in Chile, making up almost 100 percent of total biomass obtained through aquaculture. Another significant factor regarding the production of *Gracilaria chilensis* is that it is mainly planted and harvested by local fishers.

*Gelidium spp.* (*chasca* in Spanish) is especially important as a source of agar for microbiological purposes. They are collected by fishers, especially in Central Chile, from wave-exposed rocks. *Gelidium spp.* landings have varied in the last ten years between 135 tonnes and 700 tonnes per annum.

The important alginophytes in Chile include the kelp species, *Lessonia nigrescens*, *Lessonia trabeculata* and *Macrocystis pyrifera*. *Lessonia nigrescens* (*huiró negro* or *chascón* in Spanish), from the *Lessoniaceae* family, can be found in the intertidal zone, growing on rocky platforms in wave-exposed habitats (sometimes forming belts with *Durvillaea antarctica*). *Lessonia nigrescens* complex is the most produced seaweed in Chile (430 000 tonnes), and over 90 percent of its exploitation occurs in the northern regions where factors such as weather and accessibility favour subsequent processing. *Lessonia trabeculata* (*huiró palo* in Spanish) and *Macrocystis pyrifera* (*huiró* in Spanish) are found along the entire Chilean coast. *Lessonia trabeculata* and *Macrocystis pyrifera* (the latter also from the *Lessoniaceae* family) are also key seaweeds for northern Chile, with landings of 60 000 tonnes and 25 000 tonnes, respectively.



A: Pilot culture of *Macrocystis pyrifera* in Dalcahue, Chiloé Island. B: Commercial facility of *Gracilaria chilensis* at Pelluhuin.

© R. Westermeier

## Processing

After collecting from the wild, the fishers may apply simple processing methods and sell the seaweed to middlemen or directly to processing companies that add value to the products. A significant amount of the seaweed is exported.



A: Sundried luga roja (*Gigartina skottsbergii*) for carrageenan manufacturing in Faro Corona, Chiloé Island. B: Fresh giant kelp (*M. pyrifera*) bound for abalone facilities at Bahía Chasco, Atacama coast. C: Packages of dried *Lessonia trabeculata* to be sent to kelp processors in Bahía Salado, Atacama. D: Harvesting of subtidal *Gracilaria chilensis* by local fishermen at Maullín.  
© R. Westermeier (Images B - D)

*Lessonia trabeculata* is either used for haliotid foraging (blades) and alginate production (stipes). *Macrocystis* is mostly restricted for abalone feeding, although there are records regarding its processing for human consumption.

## Marketing and trade of seaweeds and seaweed products

The first trade of harvested seaweed is made between the local fishers/aquaculturers and middlemen, paid in the so-called ‘price on the beach’ rate which corresponds to the value of the seaweed, either fresh or with minimum processing (usually only air dried for some days). Price levels are highly variable, regionally and even monthly, depending on the availability of the seaweed and buying power (both are regularly correlated). According to data reported by Sernapesca (2015), higher prices are usually seen for *Porphyra* spp. (USD 1 927 per tonne) and *Durvillaea antarctica* (USD 1 718 per tonne), since a significant part of the landings is processed almost immediately after harvesting and sold on the local market. The prices for algal raw material typically range from USD 81 and USD 646 per tonne, with the exception of *Gelidium* spp. (USD 1 540 per tonne) which is

small in size and hence difficult to harvest, in addition to its value due to its particular agar composition.

### Exports

Seaweed products that have undergone some degree of processing and are of export quality sell at higher prices ( Table 20). Prices for processed (dehydrated) commodities range from USD 1 305 to USD 4 472 per tonne (IFOP, 2015), often increasing up to more than ten times as in the case of *Macrocystis*. This improvement also relates to water loss which, in certain algae, easily makes up to 90 percent of the fresh composition.

**Table 20. Chile: Exports of seaweeds, 2013–2016**

|                    | Weight in tonnes; value in USD thousands |                |               |                |               |                |
|--------------------|--|----------------|---------------|----------------|---------------|----------------|
|                    | 2014                                     |                | 2015          |                | 2016          |                |
|                    | Weight                                   | Value          | Weight        | Value          | Weight        | Value          |
| Edible seaweed     | 3 522                                    | 8 663          | 1 107         | 4 162          | 748           | 4 617          |
| Non-edible Seaweed | 71 152                                   | 134 188        | 67 052        | 96 563         | 75 170        | 103 281        |
| Agar agar          | 1 780                                    | 48 754         | 1 825         | 48 790         | 1 562         | 39 030         |
| Carrageenan        | 4 811                                    | 72 475         | 5 254         | 73 548         | 5 002         | 59 622         |
| <b>Total</b>       | <b>81 265</b>                            | <b>264 080</b> | <b>75 238</b> | <b>223 063</b> | <b>82 482</b> | <b>206 550</b> |

Source: National Customs Service (Servicio Nacional de Aduana).

As products meant for human consumption undergo a laborious, strictly-regulated food manufacturing process, their overall prices rise accordingly. There are a few exceptions, however. *Lessonia* for human consumption was the only product in 2014 that was about the same price as its dehydrated counterpart, according to the Chilean Institute for Fishery Development. The rest that was traded in that year for human consumption reached prices between USD 3 000 and USD 5 000 per tonne; the highest level was seen for *C. chamissoi*, with values of over USD 28 000 per tonne (IFOP, 2015).

Export volumes and values of carrageenan from 2011 to 2016 are listed in Annex 12. New purchasing countries appear every year, not only for the top Chilean algal goods such as carrageenan, agar and dehydrated *Lessonia* (not for human consumption) but also for products for human consumption, the volumes of which are much smaller by comparison. The top dehydrated products in 2014 were *Lessonia spp.* (60 000 tonnes), followed by *M. pyrifera*, *Durvillaea antactica* and *G. skotsbergii* (2 100 –3 300 tonnes). The main hydrocolloids were carrageenan and agars (4 781 and 1 780 tonnes, respectively), and alginates (43–264 tonnes); these were in fact, the main goods of value marketed through commercial networks in more than 50 countries. Whereas agar is mostly exported to Japan (53 percent), 60 percent of the carrageenan is sold to Denmark and the United States of America. In comparison, alginate exports are lower (USD 5 million FOB per annum), with the main destination being Japan.

In the same period, dehydrated seaweeds were the second most exported product by Chile, and their uses overseas are likely to be for hydrocolloid extraction rather than for food manufacturing. The main dehydrated product was *Lessonia spp.*, with an average annual FOB export value of over USD 83 000 000 during the 2013–2015 period, 80 percent of which was shipped to China. Other important markets for dehydrated Chilean seaweeds

in that period were Canada, Denmark, France, Japan and Norway which, altogether, amounted to 33 percent of total sales.

### Imports

Chile imports some algal products, not only for colloid processing (species such as *Euchema* and *Kappaphycus*) but also for food products like *nori*, used primarily in Asian restaurants all around the country. According to 2016 FAO data (unpublished), imports of seaweed for food totalled 3 993 tonnes in 2013. Conversely, imports of algae for other purposes decreased slightly in the same period, suggesting that trade in hydrocolloid is more or less stable.

### Domestic demand

Seaweed has been used as food in Chile since the first human settlements at Monteverde in the south of the country, approximately 14 000 years ago. The tradition spread gradually from the aboriginal people, particularly in coastal communities, into the cuisine of the Spanish colonists because of the easy transportation and preservation of seaweed, as well as the fact that it was a less expensive substitute for meat in periods of poverty during the nineteenth and early twentieth centuries. *Durvillaea antarctica* and *Porphyra spp.* can now be found in different varieties of salads and soups, especially in Southern Chile around Chiloé island. Some of these seaweeds are also exported for similar purposes.



A: *Porphyra* spp. (*luche* in Spanish) and lamb cazuela (soup).

B: *Durvillaea antarctica* (*cochayuyo* in Spanish) salad.



In Chile, *Porphyra* spp. harvesting is mostly performed by women in the south. The fronds are sundried and, if destined for market, the seaweed are usually pre-heated in cooking pots, moulded in wooden structures and/or undergo a smoking/drying process with the help of wood stoves. The final product is a ‘pressed bread’ that is sold in coastal local markets. The handling of *Durvillaea antarctica* is, on the other hand, typically carried out by men: the biomass is sundried and manually packaged using plastic cords. The product is sold in local coastal markets and basically consists of tied, dehydrated algal bunches. Sometimes, the biomass is bought fresh by

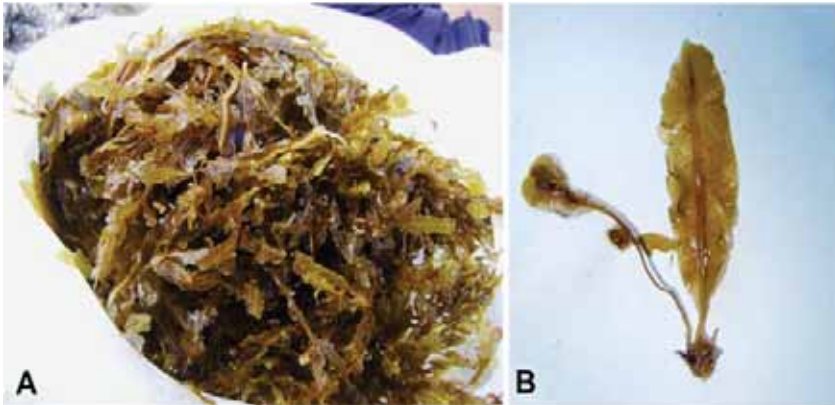
middlemen and sold to small processing facilities which inspect, chop and dry the seaweed according to buyer requirements, package it and re-sell it to local stores such as supermarkets.





Chilean seaweed products in local markets  
(A: Luche 'bread'; B: tied cochayuyo).  
© F. Küpper

Another example of a Chilean seaweed used for human consumption is *Dyctiopteris* sp. (*Auke* in Spanish). This brown algae has been harvested by locals on Easter Island for centuries, where it remains part of the local cuisine and therefore is valuable. There are neither records of their landing nor of their abundance around the island, although verbal communication from inhabitants strongly suggests that its stocks are seriously endangered (Ramírez, personal communication).



*Auke* harvested on Easter Island (A: Full bag collected by a local Islander. B: Morphology of *Dyctiopteris* sp.)  
© M.E. Ramirez

As mentioned previously, local consumption is relatively negligible in comparison to export. The most significant raw material is *Lessonia* spp., an excellent source of alginate. In addition, agar and carrageenan are produced in vast amounts in the country, using *Gracilaria chilensis* and *Gigartina/Sarcothalia* species, respectively. Several initiatives have been funded, essentially by the Chilean government, in order to expand the current use of macroalgae and, thus, the commercial opportunities for companies and local fishermen. Many of these initiatives have shown promising results, despite some having been unprofitable or technically unfeasible in Chile's current economic and/or ecological context.

### 3. MARKETING AND TRADE

In 2016, an estimated 1 million tonnes (product weight) of seaweed (dried and processed) were exported at an estimated value of USD 4 billion. These were imported by almost 100 markets worldwide, with Asia, Europe and North America being the main destinations for the trade.

An analysis of available published data indicates that the top 35 countries represented nearly 80 percent of global seaweed trade in 2016. Together, they imported nearly 650 000 tonnes (product weight) of dried seaweed, carrageenan and agar agar in that year, at a customs declared value of USD 2 billion (Table 21, Annexes 16a and 16b). This volume also represents 70 percent of the global production of farmed seaweed. It therefore comes as no surprise that aquaculture production of seaweed has almost doubled from 14 million tonnes in 2006 to close to 30 million tonnes in 2015, credited to its expanding usage and worldwide trade.

The top four import markets were China, the European Union, Japan and the United States of America (Table 22).

**Table 21. Seaweed imports into the top thirty-five countries, 2013–2016**

|                    | Weight in tonnes; value in USD thousands |                  |                |                  |                |                  |
|--------------------|--|------------------|----------------|------------------|----------------|------------------|
|                    | 2014                                     |                  | 2015           |                  | 2016           |                  |
|                    | Weight                                   | Value            | Weight         | Value            | Weight         | Value            |
| Edible seaweed     | 247 527                                  | 692 978          | 251 709        | 633 915          | 250 735        | 648 719          |
| Non-edible seaweed | 244 514                                  | 348 059          | 244 777        | 271 209          | 245 381        | 269 473          |
| Carrageenan        | 115 467                                  | 913 486          | 111 852        | 891 776          | 110 555        | 759 844          |
| Agar agar          | 11 738                                   | 243 316          | 11 771         | 231 958          | 12 052         | 225 624          |
| <b>Total</b>       | <b>619 246</b>                           | <b>2 197 839</b> | <b>620 109</b> | <b>2 028 858</b> | <b>618 723</b> | <b>1 903 660</b> |

Source: Various sources of sources of national statistics.

The most dynamic import market is for hydrocolloid products which are traded and used widely in many countries for various applications. Dried seaweed trade for further processing, mostly for the production of agar agar, alginate and carrageenan, is dominated by developing countries as the main suppliers. Meanwhile, the trade for edible seaweed (fit for human consumption) is almost exclusively conducted in countries in the Far East, namely China, Japan, the Republic of Korea and Taiwan Province of China.

Of the total seaweed imported on the global market in 2016, 50 percent comprised dried seaweed, with edible and non-edible forms having equal share in the trade. The import demand for edible dried seaweed meant for direct consumption (e.g. *wakame*, *nori*) was stable from East Asian markets, namely Japan, the Republic of Korea Rep and Taiwan Province of China. The global trade for non-edible seaweed, however, is showing a declining trend because of its increased utilization into semi-processed and processed forms in the producing countries themselves.

Notably, China has emerged as the largest importer of edible and non-edible seaweed for further processing, influencing international market prices for dried seaweed. The European Union and the United States of America also continue to be the major markets

for dried seaweed, particularly non-edible raw materials for further processing into carrageenan and other products meant for industrial usage (Table 22). However, since China has become a major centre for reprocessing – and other developing countries such as the Philippines and Indonesia have begun developing their own agar and carrageenan processing industries – imports of dried seaweed (raw material) into traditional markets in Europe have declined.

**Table 22. Top four importers of dried seaweed and hydrocolloid products, 2014–2016**

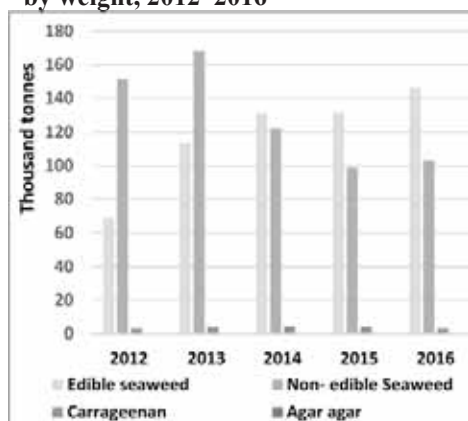
|                          | Weight in tonnes; Value in USD |                  |                |                  |                |                  |
|--------------------------|--------------------------------|------------------|----------------|------------------|----------------|------------------|
|                          | 2014                           |                  | 2015           |                  | 2016           |                  |
|                          | Weight                         | Value            | Weight         | Value            | Weight         | Value            |
| China                    | 257 959                        | 377 389          | 234 424        | 250 727          | 252 683        | 255 775          |
| European Union           | 154 924                        | 725 090          | 167 170        | 688 326          | 178 467        | 613 162          |
| Japan                    | 51 880                         | 296 750          | 48 705         | 272 589          | 49 718         | 312 749          |
| United States of America | 38 102                         | 256 442          | 38 278         | 253 227          | 40 861         | 209 143          |
| <b>Total</b>             | <b>502 865</b>                 | <b>1 655 671</b> | <b>488 577</b> | <b>1 464 869</b> | <b>521 729</b> | <b>1 390 829</b> |

Source: Relevant National Statistics.

### 3.1 CHINA

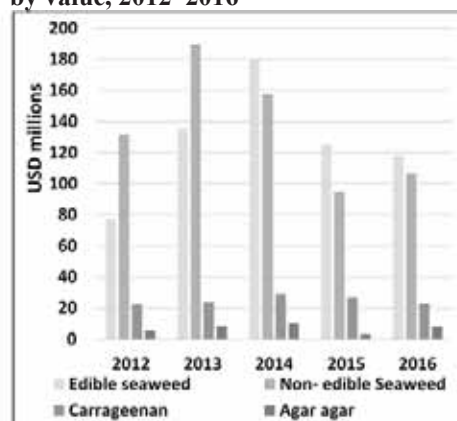
China is now the largest and most important partner in the international seaweed trade, particularly in terms of volume. During the last decade, China also emerged as the leading re-processor of hydrocolloid products processed from edible and non-edible seaweed. Imports of dried raw material reached 250 000 tonnes in 2016, 20 percent higher than the volume in 2012 (Figure 9 and Figure 10). While nearly 90 percent of edible dried seaweed imports came from Indonesia, Chile and Peru were the top suppliers of the non-edible type (Annexes 9a and 9b). Because of its dominance in the industry, China has become a price setter for trade in dried seaweed.

**Figure 9. China: Imports of seaweed, by weight, 2012–2016**



Source: China Customs.

**Figure 10. China: Imports of seaweed, by value, 2012–2016**



### 3.2 EUROPEAN UNION

The European Union is the second largest import market in terms of volume for seaweed, having bought nearly 180 000 tonnes of seaweed products in 2016, valued at USD 613 million. This makes the European Union the world's top seaweed import market in terms of value.

In terms of quantitative imports, non-edible dried seaweed ranked number one in 2016, with increased supplies into the European Union. The top importers were Denmark, Germany, Portugal and Spain. The same trend was seen for carrageenan, which also recorded the highest import value at USD 400 million in 2016. The main importing countries for this product were Belgium, Denmark, France, Germany, Spain and the United Kingdom.

In total, the European Union imported USD 613 million worth of dried seaweed, carrageenan and agar in 2016, slightly lower than in 2012 (Table 23). However, the volume increased by 31 percent during the 2012–2016 period as a result of more imports of SRC. For agar agar, France, Germany, Poland and Spain were the leading importing countries in the European Union.

It should be highlighted that the European Union is also an important reprocessing and re-export area, particularly for carrageenan and high quality agar agar. Intra- and extra-European Union seaweed exports were over 100 000 tonnes in 2016, the bulk of which comprised high quality processed seaweed (see Annexes 23a, 23b, 23c and 23d).

**Table 23. European Union: Imports of seaweed, 2014–2016**

|                    | Weight in tonnes; value in USD thousands |                |                |                |                |                |
|--------------------|--|----------------|----------------|----------------|----------------|----------------|
|                    | 2014                                     |                | 2015           |                | 2016           |                |
|                    | Weight                                   | Value          | Weight         | Value          | Weight         | Value          |
| Edible seaweed     | 22 953                                   | 75 813         | 17 175         | 60 726         | 15 184         | 59 662         |
| Non-edible seaweed | 65 310                                   | 74 957         | 89 103         | 79 962         | 88 485         | 69 496         |
| Carrageenan        | 63 302                                   | 493 021        | 57 158         | 474 686        | 70 627         | 400 249        |
| Agar agar          | 3 359                                    | 81 299         | 3 734          | 72 952         | 4 171          | 83 755         |
| <b>Total</b>       | <b>154 924</b>                           | <b>725 090</b> | <b>167 170</b> | <b>688 326</b> | <b>178 467</b> | <b>613 162</b> |

Source: Eurostat.

### 3.3 JAPAN

Traditionally, seaweed is an important item used in Japanese cuisine; hence, one way or another, most of the imports in the country are used for human consumption. Japan is the largest importer of edible seaweed (e.g. Japanese *wakame*, *nori*) for which the average import value is USD 6–7/kg compared with USD 1/kg for products used for reprocessing in Asia or in Europe. Imports generally constitute about 35–40 percent share of the overall seaweed market in Japan. Seaweed such as *Laminaria*, *Porphyra* spp., *hizikia* (Japanese *kombu*, *nori* and *hiziki*, respectively) are all marketed in dried form, while *Undaria* spp (Japanese *wakame*) is marketed in boiled and salted forms.

During the 2012–2016 period, annual imports of seaweed into Japan ranged around 50 000 to 55 000 tonnes, valued at USD 300 million to USD 600 million (Table 24,

Figure 11 and Figure 12). Chile, China and the Republic of Korea have been the key suppliers of edible seaweed to the market (see Annexes 22a-1, 22a-2, 22b, 22c, 22d-1 and 22d-2).

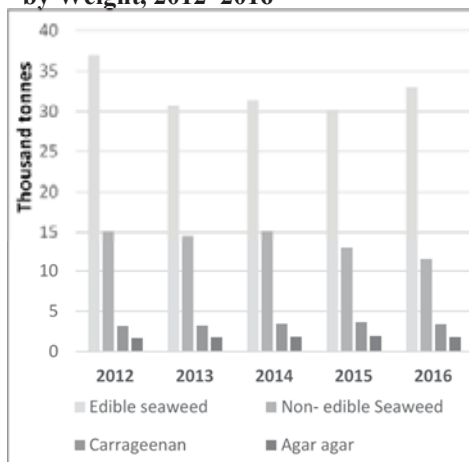
Chile, China, the Republic of Korea and Morocco are the top suppliers of agar, while several Southeast Asian countries, namely Indonesia, the Philippines and Thailand, supplied carrageenan, together with Denmark and the United States of America. The high-quality products originated from the latter two sources.

**Table 24. Japan: Imports of seaweed, 2013–2016**

|                    | Weight in tonnes; value in USD thousands |                |               |                |               |                |               |                |
|--------------------|--|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
|                    | 2013                                     |                | 2014          |                | 2015          |                | 2016          |                |
|                    | Weight                                   | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          |
| Edible seaweed     | 30 776                                   | 177 688        | 31 427        | 179 062        | 30 182        | 164 276        | 32 989        | 210 207        |
| Non-edible seaweed | 14 548                                   | 36 058         | 15 141        | 36 630         | 12 903        | 28 089         | 11 497        | 27 605         |
| Carrageenan        | 3 233                                    | 27 505         | 3 462         | 31 185         | 3 665         | 30 421         | 3 419         | 29 490         |
| Agar agar          | 1 785                                    | 46 519         | 1 850         | 49 873         | 1 955         | 49 803         | 1 813         | 45 447         |
| <b>Total</b>       | <b>50 342</b>                            | <b>287 770</b> | <b>51 880</b> | <b>296 750</b> | <b>48 705</b> | <b>272 589</b> | <b>49 718</b> | <b>312 749</b> |

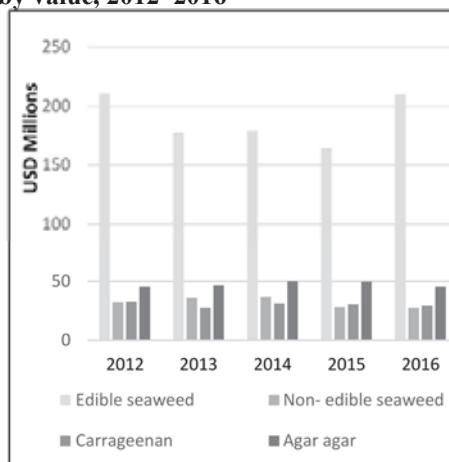
Source: Ministry of Finance, Japan.

**Figure 11. Japan: Imports of seaweed, by Weight, 2012–2016**



Source: Ministry of Finance, Japan.

**Figure 12. Japan: Imports of seaweed, by value, 2012–2016**



### 3.4 UNITED STATES OF AMERICA

The United States of America remains an important outlet for semi-processed and processed seaweed. The reprocessing industry there, however, also imports non-edible seaweed for the manufacture of non-food quality products such as alginic acid (Table 25 and Figures 13 and 14).

Carrageenan is the main component in U.S. seaweed imports. When the United States of America lifted its ban on Philippines Natural Grade (PNG) carrageenan in the late 1980s, imports of the product doubled within a few years, to approximately 10 000 tonnes annually. It has remained at that level in recent years, possibly indicating market saturation. Over the years, Chile and the Philippines have retained their number one and number two status as suppliers, while Indonesia and Malaysia have increased their overall supplies of carrageenan to the United States of America. Some reports indicate that U.S. carrageenan consumption is about 60 percent import dependent.

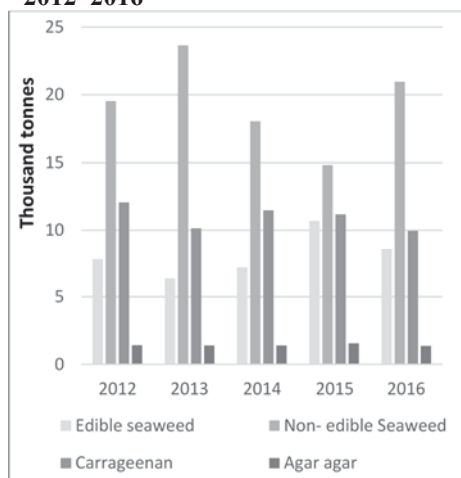
Imports of agar from the United States of America also have remained stable, at around 1 300–1 500 tonnes annually (Annex 21). Supplies were dominated by Chile, China, Morocco and Spain.

**Table 25. United States of America: Imports of seaweed, 2013–2016**

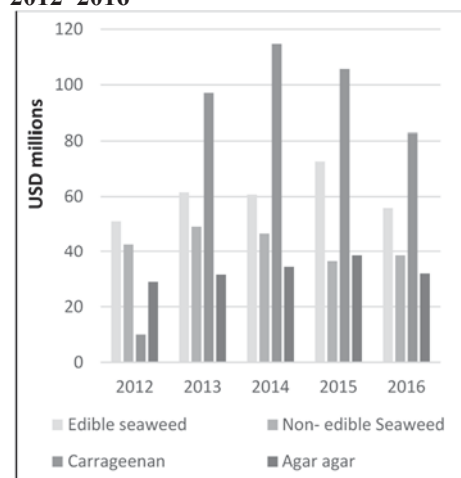
|                     | Weight in tonnes; value in USD thousands |                |               |                |               |                |
|---------------------|--|----------------|---------------|----------------|---------------|----------------|
|                     | 2014                                     |                | 2015          |                | 2016          |                |
|                     | Weight                                   | Value          | Weight        | Value          | Weight        | Value          |
| Edible seaweed      | 7 180                                    | 60 670         | 10 695        | 72 628         | 8 560         | 55 883         |
| Non- edible seaweed | 18 030                                   | 46 698         | 14 826        | 36 400         | 20 959        | 38 481         |
| Carrageenan         | 11 475                                   | 114 695        | 11 192        | 105 699        | 9 959         | 82 830         |
| Agar agar           | 14 17                                    | 34 379         | 1 565         | 38 500         | 1 383         | 31 949         |
| <b>Total</b>        | <b>38 102</b>                            | <b>256 442</b> | <b>38 278</b> | <b>253 227</b> | <b>40 861</b> | <b>209 143</b> |

Sources: U.S. Department of Customs and Border Protection; U.S. Census Bureau.

**Figure 13. United States of America: Imports of seaweed, by weight, 2012–2016**



**Figure 14. United States of America: Imports of seaweed, by value, 2012–2016**



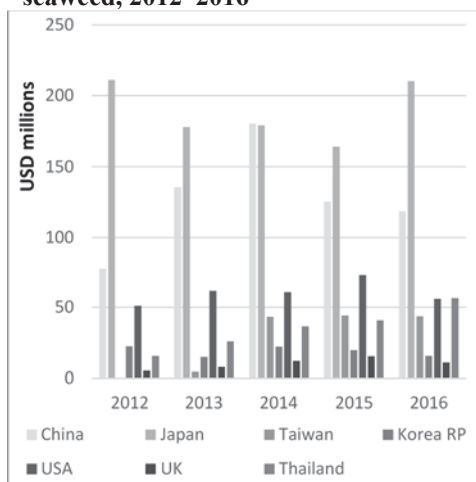
Sources: U.S. Department of Customs and Border Protection; U.S. Census Bureau.

### 3.5 MARKET TRENDS FOR DIFFERENT PRODUCT TYPES

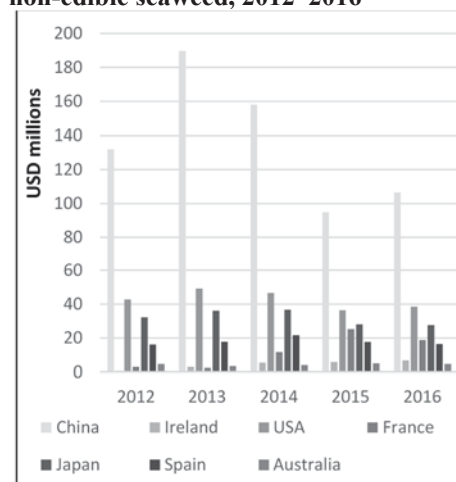
For the last few years, China has dominated the global seaweed market as an importer of raw material and exporter of semi-processed and processed products. There is a growing focus, however, on adding more value in other countries in Asia and Latin America to match the rising demand for food-grade carrageenan and agar agar, particularly from the developing markets. Meanwhile, the usage of seaweed as a binder and thickener has increased significantly in the food processing industry in Asia, Latin America and the Middle East.

In Southeast Asia, Malaysia and Thailand are net importers of semi-processed and processed seaweed. Furthermore, domestic demand for such products by the food processing industries in Indonesia is on the rise. Imports of seaweed-based products, such as jelly among others, also are growing in other large markets in South Asia (Bangladesh, India and Pakistan) where consumer demand for ready meals is increasing. In Latin America, imports of hydrocolloids have increased in Argentina, Brazil, Mexico and various other countries for usage in the food processing industry.

**Figure 15. World: Importers of edible seaweed, 2012–2016**

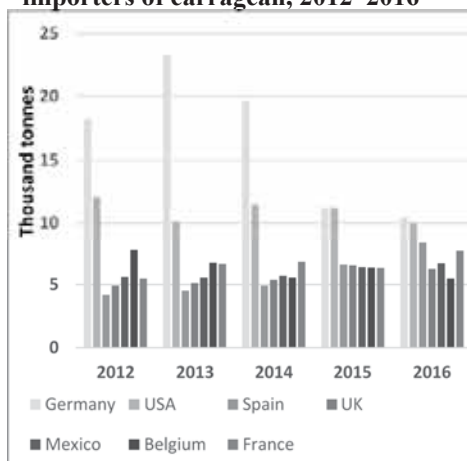


**Figure 16. World: Importers of non-edible seaweed, 2012–2016**

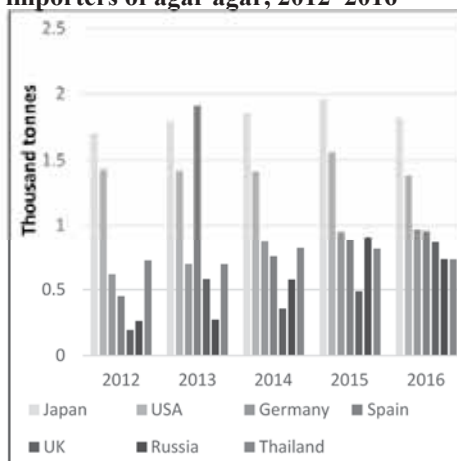


Source: National Statistics.

**Figure 17. World: Top seven importers of carrageenan, 2012–2016**



**Figure 18. World: Top seven importers of agar agar, 2012–2016**



Source: National Statistics.

### 3.6 SEAWEED EXPORT TRENDS

In 2016, the total reported exports of seaweed from the top five suppliers (Indonesia, the EU, Chile, China and the Philippines) had a combined 30-percent share in global export volume. In terms of export value, however, the top suppliers were China, the European Union, Chile and the Philippines due to higher-value carrageenan and agar agar, among others. Overall supplies of seaweed from these countries to the international market increased moderately during the 2012–2016 period, except from the Philippines (Table 26, Figure 19 and Figure 20).

The lion’s share of Indonesia’s seaweed exports consisted of dried seaweed, which had a much lower export value (USD 800–USD 1 000/tonne) compared with semi-processed carrageenan (USD 8 000–USD 10 000/tonne) and agar agar.

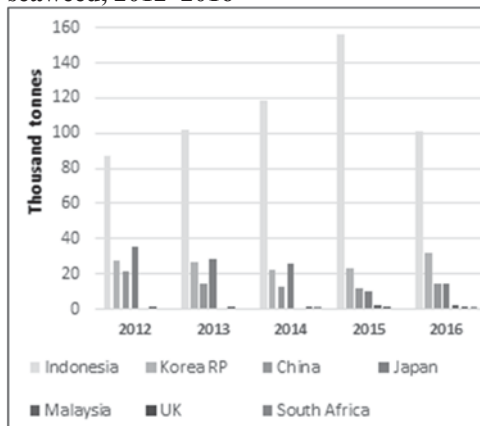
**Table 26. World: Top exporters of seaweed, 2012–2016**

|                  | Weight in tonnes |                |                |                |                |
|------------------|------------------|----------------|----------------|----------------|----------------|
|                  | 2012             | 2013           | 2014           | 2015           | 2016           |
| Indonesia        | 174 836          | 182 446        | 206 572        | 212 245        | 188 760        |
| European Union   | 82 171           | 95 411         | 103 447        | 101 546        | 101 594        |
| Chile            | 77 990           | 88 409         | 81 265         | 75 238         | 82 482         |
| China            | 69 239           | 64 284         | 68 135         | 70 828         | 78 681         |
| Philippines, The | 50 089           | 60 568         | 45 675         | 42 093         | 42 866         |
| <b>Total</b>     | <b>279 489</b>   | <b>308 672</b> | <b>298 522</b> | <b>289 705</b> | <b>305 623</b> |

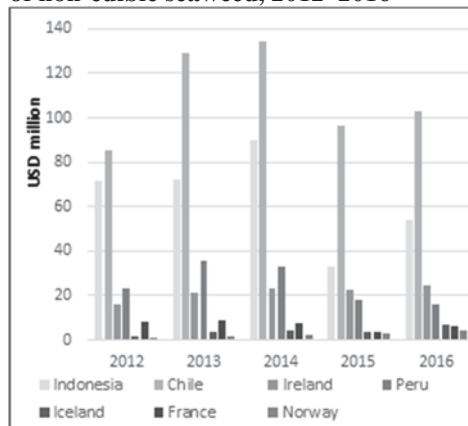
Source: National Statistics.



**Figure 19. Top seven exporters of edible seaweed, 2012–2016**



**Figure 20. World: Top seven exporters of non-edible seaweed, 2012–2016**



Source: National Statistics.

For edible dried seaweed, China, Indonesia, Japan and the Republic of Korea were the main suppliers to the global market in 2016, taking about 75 percent share in terms of the quantity. In terms of value, however, the Republic of Korea was the largest exporter, mainly selling dried seaweed for direct human consumption to the Japanese market, largely the *Undaria* and *Hizikia* species.

**Indonesia:** Seaweed exports from Indonesia are dominated by edible and non-edible raw dried products (Annexes 13 and 14), for which China is the principal market. The other key markets for these categories are Chile, Malaysia and the Philippines, which import dried seaweed for processing carrageenan and agar agar. For processed seaweed, the export volume of carrageenan has levelled off to around 5 000 tonnes annually during the 2012–2016 period, with some fluctuations. The export markets in that period for Indonesian carrageenan were the European Union, Japan and the United States of America. Exports have also increased in recent years to Australia, Brazil and the Russian Federation.

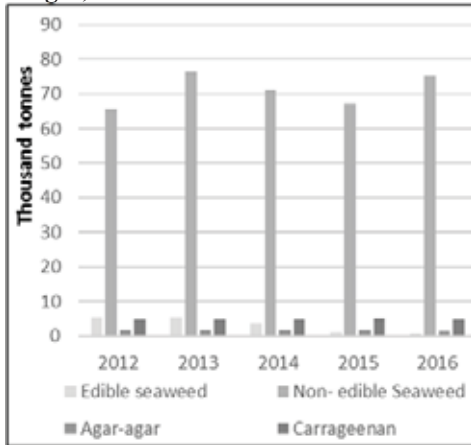
**Chile:** In terms of volume and value, non-edible dried seaweed – mostly *Gracilaria* – was the main export item from Chile. Some 80 percent of this product group went to China in 2016, continuing the increasing trend during the 2012–2016 period (Figures 21 and 22). Exports of carrageenan from Chile peaked in 2015 (Table 27) but declined in 2016. The main markets were the European Union and the United States of America. There were, however, increasing exports to the Latin American markets of Argentina, Brazil, Ecuador, Mexico and Peru. Meanwhile, Chilean exports of agar dwindled.

**Table 27. Chile: Exports of seaweed, 2014–2016**

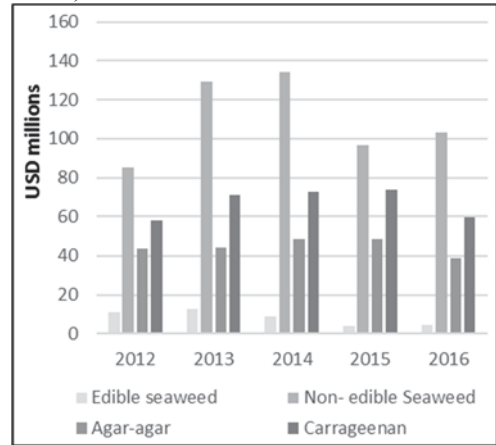
|                    | Weight in tonnes; value in USD thousands |                |               |                |               |                |
|--------------------|--|----------------|---------------|----------------|---------------|----------------|
|                    | 2014                                     |                | 2015          |                | 2016          |                |
|                    | Weight                                   | Value          | Weight        | Value          | Weight        | Value          |
| Edible seaweed     | 3 522                                    | 8 663          | 1 107         | 4 162          | 748           | 4 617          |
| Non-edible seaweed | 71 152                                   | 13 4188        | 67 052        | 96 563         | 75 170        | 103 281        |
| Agar agar          | 1 780                                    | 48 754         | 1 825         | 48 790         | 1 562         | 39 030         |
| Carrageenan        | 4 811                                    | 72 475         | 5 254         | 73 548         | 5 002         | 59 622         |
| <b>Total</b>       | <b>81 265</b>                            | <b>264 080</b> | <b>75 238</b> | <b>223 063</b> | <b>82 482</b> | <b>206 550</b> |

Source: National Customs Service (Servicio Nacional de Aduana).

**Figure 21. Chile: Exports of seaweed, by weight, 2012–2016**



**Figure 22. Chile: Exports of seaweed, by value, 2012–2016**



Source: National Customs Service (Servicio Nacional de Aduana).

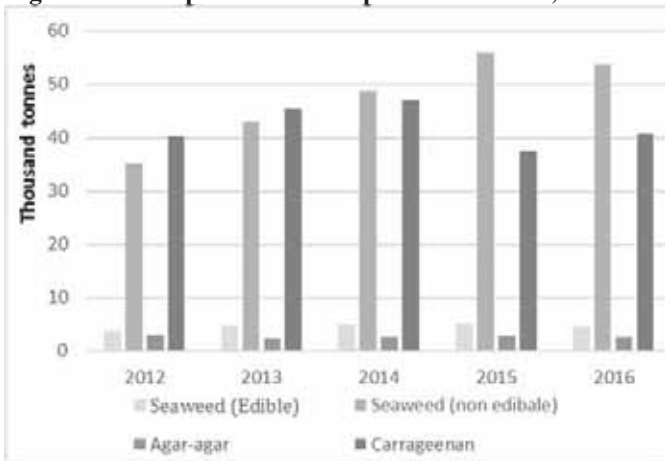
**European Union:** Non-edible dried seaweed, carrageenan and agar agar are the main seaweed exports from the European Union (Table 28). France and Ireland were the key exporters of non-edible seaweed, with smaller amounts from Germany, Portugal and Spain (Annex 14). With regard to carrageenan, France, Germany, the Netherlands and Spain are the main exporting countries from the European Union. From about 2010, however, exports increased only from Spain but declined from the others. For agar agar, the leading exporters are France, Germany and Spain and, notably, French agar agar is the most expensive because of its high grade.

**Table 28. EU: Exports of seaweed and seaweed-based products, 2012–2016**

|                      | Weight in tonnes |               |                |                |                |
|----------------------|------------------|---------------|----------------|----------------|----------------|
|                      | 2012             | 2013          | 2014           | 2015           | 2016           |
| Seaweed (edible)     | 3 733            | 4 691         | 5 041          | 5 219          | 4 607          |
| Seaweed (not edible) | 35 138           | 42 910        | 48 833         | 55 974         | 53 723         |
| Agar agar            | 2 897            | 2 431         | 2 634          | 2 766          | 2 462          |
| Carrageenan          | 40 403           | 45 379        | 46 939         | 37 587         | 40 802         |
| <b>Total</b>         | <b>82 171</b>    | <b>95 411</b> | <b>103 447</b> | <b>101 546</b> | <b>101 594</b> |

Source: Eurostat.

**Figure 23. European Union: Exports of seaweed, 2012–2016**



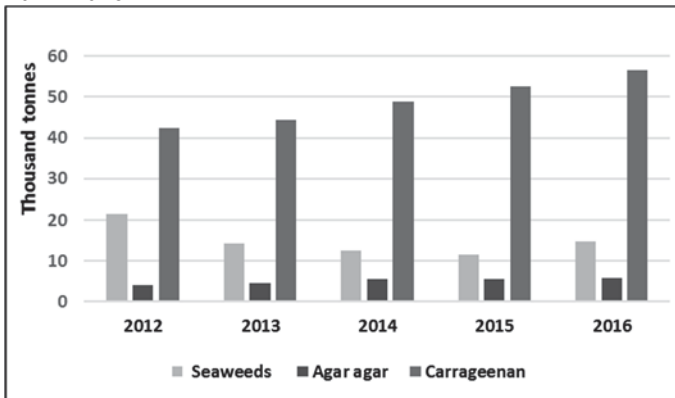
Source: Eurostat.

**China:** A major producer and exporter of processed seaweed, China exported USD 500 million worth of seaweed in 2016. Exports of dried seaweed are relatively low and consisted of higher value *wakame* and *nori*, among others, for direct consumption. Japan, the Russia Federation and Southeast Asia were the main markets that same year.

Carrageenan, the biggest component of China’s seaweed exports, increased significantly from 43 000 tonnes in 2012 to 56 600 tonnes in 2016, valued at USD 360 million (Annexes 8d and 8e, and Figure 24). The main export markets were the Asia, the European Union and the United States of America.

Agar agar exports also increased, from 4 000 tonnes in 2012 to nearly 6 000 tonnes in 2016, for which the main markets were Germany, Italy and Spain within the European Union, as well as Malaysia, the Russian Federation and Thailand. Exports also increased to many other markets in the developing world.

**Figure 24. China: Exports of dried edible seaweed and other processed products, 2012–2016**



Source: China Customs.

**The Philippines:** The seaweed export trade in the Philippines consists more of semi-processed and processed products. The country also exports a small quantity of dried seaweed.

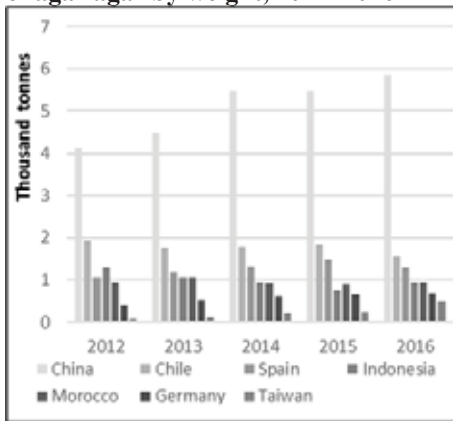
In Asia, the Philippines is the second largest supplier/exporter of semi-processed and processed carrageenan, following China. Exports of carrageenan increased by 33 percent during the 2012–2016 period, valued at USD 190 million in 2016 (Annex 11c). The United States of America has been its main market for carrageenan, followed by the Brazil, European Union, Indonesia, Japan, Mexico and Thailand. Exports have also increased to new markets, namely Argentina, Australia, Brazil, Indonesia and the Russian Federation.

Exports of dried seaweed are mainly edible varieties, and have declined over the past years. In 2016, the volume was relatively small, at 11 000 tonnes (Annex 11a).

### 3.7 PROCESSED SEAWEED IN INTERNATIONAL TRADE

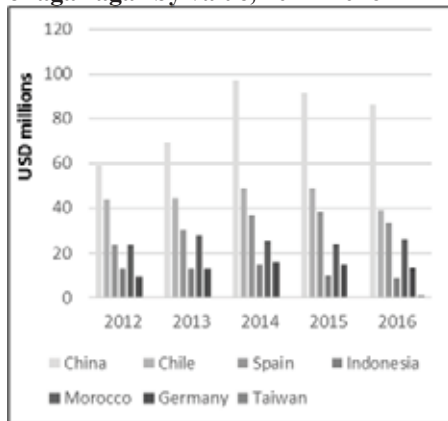
Three types of seaweed are usually sold on the international market, namely (i) edible seaweed products that are directly consumed as food; (ii) dried seaweed as raw material for further processing; and (iii) the hydrocolloids agar/alginate and carrageenan. The market dynamics mostly are due to hydrocolloid products, namely carrageenan and agar agar, which are traded and used widely in many countries for food and non-food usage.

**Figure 25. World: Top seven exporters of agar agar by weight, 2012–2016**

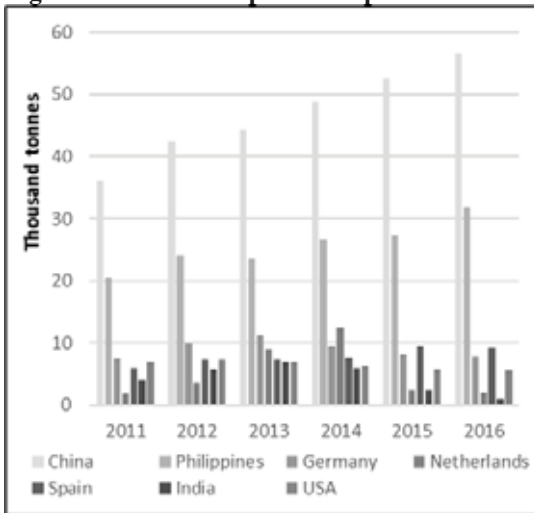


Source: National Statistics.

**Figure 26. World: Top seven exporters of agar agar by value, 2012–2016**



**Figure 27. World: Top seven exporters of carrageenan, 2011–2016**



Source: National Statistics.

### 3.8 PRICE TRENDS ON THE INTERNATIONAL MARKET

In general, seaweed prices vary between different species, product forms, quality, country of origin to name a few. Price fluctuations also take place from time to time due to supply and demand.

With regard to dried seaweed, China – as the single largest importer – dictates the international market price for the carrageenophytes *Kappaphycus alvarezii* and *E. delticulatum* (*E. spinosum*) which are grown in the Asia and the Pacific region. The price chart below (Table 29) shows the lower import price range for dried Southeast Asian seaweed (Indonesia, Malaysia, the Philippines), compared to products from Chile in Latin America.

**Table 29. China: Average import price trends for edible dried seaweed (HS 121221) by country of origin, January–July, 2015–2016**

| Exporting country        | USD/tonne |       |       |
|--------------------------|-----------|-------|-------|
|                          | 2015      | 2016  | 2017  |
| Indonesia                | 1 039     | 716   | 916   |
| Philippines              | 956       | 801   | 906   |
| Malaysia                 | 1 236     | 739   | 977   |
| Japan                    | 3 307     | 5 404 | 2 965 |
| Chile                    | 3 179     | 2 043 | 3 683 |
| Taiwan Province of China | 3 938     | 7 657 | 7 576 |

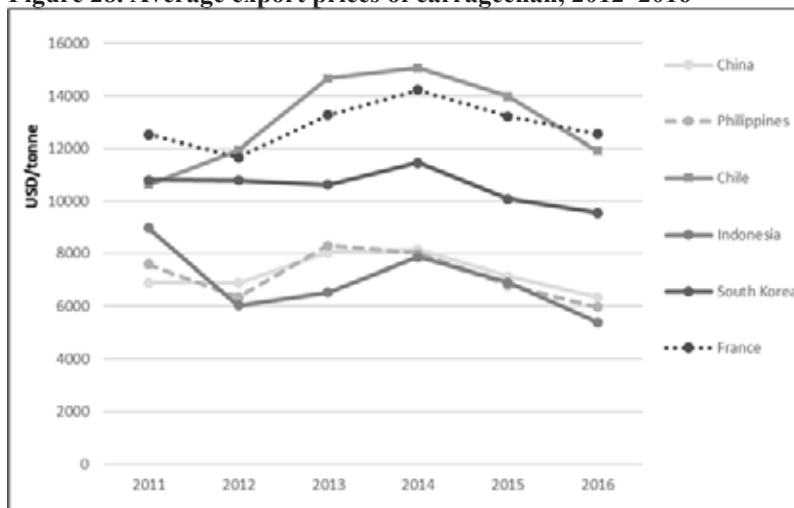
Source: China Customs.

The price of carrageenophytes, especially *E. spinosum*, is rather sensitive to supply fluctuations. Prices tend to be cyclical; as demand increases, farmers ramp up production, creating an over-supply that subsequently forces a drastic drop in prices. When prices are low, farmers tend to abandon their farms, thus decreasing supply and moving prices up

again. Similarly, for processed seaweed, there is a wide range of hydrocolloid prices that are determined by many factors, such as quality, grade type, brand name, country of origin, physical product characteristics to name a few.

Figure 28 depicts the much higher export prices of carrageenan of Chilean and French origin. These are most likely linked to high value species and product quality (particularly French products). Products of Asian origin (i.e. China, Indonesia and the Philippines) tend to be in the same price range.

**Figure 28. Average export prices of carrageenan, 2012–2016**



Source: National Statistics.

### 3.9 MARKET OUTLOOK

The global production of seaweed has increased significantly over the last decade in response to its wider usage in the food and non-food sectors. Demand for fresh and preserved forms, including dried seaweed for direct consumption, is largely limited to the East Asian markets and wherever Japanese cuisine exists elsewhere in the world. However, hydrocolloid products (carrageenan, agar agar and alginic acid) have had a further-reaching impact in the global consumer market in terms of food and non-food.

Of the processed seaweed products, carrageenan is the most widely used and has many purposes. Its current international trade is estimated to be 120 000 tonnes. While the large markets at present are the European Union and the United States of America, demand for carrageenan is growing, particularly in non-producing countries (see Annexes 20a and 20b). This trend is likely to extend into other developing countries. The market prospects for carrageenan are favourable, with positive growth expected in many new markets and market segments.

### 3.10 TARGETING THE HALAL MARKET

A study conducted by the Dubai Chamber of Commerce and Industry indicates that the global halal market is projected to grow to USD 1.6 trillion by 2018 (DCCI, 2014). Of this amount, the halal food trade alone contributes USD 630 billion. Catering to the religious obligations and preferences of Muslims has become a big business, particularly with regard to the food, clothing and tourism sectors, and in no other region is this more obvious than the Asia and the Pacific region. Even countries which are not classified as Muslim nations – notably Japan, the Republic of Korea, the Philippines, Singapore and Thailand – are encouraging their business sectors to acquire that all-important, universally accepted halal certification for food products in order to gain their share of the huge halal global market. Interestingly, Malaysia and Indonesia are the only Muslim countries (ranking eighth and ninth, respectively) in the top ten of the world's leading halal markets.

Government statistics indicate that visitors to Thailand from Muslim countries in Asia and the Middle East have more than doubled between 2006 (2.6 million) and 2016 (approximately 6 million). In addition to catering for tourists, Thailand has an established domestic market within its sizeable Muslim population in the southern part of the country. As Thailand ranks ninth in world halal food exports, it can be safely assumed that most of these products are shipped to other countries. This trend is likely to continue, aided by support from the Ministry of Industry, which budgeted THB 180 million (USD 5.1 million) to promote exports of halal products in fiscal year 2016.

Thailand's Ministry of Industry also has announced that it will spearhead development plans for halal products from small and medium enterprises on a "One Tambon, One Product" basis, with the objective of pushing Thailand's ranking to one of the world's top five halal exporters by 2020. Some THB 120 billion (USD 3.4 million) also has been allocated for the National Food Institute of Thailand and THB 60 billion (USD 1.7 billion) to the country's Department of Industrial Promotion. The Central Islamic Committee of Thailand will also receive funds to expedite certification operations for halal food products.



*Crispy Seaweed Spicy Flavour;  
Tao Kae Noi Brand carries a halal label.*

According to the National Food Institute, about half of the halal exports from Thailand consists of rice, followed by sugar (approximately 20 percent); how much of the remainder comprises seaweed and other algae is not definitive. A memorandum of understanding has been signed, however, between the institute and Halal Development Foundation Japan, where the former will assist Japanese investors to gain the official halal trademark from the Central Islamic Committee of Thailand. The result will be food from Japan, including seaweed, being accessible on the global halal market.

Singapore is worth mentioning since it is an interesting example of innovation in services. As the island state lacks space to build huge facilities to manufacture foods, it offers what some other nations may need: halal consultancy (i.e. education and awareness on how to

produce, process and market products for Muslim countries). There are more than ten active halal consultancy firms that assist companies to attain halal certification locally and globally.

In 2014, the halal certifying body in Singapore, Majlis Ugama Islam Singapura, established a company called Warees Halal Ltd. in 2014 as its executive arm. Companies from Japan and the Republic of Korea have attended the seminars organized by Warees Halal Ltd. According to the 2014 annual report of Singapore's certifying body, some SGD 4 million (USD 2.95 million) in income was derived from halal certification in Singapore in that year.

In the quest to comply with halal requirements, businesses look for plant alternatives for animal proteins and nutrients. Apart from seaweed as a direct food source, hydrocolloids from seaweed are ideally suited as substitutes for the animal-origin hydrocolloids gelatine, caseinate, whey protein, soy protein, egg white protein and chitosan. It must be noted also that halal food complies with the need for kosher food for Jewish communities, as well as the food standard requirements of the U.S. Food and Drug Administration and Codex Alimentarius Commission and are thus acceptable for all, Muslims or otherwise.

### **3.11 GLOBAL CERTIFICATION**

In addition to products for the halal market, consumers (particularly in the developed world) increasingly seek evidence that production and processing has been conducted in a sustainable manner, from the raw material being contaminant-free and safe to eat to the final product. Products certified in this manner are expected to be sold at higher prices and to line the shelves in organic sections of major supermarkets.

In response to the call for a globally accepted standard that rewards sustainability and safety, certification schemes are being developed, such as the Seaweed Standard of the joint Marine Stewardship Council and Aquaculture Stewardship Council, planned for release in its introductory phase in October 2017.

This initial phase will be open for farmed and wild seaweed operations that meet the following criteria: sustainable populations, minimizing environmental impacts, effective management, social responsibility and community relations. Certificates awarded during this phase will be valid for three years. The Seaweed Standard conforms to international norms of good conduct, including FAO Guidelines for Ecolabelling of Fish and Fishery Products from Marine Capture Fisheries as well as ISEAL Codes of Good Practice.



#### 4. PROCESSING AND UTILIZATION

Seaweed utilization, particularly in Asia, dates back more than 2 500 years. In 600 BC, the Chinese philosopher, Sze Teu, wrote that, "Some algae are a delicacy fit for the most honored guests, even for the King himself." Conversely, in a few other countries with a similarly long tradition of utilizing seaweed, such as Ireland, seaweed (Irish moss) was at one time (but no longer so) regarded as food for the indigent.

Today, China, Japan and the Republic of Korea are the world's largest consumers of seaweed, commonly used as *nori* sheets to wrap sushi; *kombu*, a soup stock ingredient; and *wakame* for soups and salads. Seaweed – partly because of the increasing popularity of sushi – is being also consumed on a large scale in the Europe. South America and the United States of America.



Dried seaweed lines the shelves of Japanese-themed outlets in many Asian supermarkets, in this case in Malaysia.

© Fatima Ferdouse

The health benefits of seaweed, due to its high complement of iodine, calcium, copper, iron, Vitamin C, Vitamin B12, Vitamin K, and protein, are an additional reason for its rising consumption. Important compounds present in seaweed include fucoidan and glutamate, which improve heart health and brain function. It is often pointed out that the Japanese, who eat seaweed regularly, have one of the highest life expectancies in the world.

##### 4.1 SEAWEED AS A COMPONENT IN MANY INDUSTRIES

Seaweed is found in many more products than commonly thought, either consumed directly or processed into food products (primarily in the East Asian countries of China, Japan and the Republic of Korea). Taking *Gracilaria* sp. as an example, in Asia, the major consumers are Indonesia, Japan (local name of *ogonori* or *ogo*), Malaysia, the Philippines (local name of *gulaman*), Thailand and Viet Nam. In the West Indies it is sold in markets as sea moss, reputed to have aphrodisiac properties, and is also used as a base for a non-alcoholic drink. In Hawaii, where *Gracilaria* is eaten as part of salad dishes, it is farmed in cages in coastal waters and fertilized by shrimp farm effluent. *Gracilaria* is also a common macroalgae for sale in the aquarium trade.

Carrageenan from red seaweed and algin or alginates from brown seaweed are used as thickening agents in confectionaries, bakery products, salad dressings, ice creams, sweets and desserts (e.g. puddings, chewing gum, jams, jellies), dairy products such as chocolate milk, beverage mixes and in processed meats, sausages and fish, as well as in clarifying of beers and wines.



© Fatima Ferdouse

Carrageenan and alginates are used also in pharmaceuticals as binders, stabilisers, emulsifiers, and for creating moulds in dentistry. Alginates are further used in oral medications such as cough medicine and in the care of wounds.

#### 4.2 CARRAGEENAN

The main algae for carrageenan extraction in the 1970s used to be *Chondrus* (Irish moss), which was harvested from the wild in Canada. The rising demand for carrageenan, however, has resulted in an expansion of *Kappaphycus alvarezii* (*cottonii*) and *Eucheuma denticulatum* (*spinosum*) farming in Fiji, Indonesia, Kenya, Kiribati, Madagascar, Malaysia, the Philippines and Tanzania. Other carrageenan genera are harvested from the wild, such as *Chondrus*, *Furcellaria*, *Gigartina*, *Sarcothalia*, *Mazzaella*, *Iridaea*, *Mastocarpus* and *Tichocarpus*, mainly sourced from Argentina, Canada, Chile, Denmark, France, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Mexico, Morocco, Portugal, Russian Federation, Spain and the United States of America.



*In Southeast Asia, carrageenan is used as a binder for items such as burgers.*

© Fatima Ferdouse

The bulk of the carrageenan is refined. Processing of the raw material takes place mainly in the Denmark, France, the Philippines and the United States of America to produce three major types: alcohol processed refined carrageenans; potassium chloride processed RCs; and SRC, also referred to as PNG (Philippine Natural Grade) or PES (Processed *Eucheuma* Seaweed). The latter has, only in recent years, been approved for food applications. It is recognized differently in European Union and U.S. legislation, the former in the Code of Federal Regulations and the latter in Annex I of the European Parliament and Council Directive 95/2/EC of 20 February 1995 on food additives. Under the Codex Alimentarius, carrageenan and Processed *Eucheuma* Seaweed have been given an Acceptable Daily Intake of “not specified” by the Joint FAO/WHO Expert Committee on Food Additives.

An important point to note is that SRC, presently utilized primarily in Asia, is increasingly in demand in Europe, where technological development can be said to be swifter than in Asia. CyberColloids Ltd., a research and product development group, reported that between 2006 and 2011, most of the new products containing SRC were launched in Europe and dominated the carrageenan market.

#### **4.3 OTHER USES OF SEAWEED**

Thalassotherapy has gained popularity in the beauty and wellness industry. Extracts of seaweed are used in diet pills (they tend to expand in the stomach, creating a feeling of fullness); or they may be part of skin care packages (facial masks, bath salts, massages, gels, shampoos, cleansers, shaving creams) or cosmetics, often mixed with aromatic oils. Some wellness centres offer full-body seaweed wraps, followed by a warming of the body with infrared lamps, claimed to improve blood circulation and help relieve rheumatic pain and remove cellulite.

In other industrial sectors, seaweed is used in soil fertilizers because of its rich plant nutrients (e.g. potassium, nitrogen and phosphorus). Algins are found in paints and pigments, paper, cardboard, textile printing, personal lubricants, as a substrate in bacterial culture, and in explosives, pesticides and fire retardants. Research is also ongoing into biofuel production using seaweed.

Seaweed is also a filtering agent due to its ability (during photosynthesis) to rapidly consume ammonia, ammonium nitrate, nitrite, phosphate, iron and copper, as well as carbon dioxide, thus filtering these nutrients out of water bodies. FAO (2015) estimates that in 2014, 124 million tons of nitrogen were used globally as fertilizer, of which between 15 percent and 30 percent ended up in coastal waters. Particularly useful is the fact that the nutrient-laden algae (especially macroalgae as opposed to microalgae) can simply be pulled out and disposed of, if necessary. This natural filtering process can be replicated in man-made environments using seaweed filters such as algae scrubbers.



*September 2017, Zanzibar – FAO Director-General, José Graziano da Silva, inspecting a variety of products made from seaweed during his visit to Paje Beach.*  
©FAO/Kevin Midigo

Seaweed also forms a part of the diet for farmed fish and fishery species – such as kelp (*Ecklonia*) for abalone feed in South Africa – and animal feeds. In addition, studies are underway on whether adding seaweed to livestock feed will substantially reduce methane emissions from cattle.

## 5. CONCLUSIONS AND OUTLOOK

For centuries, seaweed has been utilized throughout the world – in the earliest times, solely as a food source for coastal communities. Today, the global seaweed industry is worth more than USD 6 billion per annum (approximately 12 million tonnes in volume), of which some 85 percent comprises food products directly or indirectly used for human consumption.

As wild harvests decline due to over-exploitation, the aquaculture sector has expanded exponentially. In 2015, of the total global seaweed production of 30.4 million tonnes, 29.4 million tonnes originated from the culture sector. Producing nations are aware of the need to ensure the sector's long-term economic and environmental development, in addition to continuing research in identifying fast growing, high yielding and disease-resistant varieties.

At the domestic level, seaweed is seen as not only a source of nutritious food for populations, but also its culture and trade bring about the considerable enhancement of socio-economic livelihoods. Seaweed-derived extracts (carrageenan, agar, and alginates) are also a major source of trade income, making up almost 40 percent of the world's hydrocolloid market. Continuity in the availability of high-quality supplies is therefore essential, and it can be only achieved through aquaculture.

The global seaweed market is experiencing steady growth, buoyed by the increasing demand for products in the 'fit/not fit for human consumption' categories. In 2016, seaweed and seaweed products were traded at an estimated value of USD 10.6 million. Assuming an annual growth rate of about 10 percent, the total value could be as high as USD 26 million by 2025. Of the red, brown and green commercially important seaweed species, red varieties comprise slightly more than half of the global value. This trend is likely to continue due to their rising use in the food industry in the most significant growth centre, Asia, as well as across the world.

By region, the Asia and the Pacific region (China, Japan and the Republic of Korea) is the largest market, absorbing approximately 60 percent of seaweed and hydrocolloids supplies, followed by Europe and the Americas. The latter two regions are experiencing a rise in seaweed consumption due to its reputation as a healthy food as well as the increasing popularity of Japanese cuisine.

In terms of processing and utilizing products not directly consumed as food, seaweed is much more present than is generally recognized. Carrageenan from red seaweed, as well as algin or alginates from brown seaweed, are used in the thickening/gelling of food products; processing of meats, sausages and fish; clarifying alcohol; pharmaceuticals and dentistry; the health and beauty industries; soil fertilizers; textile printing; bacterial culture as a substrate; water filtration; and livestock and fishery diets.

Seaweed and other algae are an essential source of nutritious food for human consumption; provides jobs for coastal communities and growers; and are essential components in a significantly wide range of food and non-food commercial industries. Their presence is so ubiquitous in many familiar products in the retail and commercial sectors that it often goes unrecognized until labels are examined.

## **5.1 PRODUCTION AND SUSTAINABILITY**

The output of seaweed and other algae from the culture sector has increased sharply over the last decade (2006–2016). This trend is likely to continue as wild harvests stagnate or even decline due to over-exploitation, changing environmental conditions, water pollution and, most of all, market demand for seaweed as food as well as for its extracts used in commercial industries. Red seaweed has the highest application in the food and commercial sectors, making it the preferred selection for aquaculture over the brown and green varieties.

As a result of the overwhelming importance of aquaculture, the leading producing nations are focusing on ensuring the sector's long-term economic and environmental development, in addition to continuing research in identifying fast-growing, high-yielding, disease-resistant varieties of seaweed. More countries should make efforts to ensure that genetic biodiversity is preserved, potentially through the establishment of seaweed gene banks.

With regard to wild seaweed, harvesters should be made aware of the importance of ensuring sustainability; for example, they could cut or prune seaweed rather than pull it out from natural beds. Also essential is make certain that the wild seaweed is contaminant-free – an area where relevant governing authorities must implement effective coastal zone management policies.

In countries where growers are members of a group or organization, governments are more able to collectively manage and improve culture and wild harvest techniques and output, so that the relevant socio-economic benefits are not lost and that the quality of the fresh or processed seaweed is maintained. There are various approaches that can be promoted, one of which is to encourage growers to examine IMTA as a means of raising incomes in limited culture areas, manpower, and finances. Successful IMTA projects involving seaweed have existed for many years in Brazil, China and the Republic of Korea.

## **5.2 SEAWEED FOR HUMAN CONSUMPTION**

In the short term, China is expected to remain the world's leading seaweed producer, a significant portion of which goes primarily to meet the needs for human consumption and the food industry (carrageenan and agar). The rising demand for seaweed snacks and the growing global popularity of Japanese cuisine (particularly sushi) are two major factors that will continue to drive market demand for seaweed as food. Underlying this trend is the fact that seaweed is recognized as a powerhouse of vitamins and minerals that are highly beneficial to health.

Product diversification is essential when creating items to appeal to various demographics and cultures. One only has to look at the innovative products (including snack foods and ready-to-eat meals) that are being manufactured in the European Union, several Southeast Asian countries (China, Japan, the Republic of Korea and Thailand) and the United States of America; the various brands and formulations to suit regional tastes; and the reach out to a wider global market. Flavoured tidbits, noodles, health drinks, crackers, cookies,

sweets, condiments and prepared salads are some of the products constantly being invented and re-invented.

Among the key criteria in relation to the ‘seaweed for human consumption’ sector are to ensure that products are certified as sustainable and organic and that they preferably carry a halal logo. With regard to the former, globally accepted certification schemes, such as that of the Marine Stewardship Council, are present. In terms of the halal market, several countries in the Asia and the Pacific region are forging ahead with certification and the manufacture of products to appeal to not only the huge Muslim market, but also beyond that. In terms of global sales, products such as these would fetch premium prices and attract greater demand in the respective target markets. Certification would add value to the products in terms of acceptability and sales. One can expect that the global seaweed industry will continue to grow with these factors in mind.

### 5.3 SEAWEED EXTRACTS

Apart from seaweed for human consumption, its extracts (carrageenan, agar agar, and alginates) contribute about 40 percent to the global hydrocolloid market. Indonesia, the second biggest producer, focuses on species (e.g. *Eucheuma* spp., *Kappaphycus* spp. and *Gracilaria* spp.) from which carrageenan and agar agar are extracted. Currently, Indonesia and the Philippines sell the raw material to other countries (China, Japan and Norway) for processing into these extracts, although this may change in the future as the Government of Indonesia steps up plans to revitalize the seaweed production and processing sectors in Indonesia.

Carrageenan is especially in demand as a gelling agent for use in the food industry and, together with agar agar and alginates, these extracts are in widespread application as an additive in the food and non-food industries (e.g. medicine, research, pharmaceuticals, wellness, health, livestock farming and water quality control). An important – and expanding – application of carrageenan is as an alternative to bovine or porcine gelatine for use by populations that adhere to a vegetarian, vegan and/or halal (or kosher) diet for religious and/or health reasons.

The industry as a whole – as in the case of the market for seaweed for human consumption – can therefore be expected to continue expanding. While technical collaboration with foreign companies results in what is usually termed a ‘win-win’ situation for two or several parties, it makes more sense for producing countries to learn from established players and invest in their own domestic processing technologies and facilities for the manufacture and export of products such as refined carrageenan. Where there are close ties between domestic research institutions and the industry, the likelihood is high that new, useful products might be an outcome (e.g. bioactive ingredients to alleviate disease). An important factor is to ensure market acceptability for these products while simultaneously making it profitable for seaweed culturists in order to maintain adequate supplies.

#### 5.4 GLOBAL IMPORT-EXPORT TRADE IN SEAWEED AND SEAWEED PRODUCTS

The main regions in the global seaweed market are Asia and the Pacific, Europe, Latin America and North America, with the first (largely reflecting China, Japan and Indonesia) being the fastest growing in terms of volume and value. In the conventional developed markets of Japan, Europe (Western) and the United States of America, demand appears to have plateaued, perhaps due to the fact that all known applications are exploited almost fully.

Further growth prospects are considered to be very slow, with the exception perhaps of seaweed extract use as a replacement for the animal-based gelatine market, given the health concerns about bovine spongiform encephalopathy, religious dietary observances and the growing number of vegetarians. Elderly people also tend to use more processed foods in their diet and, as this population increases, so will the consumption of seaweed extract, in general, increase. Taking these factors into account, demand may expand, albeit at a lesser rate in developed countries, where the market is split more or less 50:50 between extracts in dairy and meat products.

In areas such as Central and South America, Eastern Europe, the Middle East and South and Southeast Asia, growth is likely to be stronger. According to a survey, per capita consumption of carrageenan in these regions may increase by 30–50 percent over the next decade due to improved market penetration. Allowing for population growth and assuming moderate economic expansion, a rise in carrageenan consumption by 5–7 percent per annum is probable. At present, the market is divided into approximately 20 percent dairy and 80 percent meat in terms of carrageenan application; this, however, is likely to change with a gradual increase in the dairy-food group.

For agar agar, usage is primarily for food purposes, such as in the preparation of jellies and sweet candies. This form of agar agar usually comes in strips and in powder form. The strips need to be soaked in water prior to use to facilitate the dissolving process, while the powdered form can be immediately dissolved. Consumer demand for agar agar powder, particularly from households in Asia and in the Middle East, has the potential to expand in parallel to the rising incomes of the middle class. Meanwhile, the growing range of hydrocolloids applications in the pharmaceutical and toiletry industries must be taken into account in terms of the future production of processed seaweed.

In conclusion, while the growth of the global seaweed market in the last two decades has been nothing short of impressive in terms of production and trade figures, what is equally important is the fact that seaweed harvesting, farming and simple processing sustains the livelihoods of millions of people in coastal communities throughout the world. As a result of the activities surrounding the industry, children in these communities have been able to access education, women now have the opportunity to empower themselves and families are better able to pay for their food and medical expenses. There may be no greater measure of success in the seaweed industry, to date or into the future.



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## ANNEXES

| World wild seaweed output, by species, weight in tonnes, 2006-2015 |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |  |  |
|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--|--|
| Species  | 2006             | 2007             | 2008             | 2009             | 2010             | 2011             | 2012             | 2013             | 2014             | 2015             |  |  |
| Aquatic plants nei   | 288 062          | 364 437          | 403 642          | 303 031          | 274 445          | 306 643          | 287 570          | 314 189          | 274 093          | 285 056          |  |  |
| Brown seaweeds   | 198 239          | 163 726          | 184 611          | 186 505          | 185 127          | 179 994          | 171 587          | 185 946          | 186 704          | 175 642          |  |  |
| Red seaweeds   | 78 177           | 59 645           | 55 956           | 74 530           | 63 471           | 43 948           | 42 876           | 70 487           | 120 402          | 119 986          |  |  |
| Chilean kelp   | 161 834          | 136 766          | 202 262          | 222 628          | 190 746          | 241 633          | 268 722          | 313 341          | 219 998          | 115 311          |  |  |
| [Lessonia trabeculata]   | 27 552           | 31 010           | 33 754           | 54 120           | 62 734           | 46 239           | 48 040           | 38 724           | 60 531           | 72 071           |  |  |
| Japanese kelp  | 84 677           | 72 795           | 73 246           | 80 469           | 74 232           | 61 429           | 73 107           | 56 948           | 66 766           | 71 610           |  |  |
| Gracilaria seaweeds  | 44 153           | 69 739           | 63 967           | 1 169            | 45 089           | 42 224           | 24 340           | 46 053           | 32 352           | 45 344           |  |  |
| North Atlantic rockweed  | 61 390           | 51 736           | 52 508           | 53 763           | 56 332           | 47 374           | 50 588           | 51 371           | 48 991           | 44 203           |  |  |
| Leister  | 17 135           | 12 297           | 14 941           | 34 289           | 30 194           | 29 559           | 36 758           | 34 153           | 34 693           | 41 077           |  |  |
| Giant kelps nei  | 12 377           | 10 960           | 20 814           | 18 340           | 15 370           | 22 387           | 28 285           | 33 914           | 29 169           | 31 959           |  |  |
| Skottsberg's gigartina   | 33 331           | 41 879           | 41 896           | 29 159           | 19 725           | 14 616           | 26 336           | 40 756           | 27 068           | 27 327           |  |  |
| Tangle   | 15 991           | 28 949           | 28 191           | 20 714           | 23 774           | 42 299           | 15 998           | 53 590           | 28 052           | 12 509           |  |  |
| Green seaweeds   | 20 650           | 19 700           | 18 750           | 17 850           | 16 875           | 15 935           | 15 035           | 14 135           | 12 289           | 12 171           |  |  |
| North European kelp  | 2 891            | 8 114            | 8 114            | 2 806            | 2 677            | 9 481            | 5 309            | 21 384           | 37 314           | 10 489           |  |  |
| Bull kelp  | 2 292            | 4 274            | 4 872            | 5 872            | 6 048            | 6 468            | 2 649            | 8 304            | 8 509            | 9 441            |  |  |
| Wakame   | 7 144            | 6 384            | 3 114            | 3882             | 4 783            | 2 742            | 2 184            | 2 848            | 3 547            | 4 188            |  |  |
| [Mazzaella laminarioides]  | 3 731            | 5 108            | 4 372            | 4 225            | 1 172            | 2 096            | 1 574            | 3 181            | 4 607            | 3 013            |  |  |
| Gelidium seaweeds  | 1 618            | 1 337            | 1 290            | 1 395            | 1 148            | 1 241            | 1 267            | 1 367            | 2 892            | 2 707            |  |  |
| Seaweeds nei   | 176              | 8 855            | 8 885            | 18               | -                | 3 236            | 27 368           | 1 366            | 701              | 2 533            |  |  |
| [Chondracanthus chamissoi]   | 1 590            | 980              | 1 031            | 2 001            | 914              | 998              | 1 400            | 2 475            | 2 715            | 2 199            |  |  |
| Others   | 4 544            | 6 212            | 3 808            | 3 175            | 1 052            | 2 456            | 2 275            | 1 904            | 2 111            | 2 986            |  |  |
| <b>Total</b>   | <b>1 063 010</b> | <b>1 098 691</b> | <b>1 226 216</b> | <b>1 116 766</b> | <b>1 074 856</b> | <b>1 120 542</b> | <b>1 130 993</b> | <b>1 294 532</b> | <b>1 201 393</b> | <b>1 088 836</b> |  |  |

Source: FAO.

| World wild seaweed output, by country, weight in tonnes, 2006-2015 |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |  |  |
|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--|--|
| Country  | 2006             | 2007             | 2008             | 2009             | 2010             | 2011             | 2012             | 2013             | 2014             | 2015             |  |  |
| Chile  | 301 115          | 313 551          | 384 563          | 368 032          | 368 580          | 403 496          | 436 035          | 517 929          | 417 331          | 345 704          |  |  |
| China  | 270 410          | 328 600          | 366 100          | 276 170          | 246 620          | 274 060          | 257 640          | 283 010          | 245 550          | 261 770          |  |  |
| Norway   | 145 429          | 134 671          | 154 215          | 160 361          | 158 516          | 152 382          | 140 998          | 154 150          | 154 230          | 147 391          |  |  |
| Japan  | 113 665          | 103 602          | 104 668          | 104 103          | 97 231           | 87 779           | 98 514           | 84 498           | 91 601           | 93 300           |  |  |
| Indonesia  | 4 996            | 4 643            | 2 917            | 3 030            | 2 697            | 5 479            | 7 641            | 17 136           | 70 514           | 78 230           |  |  |
| Ireland  | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           | 29 500           |  |  |
| France   | 19 160           | 39 757           | 29 757           | 18 907           | 22 597           | 47 307           | 41 229           | 69 126           | 58 512           | 19 110           |  |  |
| India  | 32 500           | 31 000           | 29 500           | 28 000           | 26 500           | 25 000           | 23 500           | 22 000           | 18 890           | 18 650           |  |  |
| Iceland  | 20 964           | 21 867           | 22 559           | 22 563           | 21 014           | 15 737           | 18 079           | 17 168           | 18 427           | 16 830           |  |  |
| Peru   | 3 434            | 10 786           | 13 779           | 5 677            | 4 368            | 5 801            | 3 585            | 22 089           | 25 827           | 14 824           |  |  |
| Canada   | 43 191           | 19 382           | 17 715           | 43 300           | 43 431           | 14 824           | 13 833           | 14 842           | 14 360           | 11 573           |  |  |
| Mexico   | 4 532            | 5 093            | 4 900            | 5 152            | 1 128            | 5 072            | 5 725            | 10 122           | 8 484            | 11 331           |  |  |
| Korea, Republic of   | 13 754           | 18 189           | 13 866           | 10 843           | 13 043           | 14 787           | 10 123           | 8 566            | 9 687            | 7 826            |  |  |
| South Africa   | 9 776            | 11 507           | 10 788           | 10 748           | 11 821           | 10 901           | 16 234           | 12 583           | 13 211           | 7 131            |  |  |
| Russian Federation   | 11 614           | 8 342            | 10 242           | 5 828            | 5 917            | 6 639            | 6 597            | 5 341            | 7 070            | 6 662            |  |  |
| United States of America   | 6 362            | 2 272            | 6 951            | 8 207            | 9 027            | 9 614            | 9 382            | 11 388           | 8 373            | 6 469            |  |  |
| Morocco  | 14 870           | 12 373           | 9 037            | 10 368           | 7 405            | 5 797            | 5 150            | 6 138            | 2 688            | 5 284            |  |  |
| Spain  | 485              | 109              | 97               | 64               | 124              | 261              | 525              | 1 215            | 2 151            | 2 386            |  |  |
| Australia  | 15 504           | 2 223            | 1 923            | 1 923            | 1 923            | 1 923            | 1 923            | 1 923            | 1 923            | 1 923            |  |  |
| Portugal   | 765              | 495              | 198              | 351              | 498              | 461              | 801              | 839              | 782              | 1 574            |  |  |
| Others   | 5 528            | 6 941            | 6 749            | 6 814            | 3 968            | 6 178            | 6 254            | 6 873            | 4 393            | 4 354            |  |  |
| <b>Total</b>   | <b>1 062 026</b> | <b>1 097 962</b> | <b>1 223 275</b> | <b>1 113 127</b> | <b>1 071 940</b> | <b>1 116 820</b> | <b>1 127 014</b> | <b>1 289 563</b> | <b>1 199 111</b> | <b>1 087 468</b> |  |  |

Source: FAO.

| World cultured seaweed production, by species, weight in tonnes, 2006-2015 |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |  |  |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--|--|
| Species  | 2006              | 2007              | 2008              | 2009              | 2010              | 2011              | 2012              | 2013              | 2014              | 2015              |  |  |
| Eucheuma seaweeds nei  | 1 159 422         | 1 582 286         | 2 016 230         | 2 870 448         | 3 481 401         | 4 615 764         | 5 852 837         | 8 430 343         | 9 033 651         | 10 189 939        |  |  |
| Japanese kelp  | 4 497 518         | 4 613 060         | 4 765 213         | 4 930 705         | 5 146 883         | 5 257 201         | 5 682 078         | 5 941 658         | 7 699 383         | 8 026 782         |  |  |
| Gracilaria seaweeds  | 1 054 024         | 1 272 509         | 1 386 547         | 1 526 393         | 1 691 028         | 2 171 031         | 2 762 556         | 3 460 203         | 3 751 396         | 3 880 748         |  |  |
| Wakame   | 2 027 763         | 1 765 619         | 1 756 197         | 1 694 540         | 1 537 339         | 1 754 504         | 2 139 477         | 2 079 099         | 2 359 413         | 2 296 468         |  |  |
| Elkhorn sea moss   | 1 452 632         | 1 495 118         | 1 674 739         | 1 772 669         | 1 888 392         | 1 956 576         | 1 962 952         | 1 726 016         | 1 710 631         | 1 753 686         |  |  |
| Nori nei   | 822 100           | 904 170           | 814 660           | 1 074 750         | 1 072 350         | 1 027 450         | 1 123 290         | 1 139 000         | 1 141 710         | 1 158 750         |  |  |
| Seaweeds nei   | 2 334 424         | 2 290 534         | 2 452 424         | 2 489 230         | 3 121 938         | 2 886 482         | 2 812 530         | 2 859 389         | 443 568           | 769 781           |  |  |
| Laver (Nori)   | 585 242           | 606 741           | 562 783           | 554 064           | 564 234           | 608 791           | 691 425           | 721 778           | 673 992           | 686 784           |  |  |
| Spiny eucheuma   | 154 622           | 187 587           | 216 424           | 220 555           | 258 652           | 266 122           | 287 975           | 233 048           | 240 817           | 273 600           |  |  |
| Fusiform sargassum   | 114 230           | 136 260           | 87 480            | 79 490            | 78 210            | 111 310           | 112 260           | 151 520           | 175 430           | 189 050           |  |  |
| Spirulina nei  | 55 870            | 66 920            | 62 320            | 70 890            | 96 942            | 73 048            | 80 266            | 82 025            | 85 705            | 89 441            |  |  |
| Brown seaweeds   | 21 943            | 21 209            | 18 961            | 21 272            | 22 747            | 27 701            | 16 962            | 15 819            | 19 149            | 30 450            |  |  |
| Green laver  | 682               | 684               | 8 003             | 5 903             | 4 531             | 6 085             | 6 002             | 5 034             | 6 055             | 6 748             |  |  |
| Fragile codium   | 165               | 158               | 1 186             | 1 796             | 1 394             | 1 005             | 855               | 2 045             | 5 550             | 3 895             |  |  |
| Aquatic plants nei   | 1 776             | 1 102             | 3 597             | 4 647             | 4 144             | 2 183             | 2 741             | 4 729             | 5 023             | 3 823             |  |  |
| Caulerpa seaweeds  | 5 444             | 5 177             | 4 288             | 3 881             | 4 309             | 5 145             | 3 928             | 3 029             | 1 199             | 1 219             |  |  |
| Bright green nori  | 10 160            | 10 550            | 12 540            | 10 600            | 11 150            | 9 100             | 8 900             | 4 390             | 1 000             | 1 000             |  |  |
| Warty gracilaria   | 5 944             | 9 382             | 6 861             | 4 383             | 4 888             | 4 865             | 3 478             | 3 210             | 936               | 634               |  |  |
| [Haematococcus pluvialis]  | 1 544             | 107               | 116               | 188               | 162               | 205               | 215               | 241               | 226               | 200               |  |  |
| [Spirulina platensis]  | 50                | 50                | 70                | 70                | 70                | 100               | 100               | 121               | 100               | 84                |  |  |
| Others nei   | 6 221             | 3 771             | 7 563             | 1 512             | 1 520             | 523               | 4 575             | 55                | 9                 | 77                |  |  |
| <b>Total, including other countries</b>                                    | <b>14 311 776</b> | <b>149 72 993</b> | <b>15 858 203</b> | <b>17 337 986</b> | <b>18 992 284</b> | <b>20 785 191</b> | <b>23 555 401</b> | <b>26 862 752</b> | <b>27 354 942</b> | <b>29 363 158</b> |  |  |

Source: FAO.

| World cultured seaweed production, by country, weight in tonnes, 2006-2015 |                   |                   |                   |                   |                   |                   |                   |                   |                   |                    |  |  |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--|--|
| Country  | 2006              | 2007              | 2008              | 2009              | 2010              | 2011              | 2012              | 2013              | 2014              | 2015               |  |  |
| China  | 9 744 210         | 9 745 025         | 9 933 885         | 10 495 905        | 11 092 270        | 11 549 555        | 12 832 060        | 13 561 445        | 13 326 315        | 13 924 535         |  |  |
| Indonesia  | 1 170 000         | 1 728 475         | 2 145 061         | 2 963 556         | 3 915 017         | 5 170 201         | 6 514 854         | 9 298 474         | 10 076 992        | 11 269 341         |  |  |
| Philippines  | 1 468 905         | 1 505 070         | 1 666 556         | 1 739 995         | 1 801 272         | 1 840 833         | 1 751 071         | 1 558 378         | 1 549 576         | 1 566 361          |  |  |
| Korea, Republic of   | 765 595           | 792 953           | 921 024           | 858 659           | 901 672           | 992 283           | 1022 326          | 1 131 305         | 1 087 048         | 1 197 129          |  |  |
| Korea, Dem. People's Rep   | 444 300           | 444 300           | 444 300           | 444 300           | 444 300           | 444 300           | 444 300           | 444 300           | 48 900            | 48 900             |  |  |
| Japan  | 490 062           | 513 964           | 456 337           | 456 426           | 432 796           | 349 737           | 440 754           | 418 365           | 373 908           | 399 300            |  |  |
| Malaysia   | 60 000            | 90 269            | 111 298           | 138 857           | 207 892           | 239 450           | 331 490           | 269 431           | 245 332           | 260 760            |  |  |
| Zanzibar   | 76 760            | 84 850            | 107925            | 102 682           | 125157            | 130 400           | 150 876           | 110 438           | 133 020           | 172 490            |  |  |
| Madagascar   | 5 300             | 3 650             | 3 650             | 3 600             | 4 000             | 1 699             | 1 400             | 3 575             | 6 970             | 15 377             |  |  |
| Solomon Islands  | 1 354             | 866               | 1 159             | 4 029             | 7 104             | 7 218             | 6 990             | 11 812            | 12 162            | 12 200             |  |  |
| Chile  | 38 219            | 26 387            | 27 703            | 88 193            | 12 179            | 14 694            | 4 126             | 12 512            | 12 836            | 11 952             |  |  |
| Viet Nam   | 15 000            | 15 000            | 15 000            | 15 000            | 18 221            | 14 019            | 18 544            | 13 561            | 14327             | 11 822             |  |  |
| Tanzania, United Rep. of   | 3 200             | 4 000             | 5 000             | 5 520             | 6 885             | 6 601             | 6 510             | 6 689             | 6 705             | 6 750              |  |  |
| Sri Lanka  | -                 | -                 | -                 | -                 | -                 | 1                 | 23                | 25                | 9                 | 4 760              |  |  |
| Papua New Guinea   | -                 | -                 | -                 | -                 | 100               | 250               | 1 400             | 2 500             | 3 000             | 4 000              |  |  |
| Kiribati   | 8 837             | 1 112             | 1 083             | 1 788             | 4 745             | 4 290             | 8 280             | 2 250             | 3 580             | 3 600              |  |  |
| India  | 1 954             | 2 522             | 4 706             | 6 922             | 4 242             | 4 502             | 4 502             | 4 502             | 3 002             | 3 002              |  |  |
| Myanmar  | -                 | -                 | 288               | 1 200             | 2 094             | 2 336             | 3 200             | 1 600             | 2 100             | 2 324              |  |  |
| Russian Federation   | 818               | 300               | 260               | 739               | 614               | 821               | 1 584             | 642               | 2 386             | 2 036              |  |  |
| South Africa   | 3 000             | 3 000             | 1 834             | 1 900             | 2 015             | 2 000             | 2 000             | 2 000             | 2 000             | 2 000              |  |  |
| Others   | 142 612           | 11 250            | 11 134            | 8 716             | 9 709             | 10 001            | 9 111             | 8 947             | 4 674             | 44 189             |  |  |
| <b>Total</b>   | <b>14 311 776</b> | <b>14 972 993</b> | <b>15 858 203</b> | <b>17 337 986</b> | <b>18 992 284</b> | <b>20 785 191</b> | <b>23 555 401</b> | <b>26 862 752</b> | <b>27 354 942</b> | <b>293 631 583</b> |  |  |

Source: FAO.

| Country                  | World cultured seaweed production, by country, value in USD thousands, 2006–2015 |                  |                  |                  |                  |                  |                  |                  |                  |                  |  |  |  |  |
|--------------------------|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|--|--|--|--|
|                          | 2006   | 2007             | 2008             | 2009             | 2010             | 2011             | 2012             | 2013             | 2014             | 2015             |  |  |  |  |
| China                    | 2 082 169  | 2 067 950        | 2 311 139        | 2 357 839        | 2 533 196        | 2 502 025        | 2 852 190        | 3 040 904        | 2 307 646        | 2 420 653        |  |  |  |  |
| Indonesia                | 210 600  | 392 980          | 300 309          | 811 822          | 1 268 367        | 1 143 653        | 1 347 538        | 1 742 233        | 1 653 108        | 842 852          |  |  |  |  |
| Japan                    | 939 490  | 957 384          | 972 037          | 1 081 155        | 1 143 130        | 994 352          | 1 397 119        | 933 056          | 863 568          | 807 300          |  |  |  |  |
| Korea, Republic of       | 269 657  | 332 524          | 311 305          | 252 112          | 327 823          | 344 276          | 391 705          | 411 137          | 496 496          | 440 575          |  |  |  |  |
| Philippines              | 173 963  | 136 850          | 291 039          | 201 154          | 256 715          | 263 110          | 231 735          | 233 618          | 256 293          | 182 779          |  |  |  |  |
| Korea, Dem. People's Rep | 244 365  | 244 365          | 66 645           | 66 645           | 66 645           | 66 645           | 66 645           | 66 645           | 73 350           | 73 350           |  |  |  |  |
| Malaysia                 | 2 454  | 3 940            | 6 686            | 7 884            | 17 444           | 21 919           | 23 616           | 25 672           | 63 752           | 33 577           |  |  |  |  |
| Chile                    | 61 660   | 43 307           | 46 731           | 114 678          | 15 841           | 25 118           | 9 512            | 27702            | 33 104           | 29 282           |  |  |  |  |
| Sri Lanka                | -  | -                | -                | -                | -                | 1                | 9                | 10               | 3                | 3 505            |  |  |  |  |
| Madagascar               | 716  | 493              | 493              | 486              | 540              | 143              | 109              | 275              | 1 446            | 2 636            |  |  |  |  |
| Russian Federation       | 982  | 360              | 312              | 887              | 737              | 985              | 1 901            | 770              | 2 863            | 2 443            |  |  |  |  |
| Zanzibar                 | 740  | 580              | 1 265            | 1 327            | 1 781            | 1 668            | 1 915            | 1 399            | 1 657            | 1 789            |  |  |  |  |
| Viet Nam                 | 2 438  | 2 422            | 2 393            | 2 285            | 2 545            | 1 880            | 2 448            | 1 782            | 1 863            | 1 484            |  |  |  |  |
| Spain                    | 678  | 951              | 1 009            | 943              | 746              | 989              | 900              | 1 004            | 909              | 790              |  |  |  |  |
| Solomon Islands          | 21   | 18               | 54               | 204              | 403              | 305              | 434              | 709              | 760              | 709              |  |  |  |  |
| Greece                   | -  | -                | -                | -                | -                | 1 517            | 971              | 548              | 678              | 621              |  |  |  |  |
| South Africa             | 1 265  | 1 208            | 756              | 807              | 744              | 747              | 659              | 561              | 498              | 426              |  |  |  |  |
| Burkina Faso             | 220  | 220              | 308              | 280              | 280              | 400              | 400              | 480              | 400              | 320              |  |  |  |  |
| Papua New Guinea         | 0  | 0                | 0                | 0                | 4                | 13               | 81               | 134              | 183              | 217              |  |  |  |  |
| Tanzania, United Rep. of | 31   | 27               | 65               | 168              | 196              | 168              | 165              | 180              | 203              | 205              |  |  |  |  |
| Others                   | 2 716  | 8 570            | 2 436            | 6 588            | 5 303            | 3 609            | 3 111            | 1 902            | 1 745            | 1 378            |  |  |  |  |
| <b>Total</b>             | <b>3 994 165</b>   | <b>4 194 149</b> | <b>4 314 982</b> | <b>4 907 266</b> | <b>5 642 440</b> | <b>5 373 521</b> | <b>6 333 161</b> | <b>6 490 720</b> | <b>5 760 527</b> | <b>4 846 891</b> |  |  |  |  |

Source: FAO.



| World cultured seaweed production, by species, value in USD thousands, 2006-2015 |                  |                  |                  |                  |                  |                  |                  |                |                  |                  |  |  |
|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------|------------------|------------------|--|--|
| Species  | 2006             | 2007             | 2008             | 2009             | 2010             | 2011             | 2012             | 2013           | 2014             | 2015             |  |  |
| Wakame   | 768 997          | 693 952          | 757 677          | 758 326          | 650 949          | 722 080          | 996 739          | 914 126        | 1 063 847        | 1 005 760        |  |  |
| Gracilaria seaweeds  | 342 551          | 374 502          | 395 464          | 503 293          | 521 677          | 600 050          | 757 306          | 959 828        | 1 024 185        | 985 069          |  |  |
| Laver (Nori)   | 929 974          | 986 165          | 926 395          | 997 397          | 1 139 060        | 1 048 385        | 1 384 333        | 993 050        | 982 643          | 930 284          |  |  |
| Eucheuma seaweeds nei  | 225 507          | 392 799          | 302 974          | 823 551          | 1 134 714        | 1 065 061        | 1 268 536        | 1 644 886      | 1 535 030        | 782 556          |  |  |
| Japanese kelp  | 428 935          | 459 293          | 307 474          | 274 905          | 276 428          | 269 492          | 304 056          | 314 907        | 357 449          | 354 387          |  |  |
| Seaweeds nei   | 966 099          | 958 189          | 1 142 391        | 1 159 345        | 1 451 258        | 1 179 606        | 1 156 738        | 1 173 132      | 208 347          | 326 251          |  |  |
| Elkhorn sea moss   | 171 269          | 136 547          | 292 944          | 204 002          | 266 151          | 274 742          | 2 44 666         | 252 186        | 312 525          | 212352           |  |  |
| Fusiform sargassum   | 45 692           | 55 867           | 40 241           | 36 565           | 35 977           | 51 203           | 51 640           | 69 699         | 80 698           | 86 963           |  |  |
| Nori nei   | 49 326           | 54 250           | 46 915           | 62 929           | 63 363           | 63 618           | 71 181           | 73 540         | 74 338           | 74 457           |  |  |
| Spirulina nei  | 22 348           | 37 475           | 37 392           | 35 445           | 48 476           | 37 942           | 41 017           | 41 520         | 43 500           | 45 297           |  |  |
| Brown seaweeds   | 15 155           | 14 424           | 15 605           | 17 280           | 19 179           | 21 851           | 17 373           | 8 549          | 43 673           | 16 271           |  |  |
| Spiny eucheuma   | 4 424            | 3 422            | 4 484            | 5 235            | 8 379            | 7 444            | 10 315           | 7 020          | 9 572            | 9 611            |  |  |
| Aquatic plants nei   | 4 454            | 4 867            | 13 795           | 9 967            | 9 931            | 12 233           | 12 093           | 21 471         | 11 066           | 8 915            |  |  |
| Green laver  | 1 172            | 897              | 6 639            | 4 141            | 3 691            | 4 467            | 3 822            | 4 509          | 4 828            | 5 428            |  |  |
| Caulerpa seaweeds  | 2 242            | 2 202            | 2 396            | 2 193            | 2 562            | 5 477            | 3 783            | 3 074          | 1 290            | 1 075            |  |  |
| Fragile codium   | 227              | 182              | 1 814            | 2 016            | 1 798            | 558              | 631              | 1 604          | 2 062            | 882              |  |  |
| [Haematococcus pluvialis]  | 3 088            | 214              | 232              | 376              | 324              | 738              | 2 183            | 4 767          | 4 299            | 400              |  |  |
| Bright green nori  | 4 572            | 4 642            | 6 145            | 4 240            | 4 460            | 3 640            | 3 560            | 1 756          | 400              | 400              |  |  |
| [Spirulina platensis]  | 220              | 220              | 308              | 280              | 280              | 400              | 400              | 496            | 400              | 361              |  |  |
| Green seaweeds   | -                | -                | -                | -                | -                | -                | -                | -              | -                | 197              |  |  |
| Others   | 7 913            | 14 040           | 13 697           | 5 780            | 3 782            | 4 534            | 2 790            | 600            | 176              | 93               |  |  |
| <b>Total</b>   | <b>3 994 165</b> | <b>4 194 149</b> | <b>4 314 982</b> | <b>4 907 266</b> | <b>5 642 440</b> | <b>5 373 521</b> | <b>6 333 161</b> | <b>6490720</b> | <b>5 760 527</b> | <b>4 846 891</b> |  |  |

Source: FAO.

| China: Cultured seaweed production, by species, weight in tonnes, 2006–2015 |                  |                  |                  |                   |                   |                   |                   |                   |                   |                   |  |
|---|------------------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--|
| ASFIS species   | 2006             | 2007             | 2008             | 2009              | 2010              | 2011              | 2012              | 2013              | 2014              | 2015              |  |
| Japanese kelp   | 3 809 960        | 3877 355         | 3988755          | 4139825           | 4418010           | 4541105           | 4895030           | 5088 685          | 6 805 175         | 7 056 445         |  |
| Gracilaria seaweeds   | 888 840          | 994 510          | 1144460          | 1253520           | 1147220           | 1513590           | 1967780           | 2461 120          | 2 622 320         | 2 701 490         |  |
| Wakame  | 1 646 300        | 1402 270         | 1320210          | 1324170           | 1091330           | 1341750           | 1751210           | 1701 110          | 2 030 990         | 1 925 020         |  |
| Nori nei  | 822100           | 904 170          | 814660           | 1074750           | 1072350           | 1027450           | 1123290           | 1139 000          | 1 141 710         | 1 158 750         |  |
| Seaweeds nei  | 2 309 570        | 2265 050         | 2434920          | 2475410           | 3111480           | 2870430           | 2793340           | 2840 970          | 421 100           | 753 280           |  |
| Fusiform sargassum  | 114 230          | 136 260          | 87480            | 79490             | 78210             | 111310            | 112260            | 151 520           | 175 430           |                   |  |
| Spirulina nei   | 55 870           | 66 920           | 62320            | 70890             | 96910             | 72820             | 80050             | 81 890            | 85 530            | 89 250            |  |
| Eucheuma seaweeds nei   | 84 080           | 86 840           | 67240            | 65900             | 64260             | 61800             | 95880             | 92 560            | 42860             | 50 050            |  |
| Bright green nori   | 10 160           | 10 550           | 12540            | 10600             | 11150             | 9100              | 8900              | 4390              | 1 000             | 1 000             |  |
| [Haematococcus pluvialis]   | 100              | 100              | 100              | 150               | 150               | 200               | 200               | 200               | 200               | 200               |  |
| Japanese isinglass  | 3 000            | 1 000            | 1200             | 1200              | 1200              | -                 | 4120              | -                 | -                 | -                 |  |
| <b>Total</b>  | <b>9 744 210</b> | <b>9 745 025</b> | <b>9 933 885</b> | <b>10 495 905</b> | <b>11 092 270</b> | <b>11 549 555</b> | <b>12 832 060</b> | <b>13 561 445</b> | <b>13 326 315</b> | <b>13 924 535</b> |  |

Source: FAO.

| China: Exports of seaweed and other algae fit for human consumption, weight in tonnes; value USD thousands, 2012-2016 |               |                |               |                |               |                |               |                |               |                |  |
|---|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|--|
| Products  | 2012          |                | 2013          |                | 2014          |                | 2015          |                | 2016          |                |  |
|   | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          |  |
| Edible seaweed  | 21 595        | 132 007        | 14 185        | 70 794         | 12 545        | 66 847         | 11 654        | 53 739         | 14 721        | 56 179         |  |
| Non-edible seaweed  | 1 007         | 1 352          | 1 214         | 983            | 1 383         | 1 317          | 1 153         | 2 948          | 1 477         | 1 896          |  |
| Agar-agar   | 4 146         | 58 803         | 4 488         | 69 065         | 5 465         | 97 184         | 5 472         | 91 558         | 5 846         | 86 024         |  |
| Carrageenan   | 42 491        | 293 323        | 44 397        | 356 549        | 48 742        | 397 032        | 52 549        | 375 782        | 56 637        | 360 134        |  |
| <b>Total</b>  | <b>69 239</b> | <b>485 485</b> | <b>64 284</b> | <b>497 391</b> | <b>68 135</b> | <b>562 380</b> | <b>70 828</b> | <b>524 027</b> | <b>78 681</b> | <b>504 233</b> |  |

Source: China Customs.

| China: Exports of seaweed and other algae not fit for human consumption, by destination, weight in tonnes, 2012-2016 |              |              |              |              |              |  |  |  |  |
|--|--------------|--------------|--------------|--------------|--------------|--|--|--|--|
| Destination  | 2012         | 2013         | 2014         | 2015         | 2016         |  |  |  |  |
| Viet Nam   | 183          | 286          | 296          | 387          | 411          |  |  |  |  |
| Korea , Republic of  | 126          | 205          | 435          | 413          | 380          |  |  |  |  |
| United States of America   | 9            | 0            | 1            | 42           | 272          |  |  |  |  |
| Malaysia   | 132          | 78           | 63           | 63           | 252          |  |  |  |  |
| Japan  | 155          | 263          | 229          | 103          | 62           |  |  |  |  |
| New Zealand  | -            | -            | -            | 16           | 29           |  |  |  |  |
| Taiwan, Province of China  | 152          | 211          | 169          | 46           | 20           |  |  |  |  |
| <b>Total, including other countries</b>  | <b>1 007</b> | <b>1 214</b> | <b>1 383</b> | <b>1 153</b> | <b>1 477</b> |  |  |  |  |

Source: China Customs.

| China: Exports of agar agar (HS 130231), by destination, weight in tonnes, 2012–2016 |               |               |               |               |               |  |
|--|---------------|---------------|---------------|---------------|---------------|--|
| Destination  | 2012          | 2013          | 2014          | 2015          | 2016          |  |
| Italy  | 480           | 722           | 850           | 549           | 775           |  |
| Spain  | 84            | 146           | 353           | 425           | 663           |  |
| Malaysia   | 350           | 670           | 665           | 614           | 612           |  |
| Thailand   | 585           | 524           | 603           | 613           | 598           |  |
| Russian Federation   | 443           | 191           | 399           | 667           | 569           |  |
| Germany  | 458           | 546           | 667           | 618           | 521           |  |
| United States of America   | 104           | 99            | 194           | 212           | 285           |  |
| India  | 228           | 260           | 241           | 247           | 253           |  |
| Japan  | 129           | 95            | 156           | 277           | 244           |  |
| Korea, Republic of.  | 81            | 157           | 186           | 166           | 181           |  |
| Chile  | 127           | 243           | 280           | 211           | 160           |  |
| Taiwan, Province of China  | 107           | 122           | 92            | 130           | 145           |  |
| Brazil   | 88            | 82            | 88            | 116           | 84            |  |
| Ukraine  | 87            | 93            | 57            | 72            | 83            |  |
| Indonesia  | 452           | 106           | 48            | 59            | 50            |  |
| Morocco  | 20            | 20            | 15            | 15            | 75            |  |
| Argentina  | 16            | 42            | 93            | 37            | 59            |  |
| Singapore  | 36            | 52            | 59            | 48            | 53            |  |
| France   | 2             | 1             | 2             | 36            | 45            |  |
| Islamic Republic of Iran   | 50            | 43            | 64            | 58            | 44            |  |
| United Kingdom   | 28            | 52            | 38            | 12            | 38            |  |
| Lithuania  | 1             | 2             | 9             | 11            | 36            |  |
| Bangladesh   | 18            | 24            | 16            | 41            | 35            |  |
| <b>Total Weight (tonnes)</b>   | <b>4 146</b>  | <b>4 488</b>  | <b>5 465</b>  | <b>5 472</b>  | <b>5 846</b>  |  |
| <b>Total Value (USD millions)</b>  | <b>58 803</b> | <b>69 064</b> | <b>97 184</b> | <b>91 558</b> | <b>86 024</b> |  |

Source: China Customs.

| China: Exports of carrageenan (HS 130239), weight in tonnes, 2012-2016 |   |               |               |               |               |               |
|--|---|---------------|---------------|---------------|---------------|---------------|
| HS Code  | Product Type  | 2012          | 2013          | 2014          | 2015          | 2016          |
| 13023912   | Algin   | 24 851        | 24 733        | 25 731        | 27 022        | 28 553        |
| 13023911   | Carrageenan   | 9 422         | 11 365        | 13 164        | 16 251        | 18 591        |
| 13023990   | Other mucilages and thickeners of vegetable product | 4 635         | 4 643         | 5 805         | 5 695         | 5 993         |
| 13023919   | Mucilages and thickeners of seaweeds and algae, Nes | 3 583         | 3 656         | 4 041         | 3 581         | 3 500         |
| <b>130239</b>  | <b>Total carrageenan</b>                            | <b>42 491</b> | <b>44 397</b> | <b>48 742</b> | <b>52 549</b> | <b>56 637</b> |

Source: China Customs.

| China: Exports of carrageenan (HS 130239), value in USD thousands, 2012-2016 |   |                |                |                |                |                |
|--|---|----------------|----------------|----------------|----------------|----------------|
| HS Code  | Product Type  | 2012           | 2013           | 2014           | 2015           | 2016           |
| 13023912   | Algin   | 151 614        | 183 579        | 188 074        | 179 972        | 182 166        |
| 13023911   | Carrageenan   | 71 626         | 95 104         | 117 691        | 116 400        | 101 198        |
| 13023990   | Other mucilages and thickeners of vegetable product | 55 396         | 56 874         | 66 236         | 57 458         | 56 803         |
| 13023919   | Mucilages and thickeners of seaweeds and algae, Nes | 14 686         | 20 992         | 25 031         | 21 953         | 19 967         |
| <b>130239</b>  | <b>Total carrageenan</b>                            | <b>293 323</b> | <b>356 549</b> | <b>397 032</b> | <b>375 782</b> | <b>360 134</b> |

Source: China Customs.

| China: Imports of seaweed fit for human consumption (HS 121221), by origin, weight in tonnes, 2012–2016 |        |         |                |                |                |  |
|---|--------|---------|----------------|----------------|----------------|--|
| Origin  | 2012   | 2013    | 2014           | 2015           | 2016           |  |
| Indonesia   | 62 283 | 105 231 | 126 950        | 126 573        | 137 450        |  |
| Korea, Republic of.   | 958    | 663     | 1 442          | 527            | 3 266          |  |
| Philippines   | 3 485  | 4 210   | 952            | 1339           | 2 662          |  |
| Malaysia  | 161    | 752     | 504            | 1 464          | 1 279          |  |
| Chile   | 1 043  | 51      | 354            | 489            | 921            |  |
| Japan   | 169    | 156     | 166            | 137            | 139            |  |
| Tanzania, United Republic of.   | 240    | 292     | 225            | 538            | 120            |  |
| Papua New Guinea  | -      | 105     | 113            | 258            | 79             |  |
| Taiwan, Province of China   | 80     | 34      | 3              | 12             | 44             |  |
| Russian Federation  | -      | -       | -              | -              | 30             |  |
| <b>Total, including other countries</b>   |        |         | <b>131 001</b> | <b>131 423</b> | <b>146 028</b> |  |

Source: China Customs.

| China: Imports of seaweed and other algae not fit for human consumption (HS 121229), by origin, weight in tonnes, 2012–2016 |                |                |                |               |                |  |
|---|----------------|----------------|----------------|---------------|----------------|--|
| Origin  | 2012           | 2013           | 2014           | 2015          | 2016           |  |
| Chile   | 45 529         | 63 785         | 51 400         | 45 554        | 59 008         |  |
| Peru  | 29 881         | 27 761         | 31 994         | 23 696        | 22 596         |  |
| Indonesia   | 58 936         | 43 492         | 24 011         | 24 226        | 15 477         |  |
| Philippines   | 13 145         | 27 408         | 9 204          | 2 990         | 2 574          |  |
| Korea, Republic of.   | 47             | 1 028          | 838            | 493           | 1 169          |  |
| South Africa  | 775            | 1 000          | 934            | 616           | 962            |  |
| Russian Federation  | -              | -              | 27             | 669           | 809            |  |
| Taiwan, Province of China   | 234            | 21             | 0              | 0             | 454            |  |
| Norway  | -              | -              | 0              | 20            | 92             |  |
| Argentina   | 33             | 37             | 70             | 0             | 45             |  |
| <b>Total, including other countries</b>   | <b>151 209</b> | <b>168 464</b> | <b>122 277</b> | <b>98 908</b> | <b>103 222</b> |  |

Source: China Customs.

| China: Imports of agar-agar (HS 1302), by origin, weight in tonnes, 2012–2016 |            |            |            |            |            |  |
|---|------------|------------|------------|------------|------------|--|
| Origin  | 2012       | 2013       | 2014       | 2015       | 2016       |  |
| Italy   | 174        | 300        | 332        | 27         | 314        |  |
| Korea ,Republic of .  | 15         | 17         | 15         | 26         | 27         |  |
| Morocco   | -          | -          | 3          | 19         | 23         |  |
| Spain   | 13         | 15         | 14         | 15         | 14         |  |
| Germany   | 6          | 5          | 9          | 14         | 14         |  |
| Indonesia   | -          | -          | 2          | 9          | 11         |  |
| Taiwan, Province of China   | 2          | 2          | 2          | 5          | 7          |  |
| Japan   | 4          | 5          | 7          | 5          | 6          |  |
| <b>Total, including other countries</b>                                       | <b>227</b> | <b>348</b> | <b>392</b> | <b>124</b> | <b>418</b> |  |

Source: China Customs.

| Destination                             | 2012          |               |                |               |                |                | 2013           |                |                | 2014           |                |                | 2015           |                |                | 2016           |                |               |
|---|---------------|---------------|----------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
|   | Weight        | Value         | Weight         | Value         | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value         |
|   | China         | 63 799        | 39 205         | 83 491        | 68 830         | 88 915         | 99 168         | 88 915         | 99 168         | 88 915         | 99 168         | 88 915         | 99 168         | 88 915         | 99 168         | 88 915         | 99 168         | 86 035        |
| Chile                                   | 5 076         | 4 620         | 5 202          | 6 426         | 6 122          | 9 912          | 6 122          | 9 912          | 6 122          | 9 912          | 6 122          | 9 912          | 6 122          | 9 912          | 6 122          | 9 912          | 4 858          | 4 544         |
| Philippines                             | 6 327         | 6 928         | 3 835          | 5 434         | 5 173          | 7 581          | 5 173          | 7 581          | 5 173          | 7 581          | 5 173          | 7 581          | 5 173          | 7 581          | 5 173          | 7 581          | 2 386          | 1 680         |
| Korea, Republic of.                     | 1 348         | 1 311         | 1 166          | 1 318         | 2 864          | 3 686          | 2 864          | 3 686          | 2 864          | 3 686          | 2 864          | 3 686          | 2 864          | 3 686          | 2 864          | 3 686          | 1 390          | 975           |
| China, Hong Kong, Special Admin. Region | 1 114         | 383           | 1 422          | 814           | 3 293          | 2 052          | 3 293          | 2 052          | 3 293          | 2 052          | 3 293          | 2 052          | 3 293          | 2 052          | 3 293          | 2 052          | 1 310          | 963           |
| Viet Nam                                | 4 173         | 3 583         | 1 504          | 939           | 4 295          | 2 745          | 4 295          | 2 745          | 4 295          | 2 745          | 4 295          | 2 745          | 4 295          | 2 745          | 4 295          | 2 745          | 1 178          | 451           |
| France                                  | 360           | 243           | 1 040          | 1 144         | 1 239          | 1 308          | 1 239          | 1 308          | 1 239          | 1 308          | 1 239          | 1 308          | 1 239          | 1 308          | 1 239          | 1 308          | 837            | 363           |
| Denmark                                 | 678           | 539           | 1 416          | 1 557         | 257            | 265            | 257            | 265            | 257            | 265            | 257            | 265            | 257            | 265            | 257            | 265            | 676            | 321           |
| Canada                                  | 0             | 0             | 0              | 0             | 1 438          | 1 420          | 1 438          | 1 420          | 1 438          | 1 420          | 1 438          | 1 420          | 1 438          | 1 420          | 1 438          | 1 420          | 441            | 186           |
| Japan                                   | 642           | 381           | 382            | 220           | 341            | 364            | 341            | 364            | 341            | 364            | 341            | 364            | 341            | 364            | 341            | 364            | 406            | 679           |
| Spain                                   | 286           | 1356          | 365            | 1 001         | 1 002          | 2 539          | 1 002          | 2 539          | 1 002          | 2 539          | 1 002          | 2 539          | 1 002          | 2 539          | 1 002          | 2 539          | 381            | 123           |
| Taiwan, Province of China               | 244           | 301           | 191            | 193           | 235            | 177            | 235            | 177            | 235            | 177            | 235            | 177            | 235            | 177            | 235            | 177            | 321            | 133           |
| Argentina                               | 870           | 693           | 550            | 516           | 726            | 952            | 726            | 952            | 726            | 952            | 726            | 952            | 726            | 952            | 726            | 952            | 193            | 139           |
| Tunisia                                 | 665           | 585           | 100            | 85            | 396            | 251            | 396            | 251            | 396            | 251            | 396            | 251            | 396            | 251            | 396            | 251            | 119            | 42            |
| United States of America                | 537           | 770           | 368            | 433           | 1 702          | 2 120          | 1 702          | 2 120          | 1 702          | 2 120          | 1 702          | 2 120          | 1 702          | 2 120          | 1 702          | 2 120          | 118            | 53            |
| Morocco                                 | 0             | 0             | 0              | 0             | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 100            | 74            |
| Singapore                               | 0             | 0             | 25             | 7             | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 57             | 21            |
| India                                   | 0             | 0             | 37             | 19            | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 55             | 90            |
| Malaysia                                | 402           | 507           | 307            | 354           | 304            | 377            | 304            | 377            | 304            | 377            | 304            | 377            | 304            | 377            | 304            | 377            | 43             | 63            |
| Germany                                 | 0             | 0             | 0              | 0             | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 41             | 14            |
| Thailand                                | 28            | 25            | 0              | 0             | 55             | 65             | 55             | 65             | 55             | 65             | 55             | 65             | 55             | 65             | 55             | 65             | 28             | 23            |
| <b>Total, including other countries</b> | <b>86 817</b> | <b>62 631</b> | <b>101 547</b> | <b>89 904</b> | <b>118 759</b> | <b>136 450</b> | <b>118 759</b> | <b>136 450</b> | <b>118 759</b> | <b>136 450</b> | <b>118 759</b> | <b>136 450</b> | <b>118 759</b> | <b>136 450</b> | <b>118 759</b> | <b>136 450</b> | <b>100 972</b> | <b>70 195</b> |

Sources: Statistics Indonesia.



Annex 10b

| Indonesia: Exports of carrageenan, weight in tonnes, 2012-2016 |  |              |              |              |              |              |
|--|--|--------------|--------------|--------------|--------------|--------------|
| HS Codes   | Product Type   | 2012         | 2013         | 2014         | 2015         | 2016         |
| 1302391010   | Carageenan In Powder Form                            | 3 707        | 4 057        | 4 164        | 4 138        | 4 565        |
| 1302399000   | Mucilages & Thickeners, Whether Or Not Modified, Der | 826          | 542          | 120          | 242          | 521          |
| 1302391090   | Carageenan Not In Powder Form                        | 732          | 700          | 648          | 810          | 417          |
| 1302391000   | Carageenan, Other                                    | 0            | 0            | 0            | 0            | 0            |
| <b>130239</b>  | <b>Total carrageenan</b>                             | <b>5 266</b> | <b>5 299</b> | <b>4 933</b> | <b>5 190</b> | <b>5 503</b> |

Source: Statistics Indonesia.

Annex 10c

| Indonesia: Exports of carrageenan, value in USD thousands, 2012-2016 |  |               |               |               |               |                |
|--|--|---------------|---------------|---------------|---------------|----------------|
| HS Codes   | Product Type   | 2012          | 2013          | 2014          | 2015          | 2016           |
| 1302391010   | Carageenan In Powder Form                            | 27 026        | 30 540        | 34 504        | 29 655        | 26 794         |
| 1302391090   | Carageenan Not In Powder Form                        | 3 879         | 3 448         | 3 995         | 5 469         | 2 093          |
| 1302399000   | Mucilages & Thickeners, whether or not modified, Der | 886           | 672           | 349           | 715           | 811            |
| 1302391000   | Carageenan, Other                                    | 0             | 0             | 0             | 0             | 0              |
| <b>130239</b>  | <b>Total carrageenan</b>                             | <b>31 791</b> | <b>34 660</b> | <b>38 848</b> | <b>35 840</b> | <b>296 989</b> |

Source: Statistics Indonesia.

Annex 11a

| Destination   | 2012   |        |        | 2013   |        |        | 2014   |        |        | 2015   |       |  | 2016   |       |  |  |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--|--------|-------|--|--|
|   | Weight | Value  |        | Weight | Value  |        | Weight | Value  |        | Weight | Value |  | Weight | Value |  |  |
|   |        |        |        |        |        |        |        |        |        |        |       |  |        |       |  |  |
| China   | 14 444 | 5 669  | 23 959 | 4 580  | 7 398  | 15 829 | 3 529  | 2 052  | 7 136  | 4 450  |       |  |        |       |  |  |
| United States of America                              | 4 607  | 4 462  | 6 709  | 7 400  | 5 622  | 9 362  | 3 888  | 4 944  | 2 033  | 1 247  |       |  |        |       |  |  |
| France  | 1 740  | 1 400  | 806    | 727    | 1 505  | 1 246  | 3 033  | 1 307  | 1 276  | 759    |       |  |        |       |  |  |
| China, Hong Kong, Special Administrative Region (SAR) | 77     | 280    | 125    | 435    | 86     | 237    | 49     | 50     | 129    | 89     |       |  |        |       |  |  |
| Spain   | 1 953  | 8 877  | 2 431  | 13 171 | 1 823  | 11 452 | 1 145  | 6 805  | 102    | 481    |       |  |        |       |  |  |
| United Kingdom  | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 101    | 477    |       |  |        |       |  |  |
| Denmark   | 18     | 12     | 0      | 0      | 0      | 0      | 0      | 0      | 66     | 218    |       |  |        |       |  |  |
| Korea, Republic of.                                   | 488    | 618    | 1 150  | 718    | 224    | 606    | 2 314  | 1 618  | 62     | 273    |       |  |        |       |  |  |
| Argentina   | 120    | 213    | 0      | 0      | 0      | 0      | 20     | 18     | 50     | 258    |       |  |        |       |  |  |
| Brazil  | 82     | 500    | 376    | 2 383  | 302    | 2 636  | 200    | 1 786  | 31     | 134    |       |  |        |       |  |  |
| Taiwan, Province of China                             | 77     | 84     | 70     | 240    | 46     | 76     | 78     | 84     | 23     | 26     |       |  |        |       |  |  |
| Viet Nam  | 381    | 281    | 174    | 137    | 384    | 153    | 94     | 53     | 20     | 21     |       |  |        |       |  |  |
| Israel  | 0      | 0      | 0      | 0      | 0      | 0      | 20     | 37     | 15     | 42     |       |  |        |       |  |  |
| Indonesia   | 132    | 1 369  | 2      | 15     | 2      | 16     | 1      | 8      | 5      | 16     |       |  |        |       |  |  |
| Japan   | 19     | 26     | 365    | 564    | 49     | 399    | 0      | 0      | 2      | 38     |       |  |        |       |  |  |
| Lebanon   | 1      | 1      | 1      | 2      | 1      | 1      | 1      | 1      | 1      | 1      |       |  |        |       |  |  |
| Malaysia  | 20     | 205    | 57     | 41     | 1      | 9      | 2      | 16     | 0      | 0      |       |  |        |       |  |  |
| New Zealand   | 25     | 88     | 74     | 127    | 10     | 94     | 13     | 100    | 0      | 0      |       |  |        |       |  |  |
| India   | 0      | 0      | 0      | 1      | 10     | 90     | 13     | 132    | 0      | 0      |       |  |        |       |  |  |
| Total, including other countries                      | 26 053 | 31 319 | 37 063 | 34 356 | 18 493 | 49 300 | 14 910 | 21 739 | 11 052 | 8 539  |       |  |        |       |  |  |

Source: Philippines Statistics Authority.

Annex 11b

| <b>Philippines: Exports of carrageenan (HS 130239), weight in tonnes, 2012–2016</b> |                                       |               |               |               |               |               |
|---|---------------------------------------|---------------|---------------|---------------|---------------|---------------|
| <b>HS Codes</b>   | <b>Product Type</b>                   | <b>2012</b>   | <b>2013</b>   | <b>2014</b>   | <b>2015</b>   | <b>2016</b>   |
| 1302391019  | Other Refined                         | 20 673        | 14 586        | 15 871        | 19 169        | 31 002        |
| 1302391009  | Other Semi- Refined                   | 1 597         | 1 525         | 369           | 286           | 486           |
| 1302391001  | Semi-Refined, Food Grade              | 10            | 4 040         | 9 489         | 7 195         | 204           |
| 1302391011  | Refined Blended With Other Gums, etc. | 4             | 7             | 16            | 0             | 61            |
| 1302399000  | Other                                 | 1 750         | 3 345         | 889           | 531           | 60            |
| <b>130239</b>   | <b>Total carrageenan</b>              | <b>24 035</b> | <b>23 503</b> | <b>26 633</b> | <b>27 181</b> | <b>31 813</b> |

Source: Philippines Statistics Authority.

Annex 11c

| <b>Philippines: Exports of carrageenan (HS 130239), value in USD thousands, 2012–2016</b> |                                       |                |                |                |                |                |
|---|---------------------------------------|----------------|----------------|----------------|----------------|----------------|
| <b>HS Codes</b>   | <b>Product Type</b>                   | <b>2012</b>    | <b>2013</b>    | <b>2014</b>    | <b>2015</b>    | <b>2016</b>    |
| 1302391019  | Other Refined                         | 130 130        | 133 647        | 126 512        | 137 350        | 185 883        |
| 1302391009  | Other Semi- Refined                   | 12 640         | 8 364          | 2 643          | 1 187          | 2 243          |
| 1302391001  | Semi-Refined, Food Grade              | 90             | 28 949         | 77 353         | 41 924         | 1 348          |
| 1302391011  | Refined Blended With Other Gums, etc. | 30             | 69             | 134            | 0              | 295            |
| 1302399000  | Other                                 | 9 937          | 24 214         | 6 596          | 5 000          | 402            |
| <b>130239</b>   | <b>Total carrageenan</b>              | <b>152 827</b> | <b>195 242</b> | <b>213 239</b> | <b>185 461</b> | <b>190 172</b> |

Source: Philippines Statistics Authority.

Annex 12

| Chile: Exports of seaweed, weight in tonnes; value in USD thousands, 2012–2016 |               |                |               |                |               |                |               |                |               |                |  |  |
|--|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|--|--|
| Products   | 2012          |                | 2013          |                | 2014          |                | 2015          |                | 2016          |                |  |  |
|  | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          |  |  |
| Edible seaweed   | 5 616         | 10 942         | 5 619         | 12 949         | 3 522         | 8 663          | 1 107         | 4 162          | 748           | 4 617          |  |  |
| Non- edible Seaweed  | 65 582        | 85 349         | 76 192        | 129 424        | 71 152        | 134 188        | 67 052        | 96 563         | 75 170        | 103 281        |  |  |
| Agar-agar  | 1 925         | 43 804         | 1 771         | 44 070         | 1 780         | 48 754         | 1 825         | 48 790         | 1 562         | 39 030         |  |  |
| Carrageenan  | 4 867         | 58 183         | 4 827         | 70 781         | 4 811         | 72 475         | 5 254         | 73 548         | 5 002         | 59 622         |  |  |
| <b>Total</b>   | <b>77 990</b> | <b>19 8278</b> | <b>88 409</b> | <b>257 224</b> | <b>81 265</b> | <b>264 080</b> | <b>75 238</b> | <b>223 063</b> | <b>82 482</b> | <b>206 550</b> |  |  |

Source: National Customs Service (Servicio Nacional de Aduana).

| Country  | World: Exports of seaweed and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012-2016 |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
|--|--|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|  | 2012   |                |                | 2013           |                |                | 2014           |                |                | 2015           |                |                | 2016           |                |                |
|  | Weight   | Value          |                | Weight         | Value          |                | Weight         | Value          |                | Weight         | Value          |                | Weight         | Value          |                |
| Indonesia  | 86 817   | 62 631         | 101 547        | 89 904         | 118 759        | 136 450        | 156 390        | 127 361        | 100 972        | 100 972        | 127 361        | 156 390        | 100 972        | 100 972        | 70 195         |
| Korea, Republic of .                             | 27 193   | 157 018        | 26 323         | 135 047        | 22 408         | 135 941        | 22 908         | 144 350        | 31 719         | 188 384        | 144 350        | 22 908         | 31 719         | 188 384        | 188 384        |
| China  | 21 595   | 132 007        | 14 185         | 70 794         | 12 545         | 66 847         | 11 654         | 53 739         | 14 721         | 56 179         | 53 739         | 11 654         | 14 721         | 56 179         | 56 179         |
| Japan  | 35 043   | 19 247         | 28 150         | 17 110         | 25 701         | 16 468         | 9 827          | 14 702         | 14 620         | 17 333         | 14 702         | 9 827          | 14 620         | 17 333         | 17 333         |
| Malaysia   | 0  | 0              | 550            | 921            | 687            | 1 326          | 2 261          | 1 871          | 2 224          | 1 764          | 1 871          | 2 261          | 2 224          | 1 764          | 1 764          |
| United Kingdom                                   | 958  | 4 524          | 1 030          | 5 077          | 1 107          | 6 183          | 1 359          | 6 039          | 1 496          | 8 082          | 6 039          | 1 359          | 1 496          | 8 082          | 8 082          |
| South Africa                                     | 269  | 670            | 290            | 649            | 1 050          | 1 357          | 731            | 1 064          | 1 299          | 1 690          | 1 064          | 731            | 1 299          | 1 690          | 1 690          |
| United States of America                         | 1 054  | 12 548         | 1 342          | 15 335         | 1 393          | 15 673         | 1 254          | 14 439         | 1 132          | 12 021         | 14 439         | 1 254          | 1 132          | 12 021         | 12 021         |
| Japan  | 992  | 19 247         | 1 209          | 17 110         | 1 136          | 16 468         | 1 169          | 14 702         | 1 061          | 17 333         | 14 702         | 1 169          | 1 061          | 17 333         | 17 333         |
| France   | 910  | 3 486          | 914            | 4 202          | 824            | 4 534          | 974            | 4 352          | 991            | 3 966          | 4 352          | 974            | 991            | 3 966          | 3 966          |
| Chile  | 5 616  | 10 943         | 5 619          | 12 949         | 3 522          | 8 663          | 1 107          | 4 162          | 748            | 4 617          | 4 162          | 1 107          | 748            | 4 617          | 4 617          |
| Germany  | 366  | 2 860          | 725            | 5 362          | 502            | 4 064          | 671            | 4 633          | 710            | 3 636          | 4 633          | 671            | 710            | 3 636          | 3 636          |
| Ireland  | 579  | 781            | 481            | 718            | 1 190          | 613            | 687            | 329            | 433            | 368            | 613            | 687            | 433            | 368            | 368            |
| Thailand   | 135  | 2 523          | 441            | 5 039          | 414            | 4 157          | 622            | 4 331          | 428            | 3 494          | 4 331          | 622            | 428            | 3 494          | 3 494          |
| Taiwan, Province of China                        | 0  | 0              | 14             | 303            | 253            | 5 138          | 236            | 4 318          | 410            | 5 038          | 4 318          | 236            | 410            | 5 038          | 5 038          |
| Denmark  | 609  | 4 738          | 549            | 4 575          | 364            | 3 332          | 364            | 2 853          | 361            | 2 880          | 2 853          | 364            | 361            | 2 880          | 2 880          |
| Netherlands                                      | 420  | 7 733          | 336            | 9 688          | 319            | 8 395          | 192            | 3 608          | 292            | 4 991          | 3 608          | 192            | 292            | 4 991          | 4 991          |
| Spain  | 308  | 2 695          | 236            | 2 311          | 202            | 3 438          | 455            | 3 877          | 238            | 2 571          | 3 877          | 455            | 238            | 2 571          | 2 571          |
| Belgium  | 126  | 994            | 108            | 941            | 168            | 1 610          | 113            | 1 402          | 171            | 1 648          | 1 402          | 113            | 171            | 1 648          | 1 648          |
| Poland   | 2  | 43             | 2              | 15             | 1              | 4              | 3              | 23             | 166            | 509            | 4              | 3              | 166            | 509            | 509            |
| Austria  | 49   | 320            | 73             | 648            | 94             | 818            | 170            | 1 214          | 163            | 1 451          | 1 214          | 170            | 163            | 1 451          | 1 451          |
| Russian Federation                               | 77   | 733            | 133            | 1 312          | 124            | 1 336          | 116            | 1 252          | 143            | 1 542          | 1 336          | 116            | 143            | 1 542          | 1 542          |
| Norway   | 162  | 287            | 6              | 79             | 10             | 173            | 10             | 189            | 114            | 406            | 173            | 10             | 114            | 406            | 406            |
| <b>Total of top 23 countries and territories</b> | <b>183 280</b>   | <b>446 028</b> | <b>184 263</b> | <b>400 089</b> | <b>192 773</b> | <b>442 988</b> | <b>213 273</b> | <b>414 810</b> | <b>174 612</b> | <b>410 098</b> | <b>414 810</b> | <b>213 273</b> | <b>174 612</b> | <b>410 098</b> | <b>410 098</b> |

Source: National Statistics.

| Country  | 2012           |                | 2013           |                | 2014           |                | 2015           |                | 2016           |                |
|--|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|  | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          |
| Indonesia  | 81 463         | 71 524         | 74 564         | 72 552         | 81 947         | 89 778         | 49 915         | 33 048         | 81 399         | 53 812         |
| Chile  | 65 582         | 85 349         | 76 192         | 129 424        | 71 151         | 134 188        | 67 052         | 96 563         | 75 170         | 103 281        |
| Ireland  | 31 829         | 15 944         | 37 754         | 21 327         | 42 153         | 23 026         | 49 313         | 22 773         | 44 722         | 24 580         |
| Peru   | 27 120         | 23 374         | 30 440         | 35 710         | 29 008         | 32 889         | 24 385         | 17 875         | 21 687         | 16 058         |
| Iceland  | 1 815          | 1 559          | 4 439          | 3 795          | 4 255          | 4 188          | 3 083          | 3 309          | 4 959          | 6 998          |
| France   | 1 408          | 8 035          | 1 824          | 8 914          | 1 622          | 7 372          | 2 293          | 3 787          | 4 448          | 6 193          |
| Norway   | 562            | 1 256          | 633            | 1 451          | 892            | 2 032          | 2 255          | 2 721          | 3 525          | 4 026          |
| Morocco  | -              | -              | -              | -              | 0              | 0              | 2 425          | 8 676          | 2 507          | 10 410         |
| Portugal   | 339            | 717            | 929            | 2 116          | 152            | 722            | 899            | 2 204          | 1 635          | 3 631          |
| China  | 1 007          | 1 352          | 1 214          | 984            | 1 383          | 1 317          | 1 153          | 2 949          | 1 477          | 1 896          |
| Russian Federation                               | 0              | 0              | 0              | 10             | 46             | 36             | 770            | 65             | 1 031          | 66             |
| Spain  | 428            | 919            | 740            | 1 978          | 887            | 2 717          | 1 171          | 2 934          | 946            | 3 029          |
| Australia  | 1 180          | 1 589          | 836            | 1 143          | 959            | 1 340          | 552            | 690            | 870            | 1 018          |
| Germany  | 88             | 677            | 248            | 2 293          | 250            | 950            | 233            | 841            | 706            | 1 437          |
| United Kingdom                                   | 486            | 1 566          | 414            | 1 605          | 843            | 2 021          | 923            | 1 989          | 481            | 1 115          |
| Mexico   | 133            | 173            | 295            | 405            | 503            | 709            | 419            | 619            | 396            | 656            |
| Netherlands                                      | 180            | 583            | 514            | 1 660          | 304            | 1 741          | 661            | 2 522          | 358            | 1 521          |
| Taiwan, Province of China                        | 0              | 0              | 5              | 22             | 47             | 447            | 75             | 458            | 292            | 388            |
| United States of America                         | 357            | 4 001          | 207            | 2 557          | 270            | 2 653          | 224            | 2 708          | 204            | 2 670          |
| Argentina  | 74             | 483            | 77             | 493            | 158            | 769            | 101            | 935            | 201            | 1 079          |
| Belgium  | 159            | 675            | 316            | 265            | 391            | 479            | 180            | 263            | 160            | 333            |
| Italy  | 26             | 64             | 20             | 64             | 41             | 162            | 76             | 180            | 158            | 410            |
| Japan  | 84             | 1 060          | 99             | 1 075          | 109            | 1 199          | 133            | 1 229          | 153            | 1 636          |
| South Africa                                     | 1 130          | 937            | 1 379          | 1 145          | 800            | 1 000          | 537            | 567            | 134            | 402            |
| Brazil   | 132            | 212            | 123            | 224            | 159            | 392            | 148            | 414            | 125            | 312            |
| India  | 0              | 0              | 157            | 3 032          | 227            | 4 507          | 295            | 5 526          | 121            | 2 406          |
| Thailand   | 195            | 552            | 189            | 406            | 189            | 349            | 123            | 343            | 114            | 296            |
| <b>Total of top 27 countries and territories</b> | <b>215 777</b> | <b>222 601</b> | <b>233 608</b> | <b>294 651</b> | <b>238 746</b> | <b>316 982</b> | <b>209 394</b> | <b>216 188</b> | <b>247 979</b> | <b>248 658</b> |

Source: National Statistics.

| Country  | World: Exports of agar-agar (HS 130231), weight in tonnes; value USD thousands, 2012–2016 |                |               |                |               |                |               |                |               |                |        |       |
|--|---|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|--------|-------|
|  | 2012  |                | 2013          |                | 2014          |                | 2015          |                | 2016          |                |        |       |
|  | Weight  | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight | Value |
| China  | 4 146   | 58 803         | 4 488         | 69 064         | 5 465         | 97 184         | 5 472         | 91 558         | 5 846         | 86 024         |        |       |
| Chile  | 1 925   | 43 804         | 1 771         | 44 070         | 1 780         | 48 754         | 1 825         | 48 790         | 1 562         | 39 030         |        |       |
| Spain  | 1 062   | 23 896         | 1 179         | 30 292         | 1 309         | 36 445         | 1 478         | 37 971         | 1 302         | 33 581         |        |       |
| Indonesia  | 1 292   | 12 861         | 1 056         | 13 084         | 933           | 14 812         | 750           | 9 932          | 946           | 8 908          |        |       |
| Morocco  | 932   | 23 677         | 1 066         | 28 225         | 925           | 25 485         | 905           | 24 117         | 936           | 26 258         |        |       |
| Germany  | 407   | 9 507          | 520           | 12 846         | 606           | 15 992         | 658           | 14 650         | 672           | 13 564         |        |       |
| Taiwan, Province of China                        | 66  | 268            | 114           | 360            | 201           | 578            | 229           | 575            | 496           | 1 050          |        |       |
| Korea, Republic of .                             | 380   | 12 152         | 478           | 13 143         | 465           | 12 727         | 416           | 10 809         | 429           | 12 039         |        |       |
| Thailand   | 135   | 1 091          | 95            | 987            | 55            | 1 015          | 189           | 1 289          | 199           | 1 507          |        |       |
| India  | 184   | 3 029          | 210           | 3 778          | 163           | 3 370          | 148           | 2 858          | 166           | 2 909          |        |       |
| France   | 152   | 5 196          | 188           | 6 589          | 170           | 4 100          | 114           | 3 243          | 138           | 4 462          |        |       |
| United States of America                         | 213   | 6 218          | 270           | 8 787          | 197           | 8 294          | 170           | 6 991          | 134           | 4 506          |        |       |
| Mexico   | 45  | 1 181          | 60            | 1 573          | 78            | 2 168          | 99            | 2 826          | 101           | 2 755          |        |       |
| Belgium  | 44  | 1 757          | 62            | 2 484          | 116           | 3 841          | 186           | 3 308          | 100           | 2 859          |        |       |
| Singapore  | 58  | 992            | 79            | 1 578          | 76            | 1 720          | 58            | 1 316          | 76            | 1 294          |        |       |
| United Kingdom                                   | 92  | 1 638          | 125           | 2 238          | 83            | 2 122          | 57            | 1 629          | 68            | 2 019          |        |       |
| Belarus  | -   | -              | -             | -              | 0             | 12             | 7             | 31             | 51            | 36             |        |       |
| Netherlands                                      | 73  | 1 469          | 97            | 1 820          | 135           | 2 626          | 124           | 1 998          | 51            | 2 035          |        |       |
| Malaysia   | 52  | 242            | 13            | 225            | 11            | 133            | 126           | 226            | 42            | 195            |        |       |
| Lithuania  | 4   | 91             | 13            | 527            | 18            | 156            | 31            | 335            | 39            | 399            |        |       |
| Japan  | 29  | 1 364          | 32            | 1 317          | 27            | 1 193          | 21            | 983            | 36            | 1 576          |        |       |
| <b>Total of top 21 countries and territories</b> | <b>13 303</b>   | <b>209 236</b> | <b>13 929</b> | <b>242 987</b> | <b>14 827</b> | <b>282 727</b> | <b>15 078</b> | <b>265 435</b> | <b>15 406</b> | <b>247 006</b> |        |       |

Source: National Statistics.

## Annex 16a

| <b>World: Exports of carrageenan (HS 130239), top 35 exporters, weight in tonnes, 2012–2016</b> |                |                |                |                |                |
|---|----------------|----------------|----------------|----------------|----------------|
| <b>Exporting countries</b>  | <b>2012</b>    | <b>2013</b>    | <b>2014</b>    | <b>2015</b>    | <b>2016</b>    |
| China   | 42 491         | 44 397         | 48 742         | 52 549         | 56 637         |
| Philippines   | 24 035         | 23 503         | 26 633         | 27 181         | 31 813         |
| Germany   | 9 821          | 11 283         | 9 460          | 8 202          | 7 871          |
| Netherlands   | 3 543          | 9 031          | 12 500         | 2 427          | 1 973          |
| Spain   | 7 271          | 7 370          | 7 722          | 9 598          | 9 128          |
| India   | 5 790          | 7 018          | 5 962          | 2 408          | 1 019          |
| USA   | 7 365          | 6 896          | 6 233          | 5 805          | 5 593          |
| France  | 6 419          | 6 043          | 5 839          | 5 145          | 5 442          |
| Indonesia   | 5 266          | 5 299          | 4 933          | 5 190          | 5 503          |
| United Kingdom  | 5 984          | 5 056          | 4 612          | 4 907          | 5 591          |
| Chile   | 4 867          | 4 827          | 4 811          | 5 254          | 5 002          |
| Belgium   | 4 498          | 3 607          | 3 786          | 3 677          | 3 513          |
| Canada  | 2 711          | 2 793          | 2 928          | 2 953          | 2 737          |
| Korea Republic of.  | 2 156          | 2 671          | 2 345          | 2 514          | 2 280          |
| Peru  | 3 341          | 2 367          | 2 264          | 2 408          | 2 487          |
| Guatemala   | 1 390          | 1 484          | 1 313          | 1 308          | 1 330          |
| Italy   | 1 632          | 1 333          | 1 615          | 1 364          | 2 165          |
| Malaysia  | 741            | 754            | 1 018          | 798            | 573            |
| Thailand  | 880            | 619            | 675            | 779            | 711            |
| Romania   | 427            | 588            | 392            | 445            | 308            |
| Switzerland   | 483            | 391            | 408            | 350            | 334            |
| South Africa  | 236            | 325            | 120            | 99             | 65             |
| Poland  | 196            | 224            | 313            | 1 089          | 3 047          |
| Singapore   | 376            | 211            | 163            | 318            | 124            |
| China, Hong Kong, Special Administrative Region   | 185            | 189            | 141            | 121            | 121            |
| Austria   | 167            | 186            | 134            | 138            | 113            |
| Greece  | 16             | 160            | 6              | 18             | 6              |
| Islamic Republic of Iran  | 18             | 152            | 330            | 597            | 89             |
| Argentina   | 128            | 144            | 357            | 132            | 332            |
| <b>Total of top 35 countries and territories</b>  | <b>142 433</b> | <b>148 921</b> | <b>155 755</b> | <b>147 774</b> | <b>155 907</b> |

Source: National Statistics.



| World: Exports of carrageenan (HS 130239), top 35 exporters, value in USD thousands, 2012–2016 |                  |                  |                  |                  |                  |  |
|--|------------------|------------------|------------------|------------------|------------------|--|
| Leading Exporters  | 2012             | 2013             | 2014             | 2015             | 2016             |  |
| China  | 293 323          | 356 549          | 397 032          | 375 782          | 360 134          |  |
| Philippines  | 152 827          | 195 242          | 213 239          | 185 461          | 190 172          |  |
| United States of America   | 91 867           | 83 374           | 80 459           | 75 345           | 70 996           |  |
| France   | 74 925           | 80 161           | 83 008           | 68 036           | 68 209           |  |
| Chile  | 58 184           | 70 781           | 72 475           | 73 458           | 59 622           |  |
| Germany  | 59 707           | 67 273           | 65 553           | 54 530           | 49 215           |  |
| Spain  | 54 488           | 62 709           | 71 489           | 75 628           | 68 571           |  |
| Indonesia  | 31 791           | 34 660           | 38 848           | 35 840           | 29 698           |  |
| Belgium  | 39 002           | 33 601           | 38 057           | 33 765           | 31 230           |  |
| United Kingdom   | 36 330           | 29 534           | 25 981           | 26 055           | 27 897           |  |
| Korea , Republic of .  | 23 270           | 28 370           | 26 872           | 25 345           | 21 771           |  |
| Canada   | 18 427           | 18 299           | 18 466           | 18 908           | 16 456           |  |
| Peru   | 23 177           | 16 882           | 13 652           | 12 176           | 9 941            |  |
| Italy  | 13 908           | 14 528           | 12 996           | 9 965            | 10 188           |  |
| Netherlands  | 9 925            | 14 161           | 14 494           | 15 927           | 12 249           |  |
| India  | 12 586           | 13 788           | 11 959           | 8 414            | 3 400            |  |
| Malaysia   | 3 618            | 5 239            | 6 463            | 4 804            | 2 694            |  |
| Guatemala  | 3 859            | 4 130            | 3 531            | 3 448            | 3 602            |  |
| Switzerland  | 3 959            | 3 497            | 3 763            | 2 445            | 2 159            |  |
| Israel   | 2 586            | 3 274            | 2 661            | 2 230            | 570              |  |
| Thailand   | 3 063            | 2 856            | 3 744            | 3 952            | 3 884            |  |
| Singapore  | 4 893            | 2 760            | 2 298            | 1 933            | 1 507            |  |
| Poland   | 2 054            | 2 509            | 3 411            | 2 606            | 2 981            |  |
| South Africa   | 1 291            | 1 809            | 603              | 354              | 266              |  |
| China, Hong Kong Special Administrative Region (SAR)   | 1 862            | 1 721            | 994              | 973              | 945              |  |
| Austria  | 1 440            | 1 327            | 972              | 910              | 721              |  |
| Estonia  | 1 186            | 1 311            | 1 350            | 1 063            | 855              |  |
| Argentina  | 1 062            | 1 220            | 3 033            | 1 120            | 2 638            |  |
| Japan  | 1 416            | 997              | 1 586            | 1 876            | 1 370            |  |
| <b>Total of top 35 countries and territories</b>   | <b>1 026 025</b> | <b>1 152 560</b> | <b>1 218 989</b> | <b>1 122 348</b> | <b>1 053 939</b> |  |

Source: National Statistics.

| World: Imports of seaweeds and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012–2016 |                |                |  |                |                |  |                |                |  |                |                |  |                |                |
|---|----------------|----------------|--|----------------|----------------|--|----------------|----------------|--|----------------|----------------|--|----------------|----------------|
| Country   | 2012           |                |  | 2013           |                |  | 2014           |                |  | 2015           |                |  | 2016           |                |
|   | Weight         | Value          |  | Weight         | Value          |  | Weight         | Value          |  | Weight         | Value          |  | Weight         | Value          |
| China   | 68 812         | 77 271         |  | 113 147        | 135 635        |  | 131 001        | 180 190        |  | 131 423        | 125 436        |  | 146 028        | 118 544        |
| Japan   | 36 910         | 211 155        |  | 30 776         | 177 688        |  | 31 427         | 179 062        |  | 30 182         | 164 276        |  | 32 989         | 210 207        |
| Taiwan, Province of China   | 0              | 0              |  | 1 436          | 4 478          |  | 17 569         | 43 252         |  | 17 676         | 44 083         |  | 16 229         | 43 581         |
| Korea, Republic of  | 17 625         | 22 231         |  | 12 665         | 14 841         |  | 14 325         | 22 125         |  | 19 135         | 19 609         |  | 12 159         | 15 587         |
| United States of America  | 7 789          | 51 028         |  | 6 370          | 61 497         |  | 7 180          | 60 670         |  | 10 695         | 72 678         |  | 8 560          | 55 883         |
| United Kingdom  | 952            | 5 137          |  | 2 339          | 7 914          |  | 5 413          | 11 943         |  | 6 889          | 15 298         |  | 5 922          | 10 817         |
| Thailand  | 2 121          | 15 417         |  | 2 759          | 25 901         |  | 3 408          | 36 334         |  | 3 837          | 40 690         |  | 4 554          | 56 450         |
| Norway  | 7 693          | 9 196          |  | 6 318          | 7 691          |  | 6 402          | 9 710          |  | 7 688          | 13 506         |  | 4 125          | 7 074          |
| France  | 16 055         | 27 760         |  | 13 068         | 25 880         |  | 11 013         | 26 443         |  | 3 246          | 9 376          |  | 3 482          | 9 557          |
| Russian Federation  | 2 568          | 5 188          |  | 2 978          | 6 610          |  | 4 384          | 11 301         |  | 2 903          | 7 797          |  | 2 506          | 6 691          |
| Australia   | 1 210          | 16 243         |  | 1 315          | 19 552         |  | 1 480          | 19 063         |  | 2 149          | 21 188         |  | 2 218          | 19 011         |
| Chile   | 2 710          | 4 863          |  | 3 993          | 7 285          |  | 2 688          | 8 194          |  | 2 986          | 7 611          |  | 1 598          | 4 889          |
| Germany   | 758            | 6 507          |  | 1 219          | 10 524         |  | 1 104          | 5 046          |  | 1 371          | 4 743          |  | 1 374          | 5 713          |
| Austria   | 694            | 1 956          |  | 1 037          | 3 477          |  | 904            | 3 120          |  | 1 026          | 3 237          |  | 1 068          | 3 977          |
| China, Hong Kong SAR  | 754            | 2 748          |  | 825            | 3 806          |  | 1 114          | 4 789          |  | 2 018          | 8 326          |  | 1 068          | 5 161          |
| Malaysia  | 0              | 0              |  | 496            | 4 190          |  | 651            | 4 546          |  | 880            | 6 204          |  | 914            | 11 430         |
| Poland  | 404            | 835            |  | 323            | 1 163          |  | 544            | 1 459          |  | 612            | 1 780          |  | 733            | 2 802          |
| Brazil  | 507            | 2 833          |  | 792            | 5 008          |  | 810            | 5 851          |  | 812            | 6 111          |  | 719            | 4 812          |
| Spain   | 227            | 1 695          |  | 257            | 2 411          |  | 552            | 5 371          |  | 605            | 3 938          |  | 592            | 5 054          |
| Italy   | 304            | 4 415          |  | 399            | 5 946          |  | 501            | 5 605          |  | 496            | 6 085          |  | 580            | 6 135          |
| Singapore   | 349            | 4 886          |  | 270            | 4 241          |  | 344            | 4 502          |  | 465            | 5 658          |  | 536            | 6 967          |
| Ukraine   | -              | -              |  | -              | -              |  | 716            | 1 667          |  | 463            | 1 020          |  | 521            | 1 093          |
| Belarus   | 479            | 2 002          |  | 743            | 3 339          |  | 723            | 2 963          |  | 678            | 2 517          |  | 517            | 1 682          |
| New Zealand   | 495            | 3 947          |  | 740            | 4 066          |  | 377            | 4 468          |  | 323            | 3 779          |  | 383            | 5 840          |
| India   | 0              | 0              |  | 217            | 5 505          |  | 209            | 9 616          |  | 177            | 10 778         |  | 355            | 5 111          |
| Belgium   | 258            | 1 622          |  | 186            | 1 769          |  | 314            | 3 033          |  | 371            | 2 489          |  | 318            | 2 535          |
| Netherlands   | 399            | 5 249          |  | 290            | 4 771          |  | 252            | 4 292          |  | 452            | 5 530          |  | 294            | 4 649          |
| Mexico  | 171            | 2 487          |  | 215            | 3 347          |  | 243            | 4 203          |  | 282            | 4 720          |  | 279            | 4 683          |
| Kazakhstan  | 311            | 474            |  | 340            | 495            |  | 270            | 413            |  | 319            | 423            |  | 187            | 258            |
| Sweden  | 117            | 1 121          |  | 127            | 1 164          |  | 150            | 1 207          |  | 172            | 1 262          |  | 176            | 1 481          |
| Denmark   | 145            | 1 767          |  | 117            | 2 207          |  | 191            | 1 963          |  | 184            | 1 632          |  | 175            | 1 758          |
| Argentina   | 0              | 0              |  | 56             | 360            |  | 79             | 465            |  | 80             | 530            |  | 110            | 785            |
| <b>Total of top 32 countries and territories</b>  | <b>17 0817</b> | <b>49 0033</b> |  | <b>20 5813</b> | <b>562 762</b> |  | <b>246 338</b> | <b>682 866</b> |  | <b>250 595</b> | <b>622 310</b> |  | <b>251 269</b> | <b>640 217</b> |

Source: National Statistics.

| Country                   | World: Imports of seaweed and other algae not fit for human consumption (HS 121229), weight in tonnes; value in USD thousands, 2012–2016 |                |                |                |                |                |                |                |                |                |
|---------------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                           | 2012   |                | 2013           |                | 2014           |                | 2015           |                | 2016           |                |
|                           | Weight   | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          | Weight         | Value          |
| China                     | 151 209  | 131 937        | 168 464        | 189 766        | 122 277        | 157 973        | 98 908         | 94 839         | 103 222        | 106 485        |
| Ireland                   | 329  | 471            | 21 511         | 3 054          | 34 140         | 5 382          | 46 089         | 5 860          | 45 563         | 6 797          |
| United States of America  | 19 539   | 42 803         | 23 652         | 49 177         | 18 030         | 46 698         | 14 826         | 36 400         | 20 959         | 38 481         |
| France                    | 1 123  | 2 962          | 1 133          | 2 442          | 8 769          | 11 738         | 17 877         | 25 258         | 17 437         | 18 772         |
| Japan                     | 15 114   | 32 210         | 14 548         | 36 058         | 15 141         | 36 629         | 12 903         | 28 089         | 11 497         | 27 605         |
| Spain                     | 5 936  | 16 093         | 6 200          | 17 823         | 6 295          | 21 664         | 8 527          | 17 560         | 9 952          | 16 452         |
| Australia                 | 5 702  | 4 612          | 4 237          | 3 536          | 7 848          | 4 102          | 11 256         | 5 094          | 8 969          | 4 733          |
| Denmark                   | 6 924  | 10 205         | 6 866          | 12 197         | 5 533          | 11 708         | 6 244          | 10 309         | 5 401          | 6 402          |
| Chile                     | 4 382  | 3 751          | 3 454          | 3 817          | 5 815          | 7 982          | 6 968          | 7 096          | 5 248          | 4 493          |
| South Africa              | 3 147  | 1 397          | 2 832          | 1 315          | 3 253          | 1 522          | 3 383          | 1 386          | 3 366          | 1 479          |
| United Kingdom            | 874  | 3 488          | 23 845         | 4 805          | 4 797          | 6 435          | 4 850          | 3 349          | 3 237          | 5 468          |
| Italy                     | 1 009  | 2 166          | 14 500         | 2 511          | 1 684          | 3 721          | 1 783          | 3 239          | 2 062          | 3 505          |
| Portugal                  | 563  | 1 733          | 768            | 3 356          | 155            | 776            | 16             | 60             | 1 277          | 2 326          |
| Germany                   | 2 604  | 3 442          | 1 109          | 3 234          | 635            | 2 440          | 770            | 2 078          | 1 154          | 2 993          |
| Korea , Republic of       | 551  | 703            | 397            | 1 274          | 737            | 1 855          | 944            | 2 137          | 1 049          | 2 018          |
| Argentina                 | 1 055  | 1 389          | 769            | 867            | 942            | 1 260          | 1 069          | 2 334          | 917            | 2 501          |
| Poland                    | 730  | 783            | 984            | 994            | 1 036          | 1 083          | 938            | 629            | 846            | 560            |
| Taiwan, Province of China | 0  | 0              | 39             | 486            | 978            | 3 146          | 1 002          | 1 243          | 652            | 1 233          |
| Turkey                    | -  | 251            | -              | 257            | 667            | 736            | 792            | 664            | 605            | 550            |
| Singapore                 | 77   | 365            | 66             | 126            | 313            | 180            | 545            | 498            | 517            | 498            |
| Brazil                    | 1 459  | 4 333          | 225            | 1 278          | 346            | 3 328          | 783            | 6 203          | 516            | 3 656          |
| Netherlands               | 422  | 1 888          | 627            | 2 062          | 1 000          | 3 248          | 896            | 2 710          | 443            | 2 087          |
| Malaysia                  | 0  | 0              | 478            | 2 859          | 455            | 2 970          | 241            | 1 216          | 381            | 1 445          |
| New Zealand               | 518  | 754            | 218            | 743            | 188            | 691            | 229            | 645            | 313            | 614            |
| Mexico                    | 76   | 443            | 90             | 646            | 178            | 648            | 206            | 746            | 264            | 908            |
| Russian Federation        | 126  | 388            | 267            | 648            | 258            | 1 003          | 157            | 564            | 260            | 1 007          |
| Hungary                   | 165  | 112            | 228            | 292            | 442            | 1 564          | 381            | 1 369          | 258            | 942            |
| Cyprus                    | 86   | 95             | 102            | 83             | 104            | 95             | 108            | 107            | 182            | 182            |
| Morocco                   | -  | -              | -              | -              | 0              | 0              | 648            | 822            | 180            | 174            |
| China, Hong Kong SAR      | 77   | 67             | 194            | 213            | 131            | 230            | 144            | 263            | 177            | 229            |
| Greece                    | 162  | 1 535          | 129            | 1 225          | 112            | 1 936          | 144            | 1 724          | 135            | 2 109          |
| Belgium                   | 231  | 1 672          | 170            | 1 180          | 209            | 1 451          | 113            | 522            | 132            | 753            |
| Czech Republic            | 133  | 159            | 192            | 196            | 154            | 145            | 128            | 112            | 126            | 99             |
| Colombia                  | 9  | 70             | 6              | 59             | 70             | 70             | 98             | 139            | 118            | 119            |
| Uruguay                   | 0  | -              | 44             | -              | 214            | 153            | 111            | 77             | 101            | 67             |
| <b>Total</b>              | <b>224 332</b>   | <b>272 279</b> | <b>285 294</b> | <b>348 578</b> | <b>242 906</b> | <b>344 563</b> | <b>244 077</b> | <b>265 340</b> | <b>247 516</b> | <b>267 741</b> |

Source: National Statistics.

| Country  | World: Imports of agar agar (HS 130231), weight in tonnes, value in USD thousands, 2012-2016 |                |               |                |               |                |               |                |               |                |  |  |
|--|--|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|--|--|
|  | 2012   |                | 2013          |                | 2014          |                | 2015          |                | 2016          |                |  |  |
|  | Weight   | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          | Weight        | Value          |  |  |
| Japan  | 1 706  | 45 536         | 1 785         | 46 519         | 1 850         | 49 873         | 1 955         | 49 803         | 1 813         | 45 447         |  |  |
| United States of America                         | 1 428  | 28 914         | 1 420         | 31 597         | 1 417         | 34 379         | 1 565         | 38 499         | 1 383         | 31 949         |  |  |
| Germany  | 618  | 12 318         | 696           | 13 715         | 867           | 18 981         | 952           | 18 541         | 969           | 18 173         |  |  |
| Spain  | 451  | 7 038          | 1 905         | 12 769         | 753           | 15 713         | 883           | 14 653         | 956           | 15 275         |  |  |
| United Kingdom                                   | 193  | 6 914          | 580           | 9 930          | 357           | 11 256         | 488           | 7 695          | 864           | 11 241         |  |  |
| Russian Federation                               | 263  | 4 229          | 273           | 4 794          | 577           | 11 756         | 906           | 17 989         | 732           | 12 530         |  |  |
| Thailand   | 724  | 9 300          | 695           | 10 102         | 818           | 11 260         | 812           | 11 801         | 731           | 11 580         |  |  |
| Malaysia   | 765  | 7 509          | 869           | 6 889          | 680           | 6 527          | 531           | 5 799          | 532           | 6 271          |  |  |
| France   | 1 107  | 9 978          | 370           | 9 234          | 393           | 9 715          | 397           | 10 120         | 440           | 11 680         |  |  |
| China  | 227  | 5 602          | 348           | 8 473          | 392           | 10 105         | 124           | 3 573          | 418           | 7 730          |  |  |
| India  | 318  | 5 531          | 375           | 6 949          | 316           | 6 613          | 298           | 5 890          | 353           | 6 038          |  |  |
| Canada   | 196  | 2 111          | 196           | 2 620          | 164           | 2 863          | 215           | 2 639          | 336           | 2 714          |  |  |
| Poland   | 222  | 4 085          | 231           | 4 768          | 238           | 5 484          | 237           | 4 819          | 253           | 4 528          |  |  |
| Korea, Republic of                               | 99   | 1 730          | 167           | 3 035          | 197           | 3 786          | 175           | 3 202          | 203           | 3 294          |  |  |
| Ukraine  | 160  | 2 751          | 184           | 3 040          | 136           | 2 702          | 166           | 3 275          | 197           | 3 266          |  |  |
| Chile  | 125  | 2 391          | 264           | 4 791          | 311           | 6 382          | 255           | 4 968          | 177           | 3 131          |  |  |
| Taiwan, Province of China                        | 136  | 1 469          | 153           | 1 592          | 124           | 1 513          | 158           | 1 828          | 172           | 2 053          |  |  |
| Morocco  | 82   | 1 460          | 106           | 1 826          | 105           | 2 200          | 82            | 1 734          | 171           | 2 604          |  |  |
| Mexico   | 126  | 2 423          | 117           | 2 427          | 113           | 2 712          | 125           | 2 812          | 165           | 3 895          |  |  |
| Belgium  | 70   | 2 047          | 93            | 2 781          | 161           | 4 585          | 239           | 4 046          | 145           | 3 495          |  |  |
| Denmark  | 126  | 3 277          | 106           | 3 288          | 88            | 2 784          | 95            | 2 644          | 119           | 3 351          |  |  |
| Venezuela  | 478  | 654            | 432           | 777            | 148           | 285            | 36            | 32             | 115           | 105            |  |  |
| Ireland  | -  | 198            | -             | 607            | 5             | 302            | 20            | 593            | 106           | 6 807          |  |  |
| Uruguay  | 18   | 360            | 19            | 407            | 210           | 493            | 1             | 492            | 100           | 332            |  |  |
| Singapore  | 125  | 1 353          | 107           | 1 784          | 119           | 1 752          | 108           | 1 580          | 99            | 1 206          |  |  |
| <b>Total of top 25 countries and territories</b> | <b>11 775</b>  | <b>169 178</b> | <b>13 504</b> | <b>194 714</b> | <b>12 553</b> | <b>22 4021</b> | <b>12 838</b> | <b>219 027</b> | <b>13 565</b> | <b>21 8695</b> |  |  |

Source: National Statistics.

## Annex 20a

| <b>World: Imports of carrageenan (HS 130239), top 35 countries, weight in tonnes, 2012–2016</b> |                |                |                |                |                |
|---|----------------|----------------|----------------|----------------|----------------|
| <b>Importers</b>  | <b>2012</b>    | <b>2013</b>    | <b>2014</b>    | <b>2015</b>    | <b>2016</b>    |
| Germany   | 18 219         | 23 229         | 19 710         | 11 204         | 10 486         |
| United States of America  | 12 062         | 10 152         | 11 475         | 11 192         | 9 959          |
| Spain   | 4 183          | 4 512          | 4 908          | 6 578          | 8 321          |
| United Kingdom  | 4 921          | 5 122          | 5 381          | 6 521          | 6 227          |
| Mexico  | 5 596          | 5 555          | 5 693          | 6 367          | 6 671          |
| Belgium   | 7 741          | 6 719          | 5 551          | 6 331          | 5 469          |
| France  | 5 475          | 6 629          | 6 802          | 6 325          | 7 683          |
| Denmark   | 4 647          | 5 198          | 4 714          | 5 601          | 5 009          |
| Russian Federation  | 2 888          | 2 795          | 3 441          | 4 507          | 4 457          |
| Netherlands   | 3 738          | 6 026          | 4 197          | 4 103          | 4 336          |
| China   | 3 039          | 3 757          | 4 289          | 3 969          | 3 015          |
| Japan   | 3 233          | 3 412          | 3 462          | 3 665          | 3 419          |
| Poland  | 3 982          | 3 626          | 3 577          | 3 630          | 3 553          |
| Brazil  | 2 252          | 2 861          | 2 681          | 3 509          | 2 352          |
| Canada  | 3 039          | 3 875          | 2 639          | 3 323          | 2 534          |
| Italy   | 5 234          | 5 170          | 4 746          | 3 252          | 5 156          |
| Thailand  | 2 549          | 2 629          | 2 918          | 2 940          | 3 517          |
| Turkey  | 2 394          | 2 599          | 2 571          | 2 143          | 2 288          |
| Ireland   | 1 671          | 3 549          | 1 989          | 2 034          | 1 812          |
| Argentina   | 1 971          | 1 669          | 1 923          | 2 015          | 1 281          |
| Philippines   | 1 302          | 1 333          | 1 676          | 1 934          | 2 309          |
| Indonesia   | 1 725          | 1 735          | 2 055          | 1 588          | 2 035          |
| Australia   | 1 677          | 1 640          | 1 682          | 1 577          | 1 540          |
| Austria   | 1 335          | 2 333          | 1 727          | 1 577          | 1 463          |
| Korea, Republic of.   | 1 132          | 1 518          | 1 465          | 1 543          | 1 305          |
| Chile   | 953            | 904            | 728            | 1 203          | 1 602          |
| Venezuela   | 800            | 1 595          | 1 436          | 1 106          | 705            |
| Ukraine   | 1 417          | 1 245          | 1 034          | 1 096          | 1 074          |
| Malaysia  | 1 035          | 1 140          | 997            | 1 019          | 977            |
| <b>Total of top 29 countries and territories</b>  | <b>110 210</b> | <b>122 527</b> | <b>115 467</b> | <b>111 852</b> | <b>110 555</b> |

Source: National Statistics.

## Annex 20b

| <b>World: Imports of carrageenan (HS 130239), top 35 countries, value in USD thousands, 2012–2016</b> |                |                |                |                |                |
|---|----------------|----------------|----------------|----------------|----------------|
| <b>Countries</b>  | <b>2012</b>    | <b>2013</b>    | <b>2014</b>    | <b>2015</b>    | <b>2016</b>    |
| United States of America  | 100 328        | 97 118         | 114 695        | 105 699        | 82 830         |
| Germany   | 101 734        | 115 124        | 118 577        | 84 254         | 69 808         |
| Denmark   | 52 262         | 57 970         | 59 974         | 62 750         | 48 361         |
| Mexico  | 49 750         | 47 692         | 50 894         | 57 209         | 52 698         |
| Spain   | 38 282         | 41 773         | 49 510         | 54 174         | 52 359         |
| Belgium   | 57 935         | 49 397         | 46 216         | 51 414         | 42 198         |
| United Kingdom  | 32 225         | 37 336         | 37 514         | 42 055         | 35 370         |
| France  | 34 974         | 36 648         | 42 695         | 41 638         | 36 753         |
| Russian Federation  | 23 943         | 24 535         | 29 760         | 34 968         | 32 447         |
| Japan   | 32 543         | 27 505         | 31 185         | 30 421         | 29 490         |
| China   | 22 313         | 23 939         | 29 121         | 26 881         | 23 016         |
| Italy   | 40 567         | 28 681         | 27 766         | 26 499         | 18 506         |
| Netherlands   | 18 413         | 24 260         | 20 070         | 25 344         | 25 654         |
| Brazil  | 18 855         | 24 700         | 23 414         | 24 896         | 17 264         |
| Poland  | 31 387         | 29 420         | 29 575         | 24 275         | 20 271         |
| Canada  | 22 545         | 29 948         | 22 582         | 23 961         | 19 038         |
| Philippines   | 14 442         | 15 026         | 17 891         | 21 346         | 15 904         |
| Thailand  | 21 645         | 24 090         | 22 475         | 21 113         | 23 954         |
| Sweden  | 4 378          | 10 673         | 11 085         | 16 901         | 11 087         |
| Argentina   | 17 482         | 13 898         | 16 196         | 16 674         | 10 665         |
| Indonesia   | 18 094         | 20 875         | 24 099         | 16 376         | 20 231         |
| Australia   | 12 635         | 12 232         | 13 629         | 12 542         | 11 940         |
| Korea , Republic of .   | 6 575          | 11 798         | 12 764         | 11 951         | 9 734          |
| Chile   | 9 406          | 9 075          | 7 914          | 11 891         | 10 592         |
| Venezuela   | 6 875          | 13 328         | 14 350         | 10 476         | 5 416          |
| India   | 8 539          | 8 382          | 11 053         | 9 277          | 10 466         |
| Ukraine   | 14 052         | 12 040         | 9 837          | 8 972          | 7 311          |
| Austria   | 8 821          | 10 225         | 10 416         | 8 946          | 7 940          |
| Malaysia  | 7 727          | 9 220          | 8 228          | 8 872          | 8 544          |
| <b>Total of top 29 countries</b>  | <b>828 724</b> | <b>866 905</b> | <b>913 486</b> | <b>891 776</b> | <b>759 845</b> |

Source: National Statistics.

| Origin                                  | 2012         |                   |  | 2013         |                   |  | 2014         |                   |  | 2015          |                   |  | 2016        |                   |  |
|---|--------------|-------------------|--|--------------|-------------------|--|--------------|-------------------|--|---------------|-------------------|--|-------------|-------------------|--|
|   | Weight       | Value             |  | Weight       | Value             |  | Weight       | Value             |  | Weight        | Value             |  | Weight      | Value             |  |
|   |              |                   |  |              |                   |  |              |                   |  |               |                   |  |             |                   |  |
| Iceland                                 | 1            | 83 006            |  | 1            | 68 702            |  | 138          | 250 384           |  | 962           | 1 290 479         |  | 2 543       | 2 973 967         |  |
| China                                   | 2 059        | 22 308 909        |  | 2 500        | 30 870 557        |  | 2165         | 24 588 057        |  | 2 002         | 25 718 326        |  | 1 815       | 19 572 496        |  |
| Canada                                  | 2 531        | 4 486 142         |  | 517          | 2 106 298         |  | 692          | 3 853 016         |  | 1 378         | 5 822 974         |  | 1 555       | 7 788 308         |  |
| Korea, Republic of                      | 784          | 8 005 581         |  | 823          | 9 551 958         |  | 881          | 10 039 991        |  | 1 034         | 11 990 293        |  | 1 144       | 11 963 898        |  |
| Philippines                             | 649          | 4 153 140         |  | 1 382        | 7 539 148         |  | 1086         | 6741416           |  | 1 388         | 5 448 660         |  | 591         | 3 217 668         |  |
| United Kingdom                          | 190          | 667736            |  | 294          | 1 109 699         |  | 180          | 908 628           |  | 468           | 2 408 076         |  | 432         | 2 547 624         |  |
| Japan                                   | 266          | 5 685 515         |  | 325          | 5 656 127         |  | 246          | 4 471 988         |  | 268           | 4 589 120         |  | 211         | 5 095 437         |  |
| Chile                                   | 26           | 1 029 227         |  | 21           | 756 342           |  | 69           | 1 291 059         |  | 1 405         | 5 830 584         |  | 103         | 1 264 425         |  |
| Taiwan, Province of China               | 120          | 586 607           |  | 145          | 710 788           |  | 114          | 478 621           |  | 45            | 214 913           |  | 41          | 179 374           |  |
| India                                   | 38           | 634 280           |  | 6            | 86 823            |  | 88           | 1 746 276         |  | 137           | 2 685 870         |  | 26          | 551 490           |  |
| China, Hong Kong SAR                    | 17           | 130 649           |  | 12           | 48 867            |  | 52           | 138 256           |  | 14            | 61 897            |  | 23          | 110 849           |  |
| Viet Nam                                | 15           | 22 202            |  | 33           | 47 065            |  | 108          | 166 978           |  | 189           | 281 285           |  | 20          | 55 692            |  |
| Mongolia                                | 0            | 0                 |  | 0            | 0                 |  | 0            | 0                 |  | 0             | 0                 |  | 16          | 115 240           |  |
| Mexico                                  | 272          | 397 179           |  | 39           | 77 573            |  | 106          | 194 300           |  | 110           | 179 596           |  | 10          | 54 971            |  |
| Thailand                                | 4            | 121 758           |  | 3            | 137 935           |  | 11           | 217 551           |  | 9             | 273 775           |  | 8           | 161 022           |  |
| Denmark                                 | 208          | 1 267 130         |  | 214          | 1 289 940         |  | 37           | 252 300           |  | 53            | 500 610           |  | 8           | 58 782            |  |
| Peru                                    | 1            | 2 304             |  | 6            | 25 333            |  | 51           | 95 019            |  | 94            | 174 338           |  | 7           | 23 901            |  |
| Australia                               | 0            | 8 284             |  | 0            | 0                 |  | 1            | 65 281            |  | 1             | 42 740            |  | 5           | 86 500            |  |
| Argentina                               | 0            | 7 905             |  | 0            | 0                 |  | 1            | 6 900             |  | 2             | 13 800            |  | 2           | 19 300            |  |
| Finland                                 | 0            | 0                 |  | 0            | 0                 |  | 0            | 0                 |  | 0             | 0                 |  | 0           | 23 547            |  |
| Germany                                 | 1            | 6 422             |  | 1            | 80 000            |  | 0            | 0                 |  | 2             | 40 500            |  | 0           | 3 511             |  |
| Netherlands                             | 6            | 80 753            |  | 2            | 109 410           |  | 1            | 61 409            |  | 1             | 31 391            |  | 0           | 14 991            |  |
| Tanzania, United Republic of.           | 0            | 0                 |  | 0            | 0                 |  | 133          | 1 412 764         |  | 125           | 1 639 050         |  | 0           | 0                 |  |
| Tonga                                   | 0            | 0                 |  | 0            | 0                 |  | 0            | 0                 |  | 0             | 2 262             |  | 0           | 0                 |  |
| Morocco                                 | 191          | 302 779           |  | 0            | 0                 |  | 153          | 316 047           |  | 57            | 130 530           |  | 0           | 0                 |  |
| Russia                                  | 0            | 21 105            |  | 0            | 25 004            |  | 0            | 22 000            |  | 0             | 0                 |  | 0           | 0                 |  |
| Spain                                   | 0            | 0                 |  | 0            | 0                 |  | 0            | 5 721             |  | 0             | 9 173             |  | 0           | 0                 |  |
| Switzerland                             | 0            | 0                 |  | 0            | 0                 |  | 0            | 0                 |  | 0             | 2 919             |  | 0           | 0                 |  |
| Madagascar                              | 379          | 320 690           |  | 0            | 0                 |  | 80           | 78 982            |  | 60            | 69 984            |  | 0           | 0                 |  |
| Indonesia                               | 0            | 0                 |  | 0            | 0                 |  | 772          | 2 700 791         |  | 880           | 2 778 035         |  | 0           | 0                 |  |
| Ireland                                 | 0            | 0                 |  | 0            | 0                 |  | 0            | 2 768             |  | 1             | 12 800            |  | 0           | 0                 |  |
| France                                  | 32           | 698 939           |  | 44           | 1 166 911         |  | 17           | 563 633           |  | 13            | 434 303           |  | 0           | 0                 |  |
| <b>Total, including other countries</b> | <b>7 789</b> | <b>51 028 242</b> |  | <b>6 370</b> | <b>61 497 265</b> |  | <b>7 180</b> | <b>60 670 146</b> |  | <b>10 695</b> | <b>72 628 283</b> |  | <b>8560</b> | <b>55 882 996</b> |  |

Sources: US Dept.of Commerce, Bureau of Census.

Annex 21b

| United States of America: Imports of seaweed and other algae not fit for human consumption (HS 121229), weight in tonnes; value in USD thousands, 2012-2016 |               |                   |  |               |                   |  |               |                   |  |               |                   |               |                   |       |
|---|---------------|-------------------|--|---------------|-------------------|--|---------------|-------------------|--|---------------|-------------------|---------------|-------------------|-------|
| Origin  | 2012          |                   |  | 2013          |                   |  | 2014          |                   |  | 2015          |                   |               | 2016              |       |
|   | Weight        | Value             |  | Weight        | Value             |  | Weight        | Value             |  | Weight        | Value             | Weight        | Value             | Value |
| Indonesia   | 2 659         | 2 178 388         |  | 1 688         | 1 517 758         |  | 1 537         | 1 605 422         |  | 2 218         | 1 569 866         | 5 378         | 2 558 549         |       |
| Canada  | 3322          | 5 808 425         |  | 5 069         | 8 758 795         |  | 5 331         | 8 938 900         |  | 4 853         | 8 428 814         | 4 094         | 8 097 883         |       |
| Tanzania, United Republic of.   | 3 731         | 3 438 066         |  | 5 439         | 3 065 684         |  | 3 602         | 1 975 262         |  | 1 495         | 914 830           | 3 675         | 1 947 876         |       |
| Philippines   | 4 129         | 4 929 564         |  | 4 051         | 7 227 385         |  | 1 962         | 6 516 453         |  | 3 047         | 8 336 892         | 3 120         | 6 897 124         |       |
| Chile   | 2 233         | 8 025 496         |  | 2 498         | 11 821 334        |  | 2 362         | 12 800 757        |  | 0             | 42 880            | 1 231         | 4 461 116         |       |
| Norway  | 165           | 1 272 405         |  | 259           | 1 663 026         |  | 317           | 2 066 696         |  | 415           | 1 851 742         | 867           | 2 757 309         |       |
| China   | 493           | 4 027 056         |  | 307           | 1 421 615         |  | 277           | 1 471 451         |  | 622           | 2 941 867         | 687           | 2 703 839         |       |
| Mexico  | 233           | 291 400           |  | 634           | 794 584           |  | 240           | 310 815           |  | 224           | 314 186           | 298           | 398 648           |       |
| Ireland   | 191           | 632 914           |  | 131           | 720 141           |  | 166           | 795 384           |  | 158           | 865 163           | 269           | 396 714           |       |
| Viet Nam  | 221           | 247 450           |  | 245           | 287 385           |  | 123           | 214 375           |  | 221           | 277 464           | 265           | 258 411           |       |
| Madagascar  | 40            | 36 811            |  | 640           | 390 024           |  | 260           | 192 651           |  | 0             | 0                 | 260           | 131 769           |       |
| United Kingdom  | 154           | 871 192           |  | 216           | 1 145 219         |  | 220           | 1 431 687         |  | 201           | 1 186 561         | 172           | 868 085           |       |
| Korea , Republic of .   | 729           | 4 371 110         |  | 495           | 1 897 682         |  | 520           | 2 058 994         |  | 516           | 2 079 683         | 139           | 657 878           |       |
| Taiwan, Province of China   | 166           | 930 023           |  | 115           | 746 896           |  | 94            | 596 452           |  | 135           | 783 010           | 135           | 956 228           |       |
| Peru  | 145           | 209 662           |  | 72            | 116 640           |  | 48            | 74 571            |  | 72            | 125 686           | 119           | 208 514           |       |
| Morocco   | 38            | 60 116            |  | 328           | 524 381           |  | 96            | 198 720           |  | 397           | 828 743           | 98            | 202 239           |       |
| India   | 134           | 2 479 370         |  | 178           | 3 197 640         |  | 95            | 1 856 850         |  | 115           | 2 176 410         | 77            | 1 532 640         |       |
| China, Hong Kong SAR  | 0             | 98 422            |  | 0             | 21 540            |  | 2             | 16 660            |  | 53            | 112 740           | 22            | 45 669            |       |
| Japan   | 30            | 872 129           |  | 15            | 197 415           |  | 10            | 157 980           |  | 36            | 213 009           | 14            | 147 675           |       |
| Thailand  | 10            | 213 299           |  | 5             | 25 355            |  | 2             | 7 540             |  | 0             | 2 073             | 12            | 414 321           |       |
| Germany   | 0             | 148 949           |  | 0             | 33 000            |  | 0             | 0                 |  | 11            | 41 096            | 9             | 45 773            |       |
| Netherlands   | 0             | 42 255            |  | 0             | 51 608            |  | 5             | 31 688            |  | 0             | 6 945             | 6             | 39 703            |       |
| Israel  | 0             | 32 500            |  | 0             | 1 263 596         |  | 5             | 1 748 500         |  | 7             | 2 401 600         | 6             | 2 013 115         |       |
| Australia   | 2             | 123 634           |  | 20            | 111 936           |  | 2             | 169 657           |  | 3             | 434 834           | 5             | 672 291           |       |
| Argentina   | 0             | 0                 |  | 0             | 4 708             |  | 1             | 63 677            |  | 6             | 44 180            | 2             | 13 765            |       |
| <b>Total, including other countries</b>   | <b>19 539</b> | <b>42 802 898</b> |  | <b>23 652</b> | <b>49 176 840</b> |  | <b>18 030</b> | <b>46 697 855</b> |  | <b>14 826</b> | <b>36 399 578</b> | <b>20 959</b> | <b>38 481 444</b> |       |

Sources: US Dept.of Commerce, Bureau of Census.



## Annex 21c

| <b>United States of America: Imports of agar-agar (HS 130231), weight in tonnes, 2012–2016</b> |              |              |              |              |              |
|--|--------------|--------------|--------------|--------------|--------------|
| <b>Origin</b>  | <b>2012</b>  | <b>2013</b>  | <b>2014</b>  | <b>2015</b>  | <b>2016</b>  |
| Spain  | 266          | 295          | 321          | 411          | 334          |
| Chile  | 372          | 257          | 263          | 297          | 261          |
| China  | 99           | 123          | 206          | 313          | 259          |
| Morocco  | 229          | 267          | 209          | 199          | 184          |
| Korea, Republic of   | 6            | 94           | 102          | 79           | 104          |
| Thailand   | 93           | 52           | 62           | 55           | 59           |
| Mexico   | 29           | 39           | 51           | 47           | 52           |
| Taiwan, Province of China  | 59           | 58           | 53           | 45           | 44           |
| Italy  | 18           | 19           | 25           | 23           | 41           |
| United Kingdom   | 0            | 0            | 0            | 0            | 12           |
| Philippines  | 13           | 10           | 15           | 14           | 8            |
| Viet Nam   | 8            | 0            | 1            | 4            | 6            |
| Japan  | 5            | 4            | 8            | 5            | 5            |
| China, Hong Kong SAR   | 8            | 9            | 8            | 8            | 4            |
| Denmark  | 2            | 1            | 0            | 2            | 3            |
| New Zealand  | 9            | 6            | 0            | 3            | 3            |
| Singapore  | 0            | 0            | 0            | 0            | 1            |
| Indonesia  | 149          | 146          | 71           | 40           | 1            |
| India  | 44           | 2            | 1            | 1            | 1            |
| France   | 0            | 0            | 0            | 0            | 0            |
| Norway   | 0            | 0            | 0            | 0            | 0            |
| Netherlands  | 0            | 1            | 0            | 0            | 0            |
| <b>Total, including other countries</b>  | <b>1 428</b> | <b>1 420</b> | <b>1 417</b> | <b>1 565</b> | <b>1 383</b> |

Sources: US Dept. of Commerce, Bureau of Census.

## Annex 21d

| <b>United States of America: Imports of carrageenan (HS 130239), weight in tonnes, 2012–2016</b> |               |              |              |              |              |
|--|---------------|--------------|--------------|--------------|--------------|
| <b>Origin</b>  | <b>2012</b>   | <b>2013</b>  | <b>2014</b>  | <b>2015</b>  | <b>2016</b>  |
| Philippines  | 6 326         | 4 805        | 5 152        | 5 653        | 4 958        |
| Chile  | 966           | 1 174        | 1 208        | 1 033        | 980          |
| Indonesia  | 570           | 606          | 696          | 655          | 711          |
| Canada   | 422           | 539          | 531          | 572          | 587          |
| France   | 626           | 549          | 540          | 478          | 464          |
| Spain  | 340           | 439          | 401          | 404          | 447          |
| China  | 462           | 465          | 703          | 498          | 375          |
| Korea , Republic of .  | 181           | 261          | 257          | 233          | 353          |
| Denmark  | 155           | 158          | 207          | 174          | 152          |
| United Kingdom   | 154           | 64           | 128          | 144          | 127          |
| Ireland  | 12            | 9            | 11           | 21           | 37           |
| Malaysia   | 15            | 0            | 122          | 107          | 28           |
| India  | 0             | 0            | 0            | 0            | 16           |
| <b>Total, including other countries</b>  | <b>10 245</b> | <b>9 105</b> | <b>9 965</b> | <b>9 981</b> | <b>9 236</b> |

Sources: US Dept. of Commerce, Bureau of Census.

| Japan: Imports of seaweed and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012-2016 |               |                |  |               |                |  |               |                |  |               |                |  |               |                |
|--|---------------|----------------|--|---------------|----------------|--|---------------|----------------|--|---------------|----------------|--|---------------|----------------|
| Origin   | 2012          |                |  | 2013          |                |  | 2014          |                |  | 2015          |                |  | 2016          |                |
|  | Weight        | Value          |  | Weight        | Value          |  | Weight        | Value          |  | Weight        | Value          |  | Weight        | Value          |
| China  | 24 434        | 120 233        |  | 23 382        | 111 954        |  | 22 275        | 103 471        |  | 22 604        | 91 709         |  | 24 967        | 113 657        |
| Korea, Republic of.  | 11 935        | 86 863         |  | 7 074         | 62 041         |  | 8 812         | 72 318         |  | 7 077         | 68 545         |  | 7 763         | 93 608         |
| Brazil   | 99            | 205            |  | 135           | 278            |  | 127           | 304            |  | 118           | 301            |  | 110           | 280            |
| Chile  | 69            | 1 934          |  | 81            | 2 427          |  | 62            | 1 739          |  | 116           | 2 462          |  | 60            | 1863           |
| Viet Nam   | 32            | 420            |  | 42            | 507            |  | 85            | 605            |  | 196           | 679            |  | 47            | 494            |
| Argentina  | 10            | 40             |  | 26            | 138            |  | 16            | 63             |  | 20            | 79             |  | 20            | 82             |
| Russian Federation   | 69            | 458            |  | 27            | 122            |  | 22            | 120            |  | 11            | 27             |  | 11            | 50             |
| France   | 1             | 7              |  | 0             | 0              |  | 1             | 4              |  | 1             | 11             |  | 5             | 21             |
| China, Hong Kong SAR.  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 4             | 26             |
| Taiwan, Province of China  | 32            | 517            |  | 6             | 107            |  | 15            | 269            |  | 18            | 316            |  | 2             | 33             |
| India  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 2             | 47             |  | 1             | 12             |
| Ireland  | 0             | 0              |  | 0             | 0              |  | 0             | 7              |  | 0             | 0              |  | 0             | 21             |
| United States of America   | 1             | 119            |  | 1             | 103            |  | 1             | 96             |  | 1             | 61             |  | 0             | 34             |
| Sweden   | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 0             | 24             |
| Spain  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 0             | 0              |  | 0             | 2              |
| Philippines  | 5             | 20             |  | 0             | 3              |  | 0             | 2              |  | 0             | 4              |  | 0             | 0              |
| Thailand   | 0             | 0              |  | 0             | 0              |  | 12            | 53             |  | 0             | 0              |  | 0             | 0              |
| Tonga  | 210           | 315            |  | 0             | 0              |  | 0             | 0              |  | 18            | 32             |  | 0             | 0              |
| Australia  | 0             | 0              |  | 0             | 2              |  | 0             | 11             |  | 0             | 0              |  | 0             | 0              |
| Canada   | 0             | 0              |  | 1             | 5              |  | 0             | 0              |  | 0             | 2              |  | 0             | 0              |
| <b>Total, including other countries</b>  | <b>36 900</b> | <b>211 155</b> |  | <b>30 670</b> | <b>177 688</b> |  | <b>31 450</b> | <b>179 062</b> |  | <b>30 900</b> | <b>164 276</b> |  | <b>32 990</b> | <b>210 207</b> |

Source: Japan Ministry of Finance.

Annex 22a-2

| Japan: Imports of seaweed and other algae fit for human consumption (HS 121221), by species, weight in tonnes; value in USD thousands, 2012-2016 |  |           |                |           |                |           |                |           |                |           |                |       |        |
|--|--|-----------|----------------|-----------|----------------|-----------|----------------|-----------|----------------|-----------|----------------|-------|--------|
| HS Codes   | Species  | 2012      |                | 2013      |                | 2014      |                | 2015      |                | 2016      |                | Value | Weight |
|  |  | Weight    | Value          | Weight    | Value          | Weight    | Value          | Weight    | Value          | Weight    | Value          |       |        |
| 121221100 THS  | Seaweeds & Other Algae, FIT for Human Consumption            | 480 332   | 31 032         | 436 345   | 25 754         | 540 157   | 30 844         | 436211    | 21 462         | 652 268   | 39 837         |       |        |
| 121221329  | Wakame (Undaria Pinnatifida), FIT for Human Consumption      | 13 221    | 21 662         | 9 942     | 15 080         | 11015     | 15 937         | 9786      | 12 346         | 12 761    | 18 855         |       |        |
| 121221321  | Wakame (Undaria Pinnatifida), FIT for Human Consumption      | 9 607     | 79 897         | 9 552     | 74 619         | 9 139     | 71 435         | 8814      | 64 180         | 9 073     | 76 509         |       |        |
| 121221310  | Hijiki (Hizikia Fusiforme), FIT for Human Consumption)       | 4 564     | 39 178         | 4 267     | 35 187         | 4 255     | 36 582         | 4479      | 39 634         | 4 861     | 46 606         |       |        |
| 121221322  | Wakame (Undaria Pinnatifida), FIT for Human Consumption      | 4 778     | 8 783          | 4 021     | 6 730          | 4 467     | 6 941          | 4007      | 5 890          | 3 182     | 7 108          |       |        |
| 121221390  | Other Seaweeds & Other Algae, FIT for Human Consumption      | 4 667     | 29 625         | 2 927     | 19 730         | 2 436     | 16 214         | 2939      | 19 385         | 2 911     | 19 439         |       |        |
| 121221200  | Seaweeds & Other Algae, FIT for Human Consumption            | 74        | 978            | 67        | 589            | 115       | 1 110          | 158       | 1 380          | 201       | 1 854          |       |        |
| <b>121221</b>  | <b>Seaweeds &amp; Other Algae, FIT for Human Consumption</b> | <b>na</b> | <b>211 155</b> | <b>na</b> | <b>177 688</b> | <b>na</b> | <b>179 062</b> | <b>na</b> | <b>164 276</b> | <b>na</b> | <b>210 207</b> |       |        |

Source: Japan Customs.

| Japan: Imports of seaweed and other algae not fit for human consumption (HS 121229), by origin, weight in tonnes; value in USD thousands, 2012–2016 |               |               |               |               |               |               |               |               |               |               |               |               |        |       |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------|-------|
| Origin  | 2012          |               |               | 2013          |               |               | 2014          |               |               | 2015          |               |               | 2016   |       |
|   | Weight        | Value         | Weight        | Value         | Weight        | Value         | Weight        | Value         | Weight        | Value         | Weight        | Value         | Weight | Value |
| Chile   | 8 521         | 10 323        | 6 823         | 10 500        | 7 655         | 13 976        | 5 518         | 6 810         | 5 518         | 6 810         | 4 156         | 5 210         |        |       |
| Norway  | 198           | 248           | 210           | 335           | 364           | 957           | 812           | 976           | 812           | 976           | 2 018         | 1 986         |        |       |
| Indonesia   | 1 039         | 1 272         | 772           | 973           | 1 265         | 1 481         | 1 664         | 1 798         | 1 664         | 1 798         | 1 508         | 1 783         |        |       |
| Morocco   | 850           | 3 524         | 851           | 3 266         | 635           | 2 388         | 694           | 2 743         | 694           | 2 743         | 1 151         | 5 154         |        |       |
| Ireland   | 1 220         | 1 236         | 1 360         | 1 446         | 1 498         | 1 631         | 1 720         | 1 605         | 1 720         | 1 605         | 1 011         | 980           |        |       |
| Korea, Republic of.   | 1 072         | 7 374         | 1 660         | 10 389        | 903           | 5 690         | 839           | 5 738         | 839           | 5 738         | 715           | 5 265         |        |       |
| Canada  | 1 102         | 5 781         | 1 830         | 7 083         | 1 650         | 7 995         | 902           | 6 603         | 902           | 6 603         | 229           | 5 251         |        |       |
| China   | 445           | 1 070         | 358           | 795           | 317           | 980           | 254           | 498           | 254           | 498           | 222           | 290           |        |       |
| South Africa  | 182           | 422           | 191           | 410           | 154           | 300           | 230           | 378           | 230           | 378           | 199           | 451           |        |       |
| Spain   | 0             | 0             | 0             | 0             | 0             | 0             | 48            | 136           | 48            | 136           | 164           | 541           |        |       |
| Senegal   | 45            | 261           | 38            | 220           | 7             | 41            | 0             | 0             | 7             | 41            | 32            | 222           |        |       |
| Mexico  | 36            | 106           | 48            | 145           | 89            | 276           | 108           | 340           | 89            | 276           | 31            | 96            |        |       |
| Brazil  | 0             | 0             | 0             | 0             | 0             | 0             | 30            | 187           | 0             | 30            | 30            | 155           |        |       |
| Malaysia  | 2             | 10            | 2             | 17            | 8             | 57            | 10            | 62            | 8             | 57            | 16            | 119           |        |       |
| Sri Lanka   | 8             | 10            | 44            | 51            | 0             | 0             | 0             | 0             | 0             | 0             | 9             | 8             |        |       |
| Viet Nam  | 0             | 0             | 0             | 0             | 10            | 19            | 0             | 5             | 10            | 19            | 3             | 26            |        |       |
| Philippines   | 305           | 194           | 258           | 177           | 11            | 29            | 6             | 44            | 11            | 29            | 2             | 11            |        |       |
| France  | 19            | 199           | 10            | 114           | 9             | 114           | 2             | 36            | 9             | 114           | 0             | 12            |        |       |
| Israel  | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 39            |        |       |
| United States of America  | 0             | 8             | 0             | 2             | 0             | 13            | 0             | 0             | 0             | 13            | 0             | 2             |        |       |
| Thailand  | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 3             |        |       |
| Turkey  | 0             | 0             | 0             | 0             | 0             | 0             | 29            | 43            | 0             | 0             | 0             | 0             |        |       |
| Ukraine   | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 3             | 0             | 0             | 0             | 0             |        |       |
| Switzerland   | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             | 0             |        |       |
| Taiwan, Province of China   | 1             | 25            | 1             | 9             | 5             | 42            | 3             | 27            | 5             | 42            | 0             | 0             |        |       |
| Iceland   | 0             | 0             | 48            | 52            | 552           | 626           | 24            | 28            | 552           | 626           | 0             | 0             |        |       |
| Australia   | 1             | 3             | 1             | 2             | 1             | 2             | 2             | 4             | 1             | 2             | 0             | 0             |        |       |
| Egypt   | 10            | 19            | 5             | 10            | 7             | 14            | 8             | 17            | 7             | 14            | 0             | 0             |        |       |
| <b>Total, including other countries</b>   | <b>15 114</b> | <b>32 210</b> | <b>14 548</b> | <b>36 058</b> | <b>15 141</b> | <b>36 629</b> | <b>12 903</b> | <b>28 089</b> | <b>15 141</b> | <b>36 629</b> | <b>11 497</b> | <b>27 605</b> |        |       |

Sources: Japan Ministry of Finance.

| Japan: Imports of agar-agar (HS 130231), by origin, weight in tonnes; value in USD thousands, 2012–2016 |              |               |              |               |              |               |              |               |              |               |               |  |
|---|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|---------------|--|
| Origin  | 2012         |               | 2013         |               | 2014         |               | 2015         |               | 2016         |               | Value         |  |
|   | Weight       | Value         | Weight       | Value         | Weight       | Value         | Weight       | Value         | Weight       | Value         |               |  |
| Chile   | 877          | 21 392        | 857          | 22 199        | 922          | 25 597        | 947          | 25 419        | 860          | 21 214        | 21 214        |  |
| Korea, Republic of .  | 321          | 11 068        | 355          | 10 096        | 339          | 9 736         | 293          | 8 009         | 278          | 8 762         | 8 762         |  |
| Morocco   | 171          | 5 510         | 265          | 7 357         | 218          | 5 993         | 242          | 6 242         | 240          | 7 087         | 7 087         |  |
| China   | 130          | 2 489         | 93           | 1 783         | 144          | 2 976         | 282          | 5 581         | 238          | 4 151         | 4 151         |  |
| Indonesia   | 134          | 2 574         | 117          | 2 101         | 182          | 3 952         | 122          | 2 488         | 156          | 2 642         | 2 642         |  |
| Spain   | 12           | 340           | 11           | 346           | 10           | 304           | 52           | 1 446         | 39           | 1 396         | 1 396         |  |
| United States of America  | 0            | 85            | 0            | 195           | 2            | 97            | 1            | 79            | 1            | 76            | 76            |  |
| Mexico  | 0            | 46            | 0            | 0             | 1            | 50            | 2            | 109           | 1            | 56            | 56            |  |
| United Kingdom  | 0            | 40            | 0            | 27            | 0            | 25            | 0            | 28            | 1            | 62            | 62            |  |
| Viet Nam  | 0            | 0             | 0            | 0             | 0            | 5             | 0            | 0             | 0            | 0             | 0             |  |
| Portugal  | 56           | 1 940         | 59           | 1 907         | 30           | 1 030         | 9            | 256           | 0            | 0             | 0             |  |
| Italy   | 2            | 51            | 3            | 83            | 3            | 104           | 5            | 145           | 0            | 0             | 0             |  |
| Germany   | 0            | 0             | 0            | 0             | 0            | 3             | 0            | 0             | 0            | 0             | 0             |  |
| <b>Total, including other countries</b>   | <b>1 702</b> | <b>45 536</b> | <b>1 785</b> | <b>46 519</b> | <b>1 850</b> | <b>49 873</b> | <b>1 955</b> | <b>49 803</b> | <b>1 813</b> | <b>45 447</b> | <b>45 447</b> |  |

Source: Japan Ministry of Finance.

## Annex 22d-1

| <b>Japan: Imports of carrageenan (HS 130239), by origin, weight in tonnes, 2012–2016</b> |              |              |              |              |              |
|--|--------------|--------------|--------------|--------------|--------------|
| <b>Origin</b>  | <b>2012</b>  | <b>2013</b>  | <b>2014</b>  | <b>2015</b>  | <b>2016</b>  |
| Thailand   | 902          | 946          | 1 034        | 1 122        | 1 056        |
| Philippines  | 300          | 335          | 557          | 554          | 477          |
| India  | 536          | 685          | 473          | 478          | 354          |
| Indonesia  | 237          | 197          | 213          | 287          | 328          |
| Denmark  | 269          | 272          | 274          | 292          | 290          |
| Korea, Republic of.  | 268          | 260          | 234          | 269          | 220          |
| Peru   | 163          | 208          | 150          | 192          | 182          |
| United States of America   | 268          | 246          | 263          | 189          | 181          |
| France   | 205          | 185          | 156          | 132          | 133          |
| Spain  | 12           | 8            | 42           | 58           | 124          |
| China  | 11           | 10           | 21           | 40           | 28           |
| Switzerland  | 12           | 10           | 19           | 20           | 18           |
| Chile  | 9            | 12           | 10           | 13           | 15           |
| Italy  | 37           | 38           | 16           | 19           | 14           |
| <b>Total, including other countries</b>  | <b>3 233</b> | <b>3 412</b> | <b>3 462</b> | <b>3 665</b> | <b>3 419</b> |

Source: Japan Ministry of Finance.

## Annex 22d-2

| <b>Japan: Imports of carrageenan (HS 130239), by origin, value in USD thousands, 2012–2016</b> |               |               |               |               |               |
|--|---------------|---------------|---------------|---------------|---------------|
| <b>Origin</b>  | <b>2012</b>   | <b>2013</b>   | <b>2014</b>   | <b>2015</b>   | <b>2016</b>   |
| Denmark  | 6 444         | 5 393         | 5 484         | 5 285         | 6 247         |
| Philippines  | 4 022         | 4 056         | 7 204         | 6 904         | 5 751         |
| United States of America   | 6 985         | 5 142         | 5 515         | 4 084         | 4 434         |
| Indonesia  | 3 573         | 2 525         | 2 881         | 3 750         | 3 721         |
| Korea, Republic of.  | 4 345         | 3 509         | 3 520         | 3 693         | 2 978         |
| France   | 3 454         | 2 821         | 2 559         | 2 142         | 1 826         |
| Spain  | 322           | 232           | 749           | 802           | 1 429         |
| Peru   | 1 264         | 1 745         | 1 170         | 1 323         | 1 046         |
| Thailand   | 780           | 729           | 769           | 750           | 786           |
| India  | 680           | 716           | 645           | 712           | 441           |
| China  | 167           | 154           | 256           | 449           | 347           |
| Chile  | 208           | 226           | 173           | 271           | 272           |
| Switzerland  | 129           | 109           | 196           | 185           | 153           |
| Italy  | 117           | 120           | 51            | 54            | 49            |
| <b>Total, including other countries</b>  | <b>32 543</b> | <b>27 505</b> | <b>31 185</b> | <b>30 421</b> | <b>29 490</b> |

Source: Japan Ministry of Finance.

## Annex 23a

| <b>European Union (Member Organization): Imports of seaweed and other algae fit for human consumption (HS 121221), value in USD thousands, 2012–2016</b> |                   |                   |                   |                   |                   |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|
| <b>EU Importers</b>  | <b>2012</b>       | <b>2013</b>       | <b>2014</b>       | <b>2015</b>       | <b>2016</b>       |
| France   | 27 763 154        | 25 894 571        | 26 503 645        | 9 418 614         | 9 593 275         |
| Germany  | 6 496 309         | 10 516 537        | 5 026 151         | 5 060 414         | 5 712 664         |
| United Kingdom   | 5 127 273         | 7 893 205         | 12 536 313        | 15 649 753        | 11 063 558        |
| Italy  | 4 414 736         | 5 946 233         | 5 605 016         | 6 084 607         | 6 135 337         |
| Netherlands  | 5 249 378         | 4 771 251         | 4 292 228         | 5 572 915         | 4 888 185         |
| Austria  | 1 955 813         | 3 476 894         | 3 120 315         | 3 213 609         | 3 977 272         |
| Spain  | 1 694 752         | 2 410 943         | 5 370 966         | 3 938 116         | 5 026 766         |
| Denmark  | 1 767 371         | 2 207 093         | 1 962 891         | 1 632 288         | 1 759 901         |
| Ireland  | 3 420 696         | 1 831 834         | 326 096           | 316 941           | 198 035           |
| Belgium  | 1 621 542         | 1 768 939         | 3 032 944         | 2 489 172         | 2 534 891         |
| Sweden   | 1 121 118         | 1 164 027         | 1 207 476         | 1 262 014         | 1 480 835         |
| Poland   | 831 927           | 1 161 263         | 1 453 515         | 1 693 216         | 2 656 844         |
| Hungary  | 993 677           | 954 942           | 116518            | 49 042            | 72 326            |
| Czech Rep.   | 594750            | 600 321           | 608 233           | 861056            | 643 979           |
| Finland  | 407 461           | 570 176           | 655 761           | 606 839           | 756 935           |
| Greece   | 406 306           | 463 591           | 918 542           | 420 193           | 226 790           |
| Portugal   | 498 281           | 429 454           | 921 556           | 702 019           | 794 768           |
| Latvia   | 356 916           | 372 693           | 360 717           | 316 556           | 336 877           |
| Lithuania  | 362 687           | 360 705           | 442 144           | 322 646           | 340 226           |
| Romania  | 471 937           | 329 136           | 310 179           | 319 859           | 392 895           |
| Slovakia   | 203 480           | 224 863           | 160 232           | 114 361           | 193 730           |
| Bulgaria   | 151 072           | 211 956           | 146 792           | 139 067           | 152 585           |
| Estonia  | 163 733           | 188 014           | 176 006           | 100 722           | 62 343            |
| Slovenia   | 99 497            | 177 755           | 197 807           | 134 144           | 68 661            |
| Cyprus   | 164 129           | 123 101           | 92 542            | 78 007            | 206 924           |
| Luxembourg   | 56 070            | 104 206           | 114 351           | 106 340           | 168 877           |
| Serbia   | 40 487            | 96 119            | 30 247            | 9 889             | 27 816            |
| Croatia  | 105 066           | 70 966            | 66 880            | 65 632            | 60 939            |
| Malta  | 23 900            | 41 596            | 57 457            | 48 148            | 128 194           |
| <b>Total EU-28 imports</b>   | <b>66 563 518</b> | <b>74 362 384</b> | <b>75 813 520</b> | <b>60 726 179</b> | <b>59 662 428</b> |

Source: EUROSTAT.

## Annex 23b

| <b>European Union (Member Organization): Imports of seaweed and other algae not fit for human consumption (HS 121229), value in USD thousands, 2012–2016</b> |                   |                   |                   |                   |                   |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|
| <b>EU Importers</b>  | <b>2012</b>       | <b>2013</b>       | <b>2014</b>       | <b>2015</b>       | <b>2016</b>       |
| Spain  | 16 072 860        | 17 823 415        | 21 664 255        | 17 560 585        | 14 585 290        |
| Denmark  | 10 205 265        | 12 197 023        | 11 708 389        | 10 308 559        | 6 400 533         |
| United Kingdom   | 3 467 322         | 4 804 009         | 6 695 674         | 5 492 262         | 6 139 272         |
| Portugal   | 1 733 307         | 3 355 556         | 776 165           | 59 681            | 2 325 880         |
| Germany  | 3 437 719         | 3 228 400         | 2 428 270         | 2 213 475         | 2 993 639         |
| Ireland  | 471 206           | 3 054 306         | 5 381 890         | 5 859 699         | 6 796 640         |
| Italy  | 2 166 086         | 2 510 635         | 3 720 625         | 3 238 694         | 3 505 074         |
| France   | 2 964 341         | 2 443 823         | 11 740 222        | 25 263 598        | 18 777 123        |
| Netherlands  | 1 887 710         | 2 061 522         | 3 248 213         | 2 709 763         | 2 087 165         |
| Greece   | 1 534 672         | 1 225 338         | 1 935 736         | 1 724 055         | 2 109 315         |
| Belgium  | 1 671 996         | 1 180 178         | 1 451 269         | 521 624           | 753 110           |
| Poland   | 781 671           | 992 459           | 1 081 415         | 629 070           | 558 918           |
| Sweden   | 229 218           | 373 736           | 361 063           | 1 916 005         | 731 774           |
| Hungary  | 111 573           | 292 038           | 1 564 033         | 1 369 058         | 873 545           |
| Finland  | 204 810           | 227 240           | 258 371           | 348 901           | 85 821            |
| Bulgaria   | 11 056            | 202 747           | 50 385            | 10 763            | 7 255             |
| Czech Rep.   | 159 067           | 195 694           | 144 570           | 112 430           | 97 984            |
| Romania  | 6 175             | 188 261           | 201 531           | 182 194           | 53 188            |
| Serbia   | 84 359            | 176 693           | 72 918            | 17 129            | 41 238            |
| Cyprus   | 95 267            | 83 361            | 94 761            | 106 708           | 182 213           |
| Lithuania  | 15 396            | 54 507            | 55 839            | 80 526            | 54 275            |
| Austria  | 139 484           | 50 294            | 109 680           | 45 050            | 188 876           |
| Slovakia   | 22 712            | 38 672            | 46 405            | 23 815            | 17 723            |
| Latvia   | 15 552            | 27 113            | 28 535            | 29 324            | 45 620            |
| Estonia  | 9 086             | 23 901            | 97 377            | 83 598            | 13 676            |
| Slovenia   | 5 784             | 12 968            | 13 324            | 14 345            | 19 008            |
| Malta  | 3 757             | 12 219            | 6 974             | 21 150            | 4 063             |
| Luxembourg   | 1 248             | 3 302             | 5 988             | 6 514             | 27 567            |
| Croatia  | 36 741            | 1 023             | 13 443            | 13 795            | 20 014            |
| <b>Total EU-28 imports</b>   | <b>47 545 440</b> | <b>56 840 433</b> | <b>74 957 320</b> | <b>79 962 370</b> | <b>69 495 799</b> |

Source: EUROSTAT.



## Annex 23c

| <b>European Union (Member Organization): Imports of carrageenan,<br/>value in USD thousands, 2012-2016</b> |                    |                    |                    |                    |                    |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>Main Importers in EU-28</b>   | <b>2012</b>        | <b>2013</b>        | <b>2014</b>        | <b>2015</b>        | <b>2016</b>        |
| Germany  | 101 733 502        | 115 123 886        | 118 576 825        | 84 254 169         | 69 808 285         |
| Denmark  | 52 262 048         | 57 970 054         | 59 974 353         | 62 749 688         | 48 360 940         |
| Spain  | 38 282 218         | 41 772 586         | 49 509 502         | 54 173 991         | 52 359 220         |
| Belgium  | 57 934 831         | 49 397 418         | 46 216 187         | 51 413 523         | 42 197 525         |
| United Kingdom   | 32 224 626         | 37 335 817         | 37 513 881         | 42 055 174         | 35 370 099         |
| France   | 34 973 990         | 36 648 219         | 42 695 438         | 41 637 813         | 36 752 751         |
| Italy  | 40 566 988         | 28 681 362         | 27 766 087         | 26 498 785         | 18 505 500         |
| Netherlands  | 18 412 858         | 24 259 577         | 20 069 913         | 25 344 348         | 25 653 850         |
| Poland   | 31 386 538         | 29 419 892         | 29 574 926         | 24 274 583         | 20 271 352         |
| Sweden   | 4 378 036          | 10 672 829         | 11 084 633         | 16 901 373         | 11 086 744         |
| Austria  | 8 820 716          | 10 224 784         | 10 416 138         | 8 945 781          | 7 939 677          |
| Ireland  | 2 805 940          | 4 952 224          | 5 252 450          | 6 632 794          | 7 044 704          |
| Czech Rep.   | 6 754 637          | 7 148 398          | 7 376 024          | 6 276 707          | 4 918 350          |
| Romania  | 3 316 822          | 3 785 095          | 4 811 726          | 4 429 734          | 2 737 462          |
| Slovakia   | 3 934 874          | 5 709 405          | 4 682 378          | 3 512 321          | 2 859 670          |
| Greece   | 3 998 828          | 2 773 642          | 2 623 923          | 2 428 349          | 2 105 992          |
| Portugal   | 1 986 709          | 2 397 751          | 1 796 012          | 1 957 595          | 1 780 945          |
| Lithuania  | 2 052 400          | 2 115 881          | 2 117 972          | 1 942 291          | 2 468 904          |
| Serbia   | 1 404 312          | 1 399 481          | 1 237 659          | 1 584 236          | 946 167            |
| Belarus  | 2 138 600          | 3 158 900          | 2 396 600          | 1 498 100          | 1 927 100          |
| Bulgaria   | 1 240 461          | 1 816 762          | 1 746 022          | 1 436 584          | 1 122 977          |
| Croatia  | 1 149 894          | 1 413 341          | 1 499 921          | 1 169 875          | 1 452 786          |
| Malta  | 763 885            | 1 357 629          | 1 180 586          | 1 004 452          | 480 421            |
| Finland  | 951 587            | 958 962            | 945 172            | 853 206            | 792 888            |
| Estonia  | 1 550 167          | 1 172 368          | 621 685            | 721 281            | 216 872            |
| Latvia   | 565 048            | 1 001 473          | 800 095            | 517 937            | 471 422            |
| Slovenia   | 690 404            | 429 158            | 378 469            | 363 815            | 451 319            |
| Cyprus   | 241 744            | 142 405            | 148 886            | 96 615             | 152 275            |
| Luxembourg   | 6 610              | 7 022              | 7 342              | 11 095             | 12 720             |
| <b>Total EU-28 imports</b>   | <b>456 529 273</b> | <b>483 246 321</b> | <b>493 020 805</b> | <b>474 686 215</b> | <b>400 248 917</b> |

Source: EUROSTAT.

## Annex 23d

| <b>European Union (Member Organization): Imports of agar-agar (HS 130231),<br/>value USD thousands, 2012–2016</b> |                   |                   |                   |                   |                   |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|
| <b>Main importers in EU-28</b>  | <b>2012</b>       | <b>2013</b>       | <b>2014</b>       | <b>2015</b>       | <b>2016</b>       |
| Germany   | 12 317 974        | 13 714 638        | 18 980 996        | 18 540 611        | 18 173 425        |
| Spain   | 7 037 599         | 12 769 434        | 15 712 573        | 14 653 308        | 15 275 287        |
| United Kingdom  | 6 914 049         | 9 929 733         | 11 255 502        | 7 694 753         | 11 240 883        |
| France  | 9 977 923         | 9 233 724         | 9 714 756         | 10 119 501        | 11 679 568        |
| Poland  | 4 084 708         | 4 768 076         | 5 484 308         | 4 818 697         | 4 528 452         |
| Denmark   | 3 277 436         | 3 288 408         | 2 783 591         | 2 643 793         | 3 350 644         |
| Belgium   | 2 046 993         | 2 781 401         | 4 584 885         | 4 045 767         | 3 494 627         |
| Austria   | 1 406 290         | 1 846 765         | 1 938 953         | 1 554 384         | 1 939 714         |
| Netherlands   | 1 047 397         | 1 618 315         | 2 205 423         | 1 584 485         | 1 279 362         |
| Serbia  | 1 274 736         | 1 459 849         | 1 811 537         | 1 293 661         | 1 595 830         |
| Lithuania   | 514 377           | 911 028           | 789 072           | 907 928           | 1 090 865         |
| Czech Rep.  | 423 464           | 761 412           | 2 238 774         | 716 925           | 677 612           |
| Finland   | 222 574           | 628 864           | 292 229           | 252 698           | 263 843           |
| Ireland   | 198 481           | 606 709           | 301 916           | 592 699           | 6 807 025         |
| Portugal  | 196 302           | 352 532           | 290 792           | 291 287           | 241 182           |
| Latvia  | 248 157           | 327 885           | 1 006 703         | 1 232 036         | 357 150           |
| Croatia   | 337 591           | 313 895           | 540 165           | 528 700           | 510 097           |
| Sweden  | 262 728           | 309 018           | 248 172           | 380 742           | 292 666           |
| Greece  | 269 552           | 296 870           | 293 170           | 251 887           | 274 376           |
| Hungary   | 211 521           | 190 534           | 195 665           | 197 830           | 196 473           |
| Slovenia  | 78 824            | 159 816           | 95 516            | 87 354            | 92 513            |
| Bulgaria  | 49 986            | 152 627           | 138 986           | 188 828           | 34 863            |
| Slovakia  | 110 302           | 114 358           | 250 118           | 217 209           | 152 020           |
| Romania   | 86 303            | 89 288            | 95 207            | 112 751           | 156 523           |
| Luxembourg  | 16 467            | 17 487            | 22 705            | 19 092            | 16 778            |
| Estonia   | 124 384           | 9 211             | 25 740            | 23 515            | 26 988            |
| Cyprus  | 1 613             | 6 309             | 1 874             | 1 172             | 6 624             |
| Malta   | 13 650            | 2 503             | 150               | 463               | 221               |
| <b>Total EU-28 imports</b>  | <b>52 751 381</b> | <b>66 660 689</b> | <b>81 299 478</b> | <b>72 952 076</b> | <b>83 755 611</b> |

Source: EUROSTAT.

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