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The Australian Seaweed Industry

A Baseline Review of Research and Development

A report for the
Rural Industries Research and Development Corporation
and the Fisheries Research and Development Corporation
by
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Connectica International



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"The Australian Seaweed Industry: a Baseline Review of Research and Development"

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Foreword

Seaweed is a very useful product with a wide range of applications. It is used in dietary foods, as manufacturing ingredients, textile additives, horticultural biostimulants, fertilisers, pharmaceutical and medical products and even in the treatment of cancers.

Research funded jointly by the Rural Industries Research and Development Corporation's (RIRDC) Asian Foods program and the Fisheries R & D Corporation, indicates seaweed is a potential new, viable food industry for Australia.

Currently, Australia is a net importer of seaweed products valued at more than \$16 million. Could Australia develop an industry viable enough to supply some of this market and even look to exports?

This important study establishes the market, production and research data to help the Australian seaweed industry along that path.

It identifies industry and research organisations. It provides a strategic analysis of the Australian seaweed industry and looks at the key factors influencing the industry's production and marketing.

The report reaches some very interesting and practical conclusions. Importantly, it stresses that the seaweed industry should be considered as a range of different, but related industries.

Peter Core

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ABBREVIATIONS

ABARE	Australian Bureau of Agriculture and Resource Economics.
ABS	Australian Bureau of Statistics.
AUSEAS	Australian Seafood Extension and Advisory Service
CSB	Commonwealth Statistical Bulletin.
DPIE	Department of Primary Industries and Energy.
FRDC	Fisheries Research and Development Corporation
NSC	National Seafood Centre
R&D	Research and Development.
RIRDC	Rural Industries Research and Development Corporation.
SWOT	Strengths, Weaknesses, Opportunities and Threats.

EXECUTIVE SUMMARY

As a result of research conducted under the Asian vegetables research program of the Rural Industries Research and Development Corporation (RIRDC), seaweed has been identified as a potential and emerging food industry opportunity for Australia. With the support of RIRDC and the Fisheries Research and Development Corporation (FRDC), this study aims to further qualify this opportunity by undertaking baseline research to establish a broad understanding of the market and supply opportunities for the Australian seaweed industry.

There are a myriad of applications for seaweed ranging from dietary foods, food manufacturing ingredients, textile additives, horticultural biostimulants and fertilisers through to pharmaceutical and medical products for the treatment of cancers and the HIV AIDS virus. From a resource perspective, the question needs to be asked 'Does Australia's extensive coastline and clean waters, afford Australia a competitive advantage for the supply of seaweeds for such international applications?'

The principal objective is to establish baseline market, production and research data for the Australian industry. This basic data shall assist in the identification of research priorities and issues for development.

The study has:

- Identified key industry and research organisations.

- Conducted a strategic analysis of the Australian seaweed industry, in terms of the commercial market focus, infrastructure and capabilities.

- Identified key factors influencing the industry in respect to production and marketing.

The key findings from the study are:

- The utilisation of seaweed throughout the world is wide and diverse, and accordingly, the seaweed industry should not be considered as one homogeneous industry; rather it is a collection of heterogeneous industries.

- Statistics on world seaweed production are not readily available, but it is conservatively estimated that the world seaweed industry is valued at some A\$1.5 billion annually, and is equivalent to a world production of over 6 million tonnes of dry weight per annum. Austrade (1996) estimates that some 4 million tonnes of seaweed are for food usage, and 2 million tonnes for industrial uses.

Recent ABS statistics confirm that Australia is a net importer of seaweed products importing over \$16 million of seaweed products in 1995/96, and exporting some \$415,000 of seaweed products. However, there is inconsistency in the export data as one industry organisation confirms that during 1995/96 they exported over \$3.5 million of product to Scotland.

Very limited information exists on the sustainability of seaweeds as a resource. However, this should not preclude the industry from recognising the potential of seaweed as a resource, and the opportunity to diversify the Australian marine industry.

Industry confirms that the development of a seaweed management plan requires to be compatible with the present fisheries management industry, marine ecosystems and environments. Further objective research data is required on the key environmental aspects of seaweed if it is to be assessed as a potential resource.

The following market factors were identified as the strategic drivers of industry growth

Improved understanding of international and Australian market growth and demand.

Critical analysis of management alternatives for seaweed based upon overseas experience.

Development of a seaweed management plan which is compatible with the present Fisheries management industry.

Recognition of seaweed as a new and emerging industry which warrants support from Government and research organisations.

Specific product development and applications of seaweed for food.

Consumer and industry awareness of the uses of seaweed.

The following market factors were identified as constraints to industry growth:

Lack of knowledge of the opportunity to utilise Australian seaweed as a food resource.

Lack of data on specific seaweed food applications and resource issues relating to sustainability and ecological impacts.

Lack of quantitative and economic data for the Australian seaweed resource

Competitive marketing strategies of international 'food' groups.

Small size of the industry, and lack of industry investment.

Conclusions and Recommendations

Industry Communication and Information

Conclusion: There is a lack of knowledge in the Australian industry of the size, nature and issues associated with Australian seaweed.

Recommendation: *Support industry development with a business and research network of organisations to improve the effectiveness of dissemination of information.*

Research Management

Conclusion: There is no systematic process to manage the support for seaweed research and development in Australia.

Recommendation: *Develop an initial R&D management framework to:*

- a. Establish an initial list of priorities for further 'seaweed' research.*
- b. Establish an Industry Advisory Group to review and assist with the development of R&D priorities for seaweed research.*

Market Research Feasibility Studies

Conclusion: There is a lack of information on the commercial feasibility for the development of seaweed product applications identified in many international research studies.

Recommendation: *Conduct feasibility studies for specific demand/supply opportunities in both the Australian and international markets.*

Product Development

Conclusion: Increased consumer awareness of seaweed food products is required for industry development.

Recommendation: *To commission new product development projects in response to opportunities identified in the market research feasibility studies.*

Trade Development

Conclusion: There is a lack of industry knowledge of world trade issues for the export of seaweed food products.

Recommendation: *Support research to develop an understanding of tariff and non-tariff trade barriers for export development of an Australian seaweed export industry.*

Research and Development

Conclusion: Research can assist with development of an Australian seaweed industry through increasing the knowledge to industry and consumers about the Australian seaweed resource and its potential uses.

Recommendation: *Support research in areas which provide strategic baseline information.*

1.0 BACKGROUND TO THE PROJECT

During July 1993, RIRDC conducted a strategic planning workshop entitled: "Asian Foods Research and Development".

As a result of this workshop and other research conducted by RIRDC, Asian Foods are a key program plan with an objective to foster the development of a viable Australian Asian Foods industry.

As a result of research conducted under RIRDC's Asian vegetables research program, seaweed has been identified as a potential and emerging food industry opportunity for Australia.

Following meetings with the Fisheries Research and Development Corporation (FRDC) it was agreed that seaweed appears to represent an opportunity to diversify the Australian fishing industry. This theme of the need for diversification in the Australian fishing industry, and the need for the sustainability of Australian marine resources was the focus of considerable attention at the Seafood Symposium and International Fisheries Congress in Brisbane during August of this year.

Accordingly, there is a fundamental need to undertake baseline research to establish a broad understanding of the market and supply opportunities for the Australian seaweed industry.

This basic data shall complement the assessment of research priorities and other commercial market activities.

Seaweeds are marine algae which attach to rocky areas from the intertidal zone to depths of up to 30 metres. Seaweeds play an important role in both marine ecology and human consumption.

2.0 OBJECTIVES OF THE PROJECT

The principal objective is to establish baseline market, production and research data for the Australian industry. This basic data shall assist in the identification of research priorities and issues for development

Specifically the key issues to be addressed in this study include:

Identification of key industry and research organisations.

A SWOT analysis of the Australian seaweed industry, in terms of the commercial market focus, infrastructure and capabilities.

Identification of key factors influencing the industry in respect to production and marketing.

As appropriate, quantify the capabilities for the Australian industry, in terms of size, market/product type, margins (as available) and other strategic issues.

The emphasis has been upon defining practical results. Accordingly, the study aims to define a capability statement for the industry based upon the following issues:

Existing industry production, capabilities and experience.

Opportunities developed through applied research.

Strategic strengths and weakness for the industry.

3.0 INTRODUCTION

The utilisation of seaweed in Australia is surrounded in controversy. In 1979 it was the centre of a debate of whether seaweed was a growth regulator or a fertiliser, and today it is the subject of debate as either a pest or a resource.

Seaweeds were considered of medicinal value in Asia as long as three centuries ago. The Chinese and Japanese used seaweeds in the treatment of goiter and other glandular ailments. The Romans used seaweeds to heal wounds, burns and rashes and more recently the British used *Porphyra* or nori seaweed to prevent scurvy on long voyages.

There are apparently a myriad of applications for seaweed ranging from dietary foods, food manufacturing ingredients, textile additives, horticultural biostimulants and fertilisers through to pharmaceutical and medical products for the treatment of cancers and the HIV AIDS virus.

From a resource perspective, the question needs to be asked:
'Does Australia's extensive coastline and clean waters, afford Australia a competitive advantage for the supply of seaweeds for such international applications?'

Indeed, it is noted by many researchers that Australia has a diverse range of over 1,300 species of seaweeds, and Sanderson (1988) and Werner (1992) notes that many of these species are or have been consumed as direct dietary foods in other parts of the world.

However, the state of the seaweed industry is not clear, and there is the need to undertake baseline research to establish a broad understanding of the market and supply opportunities for the Australian industry.

This study seeks to identify those production factors which link the industry to the market, and the practical issues which can sustain the competitive advantages for the seaweed industry in Australia.

4.0 RESEARCH METHODOLOGY

The methodology aims to provide a practical capability statement for further development by the industry.

4.1 GENERAL

The overall methodology is shown schematically at Figure 1.

The research involved an extensive program of industry consultation and was conducted in four stages:

- ▶ Stage 1.
Identification of relevant industry and research organisations.
- ▶ Stage 2.
International and Australian literature search and review.
- ▶ Stage 3.
Field interviews with both industry and relevant research organisations.
- ▶ Stage 4.
Definition and analysis of industry production and related research programs.

4.2 LITERATURE REVIEW

In order to clearly assess the issues affecting the seaweed industry, it is necessary to review developments and activities both in Australia and internationally.

Accordingly, information searches were initiated through reviews of world-wide databases, the Internet, Australian import statistics, industry organisations and related research organisations.

Huge amount of data from overseas sources

The Australian Seafood Extension and Advisory Service (AUSEAS) was commissioned to conduct a search of abstracted information relating to seaweed and algae from their information database. Over 607 abstracts were identified, and it was interesting to note that only 13 of these abstracts were written by Australian authors or had reference to Australian algae. This lack of Australian information suggests that there is both a lack of Australian information and a lack of knowledge about the industry.

A review of the abstracts showed that detailed information was available on:

- ▶ International production and marketing strategies.
- ▶ Research on the uses of seaweed and seaweed extracts in a wide range of applications including medicine, horticulture, food and other manufacturing processes.
- ▶ Case studies of commercial feasibility studies.

It would appear that the more recent focus for seaweed research has been the use of seaweed and seaweed extracts in food and high value added processes such as medical applications.

Internet information

This is a rapidly growing and dynamic source of information for seaweed. Its value relates to its usage by both research and industry organisations, and accordingly fosters the communication between these groups. At this stage it appears that the University College Galway Seaweed Internet Server in Ireland is the primary site attempting to coordinate publications on the Internet.

Major Internet home pages are shown in Appendix A and are listed below:

- ▶ International Seaweed Association and Members
(<http://is.dal.ca/~jmclachl/isa-iss.html>)
- ▶ Seaweed Information Server (University College at Galway)
(<http://www.seaweed.ucg.ie>)

4.3 DATA SOURCES AND DATA QUALITY FOR THE INDUSTRY SURVEY

Date Sources

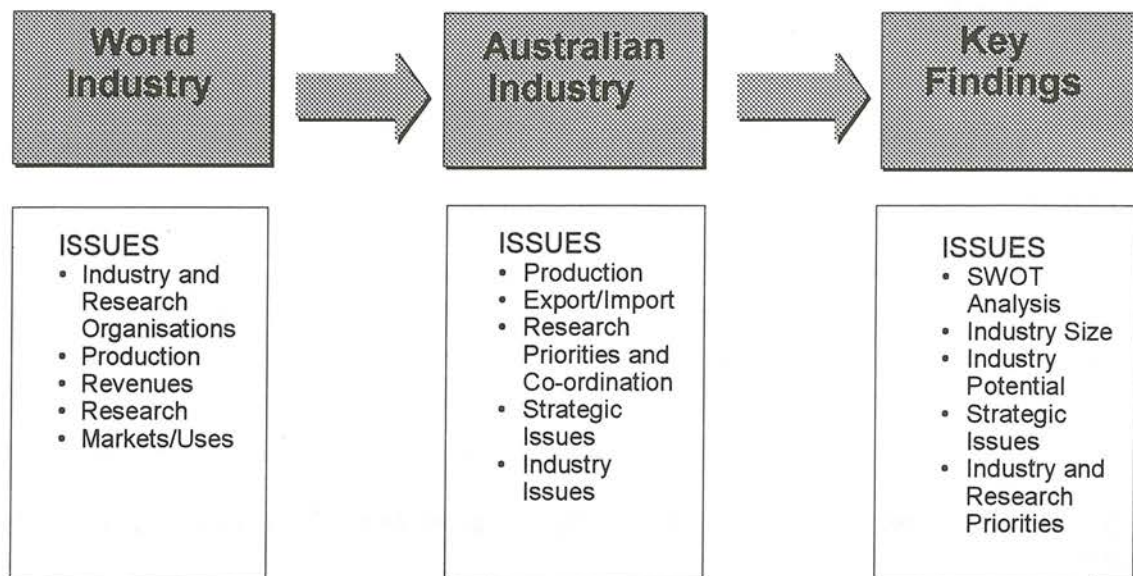
The primary sources of data for the survey included:

Government Organisations

- ▶ Australian Bureau of Statistics.
- ▶ Australian Bureau of Agriculture and Resource Economics.
- ▶ National Library of Australia (Australian Rural Research in Progress database).
- ▶ Rural Industries Research and Development Corporation.
- ▶ Fisheries Research and Development Corporation.
- ▶ Department of Primary Industries and Fisheries, Tasmania.

Figure 1

Schematic of Research Methodology



Industry Organisations

- Kelp Harvesters Association of King Island

State Departments of Fisheries and Agriculture

- Queensland Department of Primary Industries.
- Department of Agriculture Victoria.
- Department of Primary Industry and Fisheries Tasmania.
- South Australian Research and Development Institute.
- Department of Primary Industry and Fisheries Northern Territory.

Research Organisations

- AUSEAS
- National Seafood Centre
- CSIRO, Hobart.
- CSIRO, Perth..
- University of Queensland.

- University of NSW/ADFA.
- University of Melbourne.
- Monash University.
- Australian Food and Industry Science Centre.
- University of Adelaide.
- IFREMER, France.

Industry Interviews

Over 35 interviews were conducted with industry and research groups in the seaweed industry.

Data Quality

Published data from the Australian Bureau of Statistics were inadequate, and generally underestimated the size of the industry. The industry is widely-dispersed throughout most States of Australia, and there appears to be limited communication between groups in the various States.

In general any available data (eg ABS 1996) appears to underestimate the size of the industry.

For much of this study, estimates relied heavily upon field surveys and interviews with State Departments' of Fisheries and Agriculture, and industry in NSW, Victoria, Tasmania, Queensland, and Western Australia.

5.0 OVERVIEW OF THE WORLD INDUSTRY

Plants in the sea are usually called seaweeds and belong to the simplest group of plants known as algae. With few exceptions, these plants are so simple that they have no distinguishable roots, stems or leaves, and all parts of the plant look much alike.

5.1 GENERAL

Despite the fact that the seaweed industry plays an important role in almost every aspect of modern life, the world seaweed industry remains one of the least known and understood. Seaweeds and their products are used in a wide range of applications including processed meats, sauces, dressings, ice-cream, beer and wine, petfood, toothpaste, air fresheners, carpets, papers, pesticides, fertilisers and medicines. The average consumer would unknowingly be in contact with seaweed and its products on an almost daily basis.

The utilisation of seaweed throughout the world is wide and diverse, and accordingly, the seaweed industry should not be considered as one homogeneous industry; rather it is a collection of heterogeneous industries.

Statistics on world seaweed production are not readily available, but it is conservatively estimated that the world seaweed industry is valued at some A\$1.5 billion annually, and is equivalent to a world production of over 6 million tonnes of dry weight per annum. Austrade (1996) estimates that some 4 million tonnes of seaweed are for food usage, and 2 million tonnes for industrial uses.

Seaweeds are noted for their growth all around the world, however over 80% of commercial seaweed production is from the Asia-Pacific region (such as Japan, China, Korea, Philippines and Thailand). Conversely, the majority of seaweed processing occurs in westernised countries in Europe and North America.

From a commercial perspective, seaweeds may be classified into 3 main groups largely on the basis of pigmentation, physiology, chemical composition and their uses:

- ▶ Red algae or *Rhodophyta* which is used for Nori in sushi foods, and other applications including carageenan and agar manufacture.
- ▶ Brown or *Phaeophyta* which is used for many other Asian foods (eg, Kombu, Wakame) and is also the basis for Australia's kelp industry on King Island which is used for the manufacture of alginates.
- ▶ Green or *Chlorophyta* which used for both plant and animal feeds.

5.2 SEaweEDS AND THEIR USES

The use of seaweeds may be grouped into the following applications:

1. Direct Food Source

Seaweed may not be considered as a mouth-watering vegetable to most Western people, however Asians have been eating seaweeds for thousands of years. Asians are well-known for their dietary use of seaweed, both fresh and cooked. Many species of seaweed have been used in their diets and include:

- ▶ *Porphyra* is used for nori in sushi foods,
- ▶ Kelps or large brown seaweeds are used as 'kombu' and 'wakame' for soups, capsules and tablets for health foods.

While it is estimated that the average persons diet in Japan may include up to 10% of seaweed by weight, the average western consumer considers seaweeds a 'health-food' item. For example, in France seaweed is being increasingly marketed as a 'sea-vegetable' with support from the French regulatory authorities (Mabeau and Fleurence, 1993).

In general, seaweeds contain a high percentage of indigestible carbohydrates, and in this sense they are comparable to roughage foods such as celery and lettuce. With a focus upon health benefits, the greatest nutritional value of seaweeds lies in the vitamins, minerals and trace elements. Werner (1992) notes that many seaweeds in Victoria are high in dietary fibre, low in fat and higher in the trace elements of zinc and magnesium than that found in more popular terrestrial vegetables such as lettuce, spinach. Tran (1996) has also recently noted the high levels of omega-3 fatty acids in a range of Australian seaweeds.

While there is a lack of world market demand statistics for seaweed as a food, evidence shows that the dietary use of seaweeds is increasing. For example, the overseas literature confirms that there is a growth in market demand for Asian seaweed as a food product both in Western and Asian countries (Jetro 1995, CEVA 1991).

Of significance, Jetro notes that in 1995 the total market demand for seaweed in Japan has increased to 220,000 tonnes per annum, while the production of seaweed in Japan has decreased by almost 20% in the last 2 years to less than 100,000 tonnes. China is now a major supplier of seaweed food products to Japan.

2. Food Manufacturing/Industrial Colloid Applications

In comparison to Asians who primarily eat seaweeds, the majority of western people use seaweeds for industrial and food additive purposes such as thickeners and emulsifiers. This market is a world market controlled by a small number of large companies such as Kelco Corporation and FMC Marine Colloids in the USA, and Hercules in Norway. Contrary to the world supply for seaweeds, the seaweed colloid manufacturing industry remains concentrated in a few developed countries such as Denmark, Norway, France, Spain, UK, Japan and the USA.

This involves the extraction of valuable chemicals, called phycocolloids from red and brown seaweeds. Phycocolloids are carbohydrates or polysaccharides which occur naturally in seaweeds. They are also called hydrocolloids because of their ability to form colloidal systems when in water. Hence these products have the ability to give viscosity, gel strength and stability to liquids and liquid mixtures.

With such properties they play an important role in the production of many processed foods, dairy products, cosmetics, fertilisers and animal feeds.

The three major phycocolloids are agar, carageenan and alginate products.

i. Agar

Agar is able to bind considerable quantities of water to form a gel substance. It is manufactured from certain species of red algae such as *Gelidium*, *Gracilaria* and *Pterocladia*. Agar is a mixture of polysaccharides which is soluble in hot water but becomes water insoluble at room temperature. Agar is marketed as bars, strips, flakes and powders. Because of agar's ability to form gels at very low concentrations and to hold large amounts of water it can be used as a stabiliser in a range of foods including pastries, jellies, confectionery, ice cream and meats.

However, agar's most important application is as a bacteriological medium as many microorganisms are unable to decompose it. Agar's neutral status enables it to be used extensively as a culture for medical and plant tissue applications.

ii. Carageenan

Carageenan is primarily obtained from red seaweeds such as the species of *Gigartina*, but it can also be extracted from at least 20 other species of red algae. Carageenan resembles agar chemically but it contains a higher ash content and requires higher concentrations to form a gel. However, due to its ability to stabilise water/fat emulsions during preparation, cooking and storage it is able to increase product quality and yield, and hence profits.

Carageenan is used extensively in milk-based products and common household items such as toothpastes, diet foods, hand creams, paints, inks and cosmetics.

iii. Alginates

As with the above, alginates are also used for their water retentive, gelling, emulsifying and stabilising properties in the textile and food industries. Alginates are the most widely used seaweed colloids however the technologies for their production and marketing is closely guarded by a small number of producers. Alginate material is present in most species of brown seaweeds

Australia's major export of seaweed from King Island is as a kelp product for alginate manufacture in Scotland.

3. Agricultural applications.

Seaweed is used for the production of fertilisers, biostimulants or growth promotants and pesticides. Seaweed has long been known to aid and stimulate growth of vegetables, crops and other plants (Van Standen, 1995), and has even been cited as a biostimulant for Eucalyptus trees. (eg, Beckett et.al, 1994, Crouch 1991, Abetz 1980) Such international research has demonstrated that seaweed products can improve and enhance various aspects of plant growth and development. Of interest is the specificity of different plants to the concentration and mode of application of the seaweed products. However, Crouch and Van-Standen (1994) notes that while seaweed products have great potential for horticulture practices, it would appear that they are being under-utilised. It is suggested that a better knowledge of seaweed applications would increase their usage.

4. Biomedical applications such as pharmaceutical and medical products.

An important and growing market is the use of seaweed extracts in the pharmaceutical and medical markets. Indeed the major focus of international research is the utilisation of polysaccharides from seaweed for medical treatments for such diseases as cancer, angina, and the HIV AIDS virus. This is an area of focus for the CRC for Industrial Plant Biopolymers at the University of Melbourne.

In the pharmaceutical industry, seaweed extracts are used for health-care, skin-care and cosmetics. In a related area, 'thalassotherapy' or 'algototherapy' baths has been revived in recent years and has developed into a major tourism industry in France, Ireland and Bali where tourists bath in hot seawater containing whole or macerated seaweed. The market perception is that seaweed extracts as natural products provide desirable properties for skin and health-care.

5.3 INTERNATIONAL RESEARCH

The literature search in this study has been relatively comprehensive and clearly shows that there is a very significant body of research available in the public domain. The AUSEAS literature review confirms that since 1975 there are over 600 abstracts from major seaweed producing countries including China, Philippines, Korea, Indonesia, Thailand, France, Norway, and Chile.

As an example, some of these publications include:

- Korea's edible seaweed trade including food products, trade, industrial colloids, and marketing opportunities.
- Chile's seaweed resources and management for fisheries development.
- China's medical applications for seaweed.
- South Africa's agar marketing plans.
- Norway's biotechnology applications of seaweed hydrocolloids.

There appears to be a vast wealth of management, marketing, production and research information available for development by the Australian industry from overseas groups.

While it is acknowledged that there is a significant proportion of seaweeds which are endemic to Australia, overseas research experience can potentially assist in the development of the Australian seaweed industry.

For example, Austrade has identified that the following areas of French technology may have application in Australia:

- Mapping of the Australian seaweed resource using SPOT imaging techniques.
- Harvesting and propagation techniques.
- Identification of species priority for development.
- Balancing of Fishery and Seaweed industry interests.
- Cultivation techniques for *Undaria* which is the 4th most significant edible seaweed by consumption in Japan.

5.4 INDUSTRY SUSTAINABILITY AND ECOLOGICAL IMPLICATIONS

Sustainability of the world's seaweed resource is a major issue for consideration by the industry. There have been a number of case studies which review this issue, and while it is acknowledged that seaweed is a finite biomass, reports to date indicate that seaweed gathering and harvesting has had little adverse environmental impact.

Several of these case-studies are noted below:

- ▶ Mann (1973) undertook a major 2 year study of the rate of growth of seaweeds in Canada and may have parallels in other similar areas such as the west coast of California and in the Indian Ocean. The study showed that for sampled seaweeds in temperate latitudes, the biomass of new tissue produced annually was up to 20 times the initial biomass of the seaweed blade. Mann concludes that seaweeds are highly productive; indeed often more productive than land based plants. Furthermore, naturally occurring seaweeds take their nutrients from the surrounding water with no adverse impact on the marine environment, and because this water is in motion, the nutrient supply is considered by many as inexhaustible.
- ▶ Cullinane (1984) in Ireland reports that :
'...in terms of biomass, only a small fraction of Ireland's seaweed resources are currently being harvested...Seaweed gathering and harvesting is having little environmental impact at present. Harvesters of *Ascophyllum* generally observe a 4-5 year cutting periodicity and leave adequate stumps for regeneration.'

- ▶ Cullen (pers.comm.) from the King Island operation in Australia notes that their annual harvest of cast bull kelp has averaged 25,000 - 28,000 wet tonnes, and this has been a relatively consistent harvest with no adverse environmental impacts throughout over 20 years of operations.

Seaweeds have a significant ecological interaction with other marine life. Recently there has been a focus on the opportunity for seaweeds to co-exist with and support other marine industries. For example, seaweeds may be able to grow on ropes associated with mussel farming, and both abalone graze on seaweeds which in turn are protected by the seaweed from high energy wave and current. More recently, red drift seaweed is harvested from the east coast of Australia as a high-value feed for the abalone industry which is of significant economic value to Australia.

Very limited information exists on the sustainability of seaweeds as a resource. However, this should not preclude the industry from recognising the potential of seaweed as a resource, and an opportunity to diversify the Australian marine industry.

Clearly, further objective research data is required on the key environmental aspects of seaweed if it is to be assessed as a potential resource.

6.0 OVERVIEW OF THE AUSTRALIAN INDUSTRY

Seaweed - Pest or Resource?

6.1 GENERAL

As in many western countries, seaweed in Australia is not perceived as a resource but more often is perceived to be a pest associated with the fouling of beaches, wharfs and coastline areas. There appears to be a perception that seaweed in Australia is not a food resource material, and that its exploitation shall be incompatible with the present fisheries industry.

In many ways, this perception is understandable as there is no or very little objective data available to assess the compatibility of seaweed exploitation with other living marine resources.

Existing seaweed management plans, appear to be weighted in favour of issues relating to resource sustainability and possible ecological disruption to marine and fishery communities. Accordingly the management plan aims to restrict the harvest of live native marine plants.

6.2 THE AUSTRALIAN SEAWEED BALANCE OF TRADE

Recent ABS statistics confirm that Australia is a net importer of seaweed products importing over \$16 million of seaweed products in 1995/96, and exporting some \$415,000 of seaweed products. However, there is inconsistency in the export data as one industry organisation confirms that during 1995/96 they exported over \$3.5 million of product to Scotland.

The imported seaweed products fall into the two categories of:

i. Food Products For Human Consumption

Over \$3.5 million or 250 tonnes of fresh or dried seaweed for food usage was imported in 1995/96. Indeed, this figure is an increase of over 200% over the previous year 2 years, and industry issues have recently been raised over the conformance of these seaweed imports with the Australian food codes and heavy metal concentrations.

The major sources of these products by value are Japan, Philippines, and the USA.

ii. Food Manufacturing/Industrial Colloid Products

Over \$12.7 million of industrial colloids such as agar and carageenan were imported during 1995/96, and it is estimated by industry that \$2.5 million of these colloids are used in the Australian food manufacturing industry.

The major sources of these products by value include Japan, China and Thailand and the UK.

However for both of the above categories of imports, the ABS statistics in Appendix B show that the highest value source countries are not necessarily the countries which supply Australia with the highest volume of seaweed products. For example, during 1995/96 the Philippines supplied over 128,000 kgs of fresh or dried seaweed at a value of \$1 million, however during the same period Japan supplied 25,000 kgs of seaweed with a total value of \$1.26 million.

6.3 AUSTRALIAN SEAWEED MANAGEMENT PLANS

Tasmania is the most advanced State in terms of marine environment management plans for seaweed. Reviews and discussions were conducted of "Policy Document and Fishery Management Plan for the Tasmanian Plant Resources" and the Tasmanian "Living Marine Resources Management Act 1995". The emphasis in both documents is to ensure that "fisheries resources are used in an ecologically sustainable manner and as efficiently as possible".

The intention is on placing controls and measures to ensure that native seaweed biomass is maintained at sustainable levels and that marine farming and commercial fishing is not adversely effected by seaweed harvesting. There is little or no recognition of seaweed as a potential national resource.

6.4 THE AUSTRALIAN SEAWEED INDUSTRY

Overall, the Australian industry is relatively small with less than 50 full-time people employed in the industry. The major industry organisations include:

- ▶ Australian Sea Vegetables, Victoria
- ▶ Kelp Industries, Tasmania/King Is
- ▶ Ms Sheena McDuff Tasmania
- ▶ Tasmanian Wakame Tasmania

The following organisations warrant comment:

- a. Tasmanian Wakame which harvests *Undaria Pinnatifida* under license from the Tasmanian Department of Primary Industries and Fisheries, and is active in the market development and use of seaweed in food products including bread, soups, salads and other food manufacturing applications.
- b. Kelp Industries has been established on King Island for over 20 years and supply dried cast-bull kelp to Scotland for further mixing with other kelps for the production of alginates. The industry consists of some 40 people, and it was reported that the Australian kelps have the highest content of alginate in the world. The product is exported in a minimally processed and dried form.

Fundamentally there is a lack of quantitative resource and economic information on Australia's seaweed resource.

Due to this lack of information about seaweed in Australia, seaweed struggles to be recognised by the Fisheries industry. There appears to be an (understandable) perception that Australian seaweed is not a resource material; their exploitation being incompatible with the present Fisheries management industry.

6.5 THE AUSTRALIAN RESEARCH INDUSTRY

The following research organisations are either directly or indirectly associated with 'seaweed' research in Australia:

- ▶ Adelaide University, South Australia
- ▶ Agriculture Victoria, Victoria
- ▶ Auseas, Queensland
- ▶ Australian Institute of Marine Science, Queensland
- ▶ Australian Food Industry Science Centre, Victoria
- ▶ Aust'n Defence Force Academy/UNSW, ACT
- ▶ CSIRO, Tasmania, WA
- ▶ Dept of Primary Industries & Fisheries, Tasmania
- ▶ Melbourne University, Victoria
- ▶ Monash University, Victoria
- ▶ National Seafood Centre, Queensland

Due to confidentiality issues associated with the support of some of the above research, a comprehensive review of the research work cannot be provided. As appropriate, requests for further information on research may be directed to the above organisations.

However, a number of key research issues for food applications of seaweed warrant note:

- ▶ There is an extremely wide and diverse range of seaweed flora in Australia. The University of Adelaide notes that there are over 1300 described species and estimates that there are over 2,000 species of seaweed in Australia.
- ▶ The biological and chemical cleanliness of Australian seaweeds. This has been recently reported in RIRDC supported research by Tran (1996), which showed levels of heavy metals in Australian seaweeds were over often over two orders of magnitude less than imported seaweeds.
- ▶ As a renewable resource, recent research has shown that Australian seaweeds are a significant protein and nutrient material resource for the food and non-food industry in Australia. It has been noted that the protein levels of some seaweed species are higher than that in many legumes such as lupin, chickpea and soybean.
- ▶ Research by Werner (1992) recommends that seaweeds (fully hydrated) may be able to be further promoted as a food product in Australia by grouping seaweeds with fish and shellfish in the Australian food regulations. Such a grouping would enable seaweeds to

be recognised as a marine organism which is naturally higher in heavy metals than terrestrial foods. However, as mentioned previously, this may also increase the market opportunity for imported seaweeds.

7.0 STRATEGIC REVIEW OF THE AUSTRALIAN SEAWEED INDUSTRY

7.1 STRENGTHS OF THE AUSTRALIAN SEAWEED INDUSTRY

The industry's strength lies in its large seaweed resource which grows in one of the cleanest marine environments in the world.

7.1.1 The two fundamental strengths for the industry are:

- ▶ There is an extremely wide and diverse range of seaweed flora in Australia. The University of Adelaide notes that there are over 1300 described species and estimates that there are over 2,000 species of seaweed in Australia. Similarly, over 106 species of potentially edible seaweed are reported by Sanderson (1988) as occurring in the waters of Tasmania.
- ▶ The biological and chemical cleanliness of Australian seaweeds. This has been recently reported in RIRDC supported research by Tran (1996), which showed levels of heavy metals in Australian seaweeds were over often over two orders of magnitude less than imported seaweeds.
- ▶ As a renewable resource, recent research has shown that Australian seaweeds are a significant protein and nutrient material resource for the food and non-food industry in Australia. It has been noted that the protein levels of some seaweed species are higher than that in many legumes such as lupin, chickpea and soybean.

7.1.2 The industry has access to a significant and established scientific and research resource including State Government Agriculture, Fisheries and research organisations. It is estimated that approximately 20 researchers are active in the seaweed food industry.

7.2 WEAKNESSES OF THE AUSTRALIAN SEAWEED FOOD INDUSTRY

7.2.1 Fundamentally there is a lack of quantitative biomass and economic information on Australia's seaweed resource. There is however an existing knowledge base of the location of the seaweed resource.

- ▶ With the exception of the kelp resources on King Island and the north-west Tasmanian coast, there is insufficient quantitative data on the nature of the existing Australian seaweed resource.
- ▶ A key issue for export and Australian market development is the volume and continuity of (quality) supply.
- ▶ The potential annual tonnage of seaweed material is fundamental to any investment and development. This appears to be one of the factors contributing to the closure of the Alginates (Aust) plant at Triabunna in Tasmania during 1973.

7.2.2 There appears to be a perception that Australian seaweeds are not a resource material, and that their exploitation shall be incompatible with the present Fisheries management industry.

- ▶ This perception is understandable as there is no or very little objective data available to assess the compatibility of seaweed exploitation with other living marine resources.
- ▶ Existing seaweed management plans appear to be weighted in favour of issues relating to resource sustainability and ecological disruption to marine and fishery communities. Accordingly the management plans aim to restrict the harvest of live native marine plants.
- ▶ In Tasmania, attached marine plants exploitation is prohibited and this would appear to be at odds with overseas seaweed management experience.

7.2.3 The industry is small, fragmented and disparate. It is estimated that the Australian seaweed industry employs less than 50 people.

- ▶ Other than the Kelp Harvesters Association on King Island, there is no industry organisation, a lack of working together and no industry management or development strategy.

7.2.4 Much of the seaweed product is 'fragile' with a short shelf-life, and there is a requirement to improve post-harvest processing, handling and packaging techniques.

- ▶ The industry such as Kelp Industries on King Island and Tasmanian Wakame use drying and milling to process their seaweed product. However the potential to exploit seaweed as a fresh seaweed resource has not been developed.

- ▶ There is lack of availability of further processing facilities for further processing, post-harvest preservation or packaging.
- ▶ There is a significant Australian R&D resource however, this resource is not generally utilised by the industry.

7.3 OPPORTUNITIES FOR THE AUSTRALIAN SEAWEED INDUSTRY

7.3.1 The overseas literature confirms that there is a growth in market demand for Asian seaweed as a food product both in Western and Asian countries.

- ▶ This market demand is being fuelled by the current focus upon nutritional food products. For example, France recently authorised 10 species of seaweed as vegetables or condiments for human consumption.
- ▶ Similarly, Jetro in a market survey of edible seaweeds in 1995 confirmed that the demand for seaweed was increasing due to a renewed focus upon health and nutrition.
- ▶ Of significance, Jetro notes that the total market demand for seaweed in Japan is 220,000 tonnes per annum, and that the production of seaweed in Japan has decreased by almost 20% in the last 2 years to less than 100,000 tonnes. By comparison, China's production of seaweed has increased to 300,000 tonnes per year and has become a major supplier to Japan.

7.3.2 There appears to be a vast wealth of management, marketing, production and research information available for development by the Australian industry from overseas groups.

- ▶ The published literature documents a large amount of new product development opportunities in the food and chemical industries, and the methods of production. These include reformed seafood 'steaks', seaweed yoghurt from France, seaweed recipes from India, colloid extracts from red and brown seaweeds in the Philippines, the application of seaweeds as biostimulants in horticulture, and the utilisation of seaweed 'fine' chemicals for high value pharmaceutical applications.
- ▶ A literature review by Auseas confirms that since 1975 there are over 579 abstracts from major seaweed producing countries including China, Philippines, Korea, Indonesia, Thailand, France, Norway, and Chile.
- ▶ Many of the abstract publications describe both commercial and technical issues such as:
 - Korea's edible seaweed trade including food products, trade, industrial colloids, and marketing opportunities.
 - Chile's seaweed resources and management for fisheries development.
 - China's medical applications for seaweed.
 - South Africa's Agar marketing plans.
 - Norway's biotechnology applications of seaweed hydrocolloids.

7.3.3 Overseas research can potentially assist in the development of the Australian seaweed industry.

- ▶ For example, Austrade has identified that the following technology could be available

from IFREMER in France under Australia's bilateral technology agreement (FAIR):

- Mapping of the Australian seaweed resource using SPOT imaging techniques.
- Harvesting and propagation techniques.
- Identification of species priority for development.
- Balancing of Fishery and Seaweed industry interests.
- Cultivation techniques for *Undaria* which is the 4th most significant edible seaweed by consumption in Japan.

7.3.3 The development of an Australian seaweed industry provides the opportunity for the fisheries industry to diversify into complimentary industries.

- ▶ Recent research confirms that there have been precedence examples for the commercial development of seaweed as an Australian resource.
 - Cast bull kelp industry on King Island.
 - Harvesting of Wakame or *Undaria* in east coast Tasmania.
 - Utilisation of drift red seaweed as an abalone feed.
 - Identification of Omega-3 fatty acids in Australian seaweeds.

- ▶ Australia currently imports over \$3 million (ABS, 1996) of seaweed food products, and an Australian seaweed food industry provides the opportunity for import replacement of many of these processed seaweed products.

7.4 THREATS TO THE AUSTRALIAN SEAWEED INDUSTRY

7.4.1 The seaweed industry is small and fragmented, and the interests of other marine resource groups gain greater recognition from current industry management strategies.

- ▶ Without an industry management and development strategy, an Australian seaweed industry shall not be able to approach its potential.

7.4.2 The inability for industry to apply research and industry information from both overseas and within Australia.

- ▶ Industry needs to gain an accurate understanding of market requirements and competition. It would appear that the Australian industry is unable to compete on price, and needs to develop competitive advantages unique to Australia.

7.4.3 International producers and processors of seaweed have competitive marketing strategies for their industries.

7.5 SUMMARY SWOT ANALYSIS

7.5.1 SWOT Analysis of the Industry's Commercial Market Focus

STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
Quality and variety of seaweed (eg, alginates)	<p>No industry organisation</p> <p>No industry management strategy</p> <p>Lack of strategic market intelligence</p>	<p>Strategic positioning of seaweed as a compatible resource with other marine resources.</p> <p>International seaweed is recognised as food resource, and this experience is potentially available to Australia.</p>	International producers and processors of seaweed have competitive marketing strategies for their industries.

7.5.2 SWOT Analysis of the Industry Infrastructure

STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
<p>Major technical resource of State fisheries, agriculture and research organisations</p> <p>Core group of seaweed harvesters and processors.</p>	<p>No market development organisation</p> <p>No national communication for the industry</p> <p>Limited harvesting & processing facilities</p>	<p>Industry & research driven market development</p> <p>Establishment of strategic industry plan</p> <p>Establishment of further processing facilities</p>	<p>Management philosophies which 'prohibit' harvesting of seaweeds without scientific information.</p> <p>Previous citations of industry 'failures' in Tasmania and Darwin.</p>

7.5.3 SWOT Analysis Of Industry Capabilities

STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
Industry infrastructure for technical support Biologically and chemically clean seaweed resource	Lack of export and Australian market development	Diversification and value-added processing for the marine resources industry Utilisation of R&D/technical developments	Lack of industry cohesion

7.5.4 Summary

Market Factors and Drivers of Industry Growth
<ul style="list-style-type: none">▶ Improved understanding of international and Australian market growth and demand.▶ Critical analysis of management alternatives for seaweed based upon overseas experience.▶ Development of a seaweed management plan which is compatible with the present Fisheries management industry.▶ Recognition of Seaweed as a new and emerging industry which warrants support from Government and research organisations.▶ Specific product development and applications of seaweed for food.▶ Consumer and industry awareness of the uses of seaweed.

Market Factors and Constraints to Industry Growth
<ul style="list-style-type: none">▶ Knowledge of the opportunity to utilise Australian seaweed as a food resource.▶ Lack of data on specific seaweed food applications and resource issues relating to sustainability and ecological impacts.▶ Lack of quantitative and economic data for the Australian seaweed resource.▶ Competitive marketing strategies of international 'food' groups.▶ Small size of the industry, and lack of industry investment.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 INDUSTRY COMMUNICATION AND INFORMATION

Conclusion: There is a lack of knowledge in the Australian industry of the size, nature and issues associated with Australian seaweed.

Recommendation: *Support industry development with a business and research network of organisations to improve the effectiveness of dissemination of information.*

Objective: To support industry development and improve the communication and the flow of industry information.

Key Issues:

- Assess collaborative industry research opportunities with relevant international organisations such as IFREMER.
- Availability of current information is not in a 'user-friendly' form for industry dissemination.

8.2 RESEARCH MANAGEMENT

Conclusion: There is no systematic process to manage the support for seaweed research and development in Australia.

Recommendation: *Develop an initial R&D management framework to:*

- a. Establish an initial list of priorities for further 'seaweed' research.*
- b. Establish an Industry Advisory Group to review and assist with the development of R&D priorities for seaweed research.*

Objective: To install a management process which supports the objective assessment and support for research development of seaweed.

Key Issues:

- Development of a seaweed management plan which is compatible with the present Fisheries management industry.
- Development of a seaweed management plan which is compatible with marine ecosystems and environments in Australia.
- Current 'debate' of whether seaweed in the fisheries industry is a pest or a resource.

- Critical analysis of management alternatives for seaweed based upon overseas experience.
- Lack of objective data and misinformation on seaweed in Australia.
- Lack of industry knowledge about the opportunities for the seaweed biomass in Australia.

8.3 MARKET RESEARCH FEASIBILITY STUDIES

Conclusion: There is a lack of information on the commercial feasibility for the development of seaweed product applications identified in many international research studies.

Recommendation: *Conduct feasibility studies for specific demand/supply opportunities in both the Australian and international markets.*

Objective: Development of quantitative and commercial viability information for specific market opportunities for the development of an Australian seaweed industry.

- Key Issues:**
- Import replacement opportunities for the \$3 million of seaweed products currently imported into Australia annually.
 - Availability and base of industry knowledge of Australian seaweed.
 - Improved understanding of international and Australian market growth and demand.
 - Detailed review of existing international knowledge and experience as shown in the literature review of this study.

8.4 PRODUCT DEVELOPMENT

Conclusion: Increased consumer awareness of seaweed food products is required for industry development.

Recommendation: *To commission new product development projects in response to opportunities identified in the market research feasibility studies.*

Objective: To support diversification and value-adding of the fisheries industry through new product development.

- Key Issues:**
- Market research and commercial viability of new products including:

- New food products (eg, reformed fish steak products) which utilise industry by-products and increases industry yields.
- Enhancement of existing food products with functional/nutritional properties from seaweed.
- Biostimulants for horticulture.
- Pharmaceutical applications including applications of agar/HIV.
- Market development and communication to industry.
- While many factors influence our acceptance of foods, two of the more important ones are knowledge of the food and tradition. By increasing the Consumer's awareness of seaweed as a direct food, we may well establish a new or capitalise on existing food traditions.
- Competitive supply from other countries.
- Australian industry support.
- Import replacement opportunities.
- Post-harvest handling and packaging techniques.

8.5 TRADE DEVELOPMENT

Conclusion: There is a lack of industry knowledge of world trade issues for the export of seaweed food products.

Recommendation: *Support research to develop an understanding of tariff and non-tariff trade barriers for export development of an Australian seaweed export industry.*

Objective: Support of the commercialisation of 'seaweed' industry research.

Key Issues:

- Liaison with industry and Australian and international trade development organisations.
- Import and non-tariff trade barriers.
- Food code standards.

8.6 RESEARCH AND DEVELOPMENT

Support research in areas which provide strategic baseline information.

Objective: To develop a strategic knowledge base on the Australian seaweed biomass.

Key Issues:

- Sustainability and ecological impacts of harvesting and utilisation.
- Communication of 'seaweed industry researchers' and the AFISC seaweed researchers network.
- Development of a nationally co-ordinated R&D program and

- database for seaweeds.
- Mapping of the Australian seaweed resource.
- Harvesting and propagation techniques.
- Identification of species priority for development.

9.0 APPENDICES

APPENDIX A

MAJOR INTERNET HOMEPAGES FOR THE SEAWEED INDUSTRY

Seaweed Information Server



Swans at The Claddagh Co. Galway. [More pictures](#)

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APPENDIX B

AUSTRALIAN IMPORT STATISTICS FOR SEAWEED

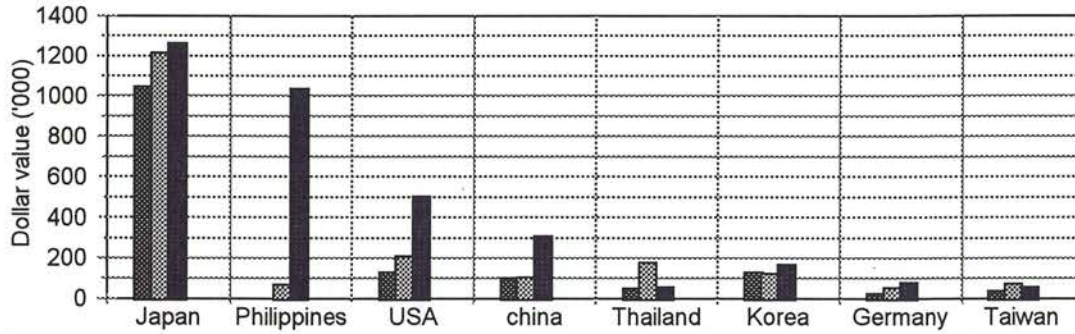
(ABS, 1996)

IMPORT OF SEAWEEDS

1212200026 Fresh or dried seaweed and other Algae									
	Qty (KG)			Value ('000)			Cost per kg		
	1993-1994	1994-1995	1995-1996	1993-1994	1994-1995	1995-1996	1993-1994	1994-1995	1995-1996
Japan	17062	26134	25200	1046	1214	1261	61.31	46.45	50.04
Philippines		21075	128125		69	1037		3.27	8.09
USA	7283	5700	21172	130	208	503	17.85	36.49	23.76
Cina	12165	8807	18302	102	103	307	8.38	11.70	16.77
Thailand	2000	6696	2000	51	179	57	25.50	26.73	28.50
Korea	18271	27276	29256	130	125	167	7.12	4.58	5.71
Germany	2085	3047	4204	25	54	77	11.99	17.72	18.32
Taiwan	1021	2480	2441	36	73	58	35.26	29.44	23.76

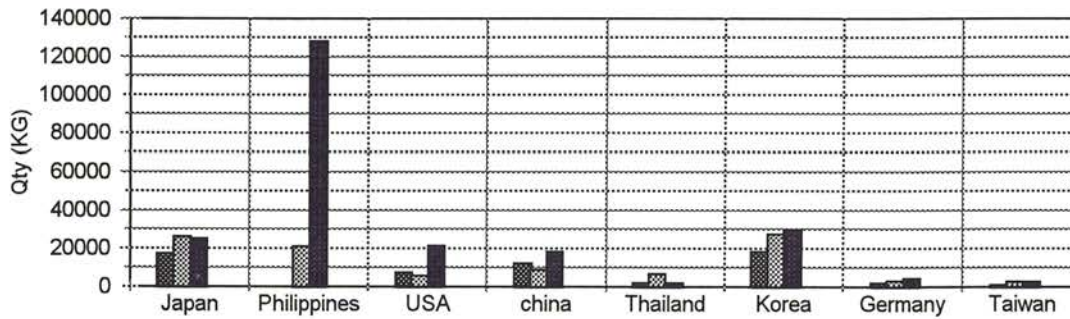
Import of fresh or dried seaweed

1993-1996



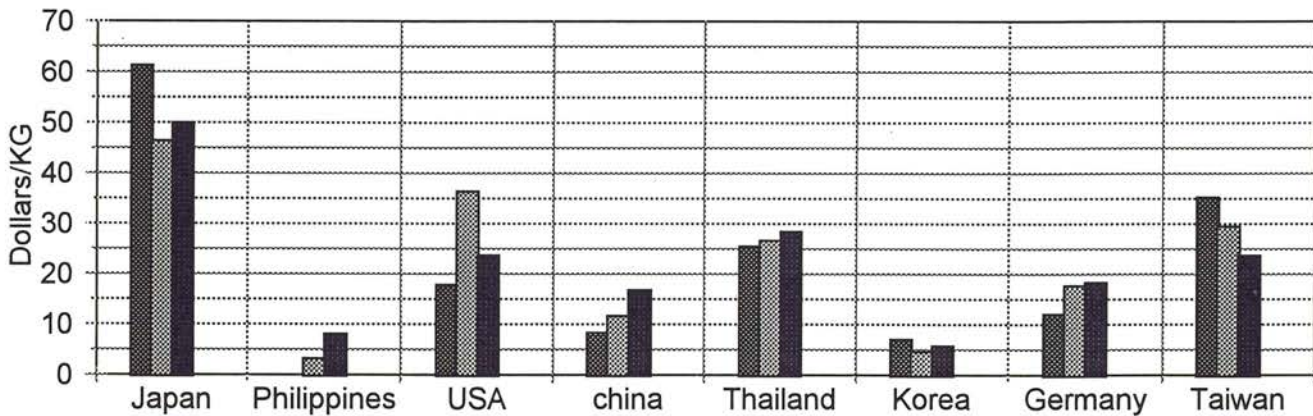
Import of fresh and dried seaweed

1993-1996



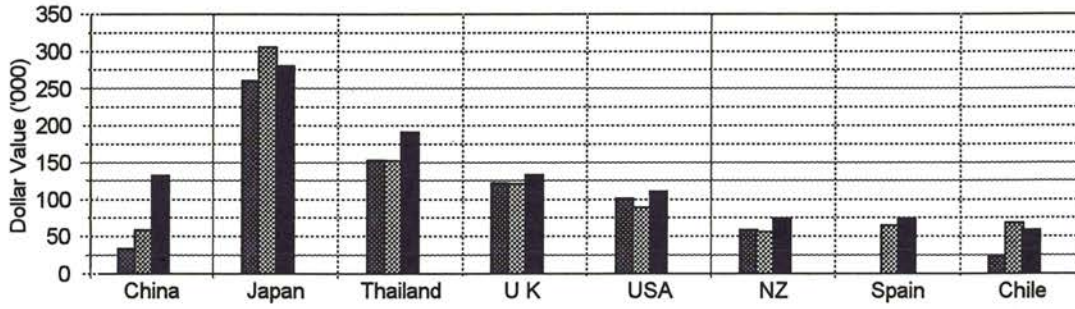
Import of fresh or dried seaweed

1993-1996

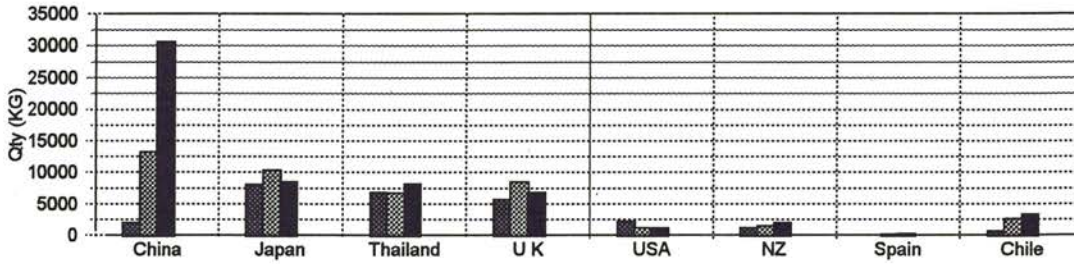


IMPORT OF SEAWEEDS									
1302310012 Agar-Agar									
	QTY (KG)			Value ('000)			Cost per Kg		
	1993-1994	1994-1995	1995-1996	1993-1994	1994-1995	1995-1996	1993-1994	1994-1995	1995-1996
China	1978	13218	30606	34	59	132	17.19	4.46	4.31
Japan	8102	10311	8505	261	306	281	32.21	29.68	33.04
Thailand	6804	6736	8182	153	152	191	22.49	22.57	23.34
U K	5671	8462	6879	122	121	133	21.51	14.30	19.33
USA	2242	1137	1176	101	89	111	45.05	78.28	94.39
NZ	1210	1517	2000	59	56	74	48.76	36.91	37.00
Spain		175	196		65	74		371.43	377.55
Chile	664	2637	3350	22	68	59	33.13	25.79	17.61

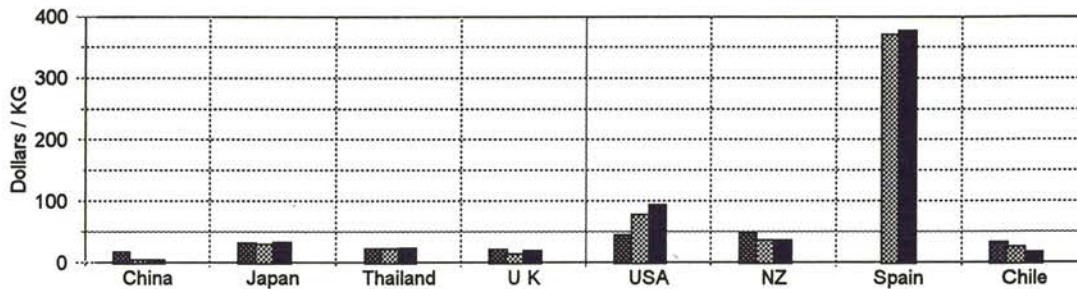
Import of Agar- Agar 1993-1996



Import of Agar- Agar 1993-1996



Import of Agar- Agar 1993-1996



APPENDIX C

INDUSTRY CONTACTS
TABLE A
AUSTRALIAN SEAWEED INDUSTRY
KEY INDUSTRY GROUPS

Research Organisations	Direct Food	Food Manufacturing/ Industrial Colloid
Adelaide University South Australia	Australian Sea Vegetables, Victoria	AC Hatrick NSW
Agriculture Victoria Victoria	Kelp Industries, Tasmania/King Is	Applied Technical Products NSW
Auseas Queensland	Ms Sheena McDuff Tasmania	Consolidated Chemicals Victoria
Australian Institute of Marine Science Queensland	Tasmanian Wakame Tasmania	Colgate-Palmolive NSW
Australian Food Industry Science Ctre Victoria		Marrickville Margarine NSW
Aust'n Defence Force Academy/UNSW ACT		Schemberg NSW
CSIRO, Tasmania, WA		Swift & Co NSW
Dept of Primary Industries & Fisheries, Tasmania		Unilever/Quest NSW
Melbourne University Victoria		
Monash University Victoria		
National Seafood Ctre Queensland		

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