

## 2.5 Seaweed Research Programme

### 2.5.1 Introduction

Seaweed is a sustainable natural resource with industrial potential that is not fully utilised<sup>10</sup>. The industry is broadly based, with the product being supplied to agriculture/horticulture, cosmetics, thalassotherapy, the biopharma sector (functional foods/nutraceuticals), and for human consumption. At present, about 32,000 tonnes of wet weed is harvested to supply the constituent sub-sectors and there is considerable interest in expanding the potential product range; especially in adding value to extracted components for a wide range of uses.

### 2.5.2 Sector Profile

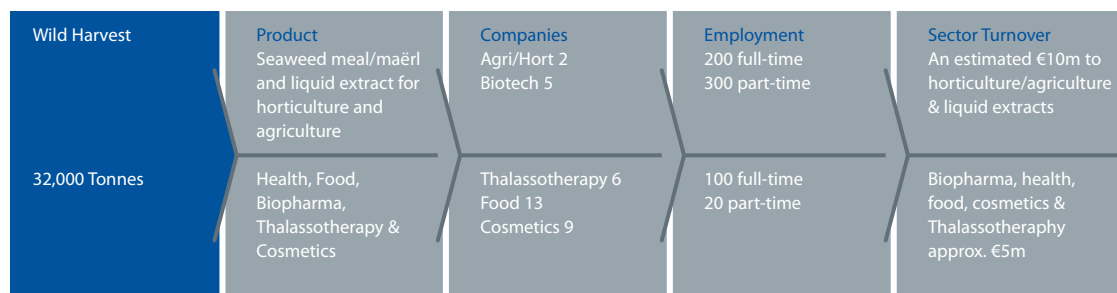


Figure 2.13 Key Components of the Irish Seaweed Sector

### 2.5.3 Key Opportunities and Challenges

Raw material supply will be a key driver for the sector going forward. It is increasingly difficult to maintain the supply of *Ascophyllum* sp. from hand-harvested weed as the age profile of traditional cutters is increasing and there is less interest in this activity amongst younger generations. It will be challenging for the seaweed sector to maintain sustainable harvests and raw material supply—as has been the case with rotational hand cutting over the last 60 years—using a mixture of hand-harvested weed and the development of more mechanised processes.

There are opportunities to develop new organic product ranges and considerable R&D effort will be required to take advantage of the large potential of seaweed as a raw material base for the development of further cosmetic products, functional food and nutraceuticals. There is considerable interest in the use

<sup>10</sup> National Seaweed Forum (2000). National Seaweed Forum Report. Dublin.

of seaweed in bioremediation processes, e.g. through reducing excess nutrients in discharge waters from sewage treatment plants and onshore aquaculture production units, and treatment of tannery wastes.

There are significant R&D challenges related to the development of aquaculture techniques to produce targeted algae with specialist product potential.

Building on the past success of good management of the wild resource in developing harvesting regimes for kelp, and other species with potential for commercial harvest, will require considerable and sensible progression by regulators and industry. The resulting environment will offer a more attractive opportunity for entrepreneurial investment and significant sector development.

#### 2.5.4 2020 Scenario

##### 2020 SCENARIO

By 2020, the seaweed sector will have evolved from the current hybrid of declining wild harvest and fledgling aquaculture production into a sector with:

- > Sustainable, scientifically based harvesting of kelp, *Ascophyllum nodosum*, fucoids and maërl;
- > Seaweed from aquaculture production forming the basis for downstream processing of value-added biopharma and nutraceutical products; and
- > Regular use of seaweed in biotechnology.

The seaweed production and processing sector will be worth **€30 million** p.a. and play an increasing socio-economic role as part of the mosaic of marine resource utilisation, in the context of marine spatial planning in the coastal zone.

#### 2.5.5 2013 Objectives

The following objectives have been identified as critical milestones to be achieved by 2013:

##### 2013 OBJECTIVES

- 1 Agree, with National Parks & Wildlife Service (NPWS), Department of Communications, Marine & Natural Resources (DCMNR) and research agencies, a regulatory framework and management plan for sustainable harvest of wild seaweed.
- 2 Develop integrated systems for seaweed aquaculture, including polyculture methodologies and seed hatchery production.
- 3 Develop a screening programme for potential seaweed products (including nutritional and biochemical analysis) across the range of candidate species.
- 4 Improve availability and dissemination of applied R&D outputs to potential new industry entrants.

### 2.5.6 RTDI Requirements/Key Outputs

The identified RTDI requirements and key outputs for delivering on the 2013 Objectives of the research programme are presented below.

**Table 2.14** Research Requirements & Key Outputs for the Seaweed Sector to 2013

Objectives 2013	RTDI Requirements	Key Outputs
<p><b>1</b> Agree, with National Parks &amp; Wildlife Service (NPWS), Department of Communications, Marine &amp; Natural Resources (DCMNR) and research agencies, a regulatory framework and management plan for sustainable harvest of wild seaweed.</p>	<ul style="list-style-type: none"> <li>&gt; Trials in mechanical harvesting and rotation for the key species</li> <li>&gt; Monitoring and assessment of environmental impacts of mechanical harvesting</li> <li>&gt; Assess constraints, profile other users and integrate seaweed harvesting within Marine Spatial Plans</li> <li>&gt; Assess resource and draft long-term harvest and management plans</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Map of resource availability and identified harvesting sites and cycles</li> <li>&gt; Best practice/regulatory guidelines for mechanical harvesting of seaweed</li> </ul>
<p><b>2</b> Develop integrated systems for seaweed aquaculture, including polyculture methodologies &amp; seed hatchery production.</p>	<ul style="list-style-type: none"> <li>&gt; Develop seed hatchery and on-growing techniques, including spore release and rope-seeding technology</li> <li>&gt; Model and assess the production carrying capacity of bays with polyculture</li> <li>&gt; Assess mitigation benefits of integrated culture systems</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Technologies developed for a range of farmed seaweed products</li> <li>&gt; Algae as an integrated tool for polyculture</li> </ul>
<p><b>3</b> Develop a screening programme for potential seaweed products (including nutritional and biochemical analysis) across the range of candidate species.</p>	<ul style="list-style-type: none"> <li>&gt; Screen seaweeds to identify and develop a range of value-added products, including biomedical compounds, functional foods, enzymes and bioactive derived compounds</li> <li>&gt; Biochemical analysis of seaweed compounds.</li> <li>&gt; Market segmentation to determine possible applications of seaweed products</li> </ul>	<ul style="list-style-type: none"> <li>&gt; A range of downstream products.</li> <li>&gt; Seaweed compounds identified as an input to biotechnology projects</li> </ul>
<p><b>4</b> Improve availability and dissemination of applied R&amp;D outputs to potential new industry entrants.</p>	<ul style="list-style-type: none"> <li>&gt; Develop mechanisms for transfer and licence of seaweed production technology, including commercialisation opportunities resulting from national and international R&amp;D results</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Industry awareness of the R&amp;D results and product potential, including opportunities from overseas technology transfer</li> <li>&gt; Improved commercialisation methodology</li> </ul>

## 2.5.7 RTDI Capacity/Capabilities

### Current Research Capacity

#### Third-level Sector

Active seaweed research within the third-level sector comprises six research groups. Together, these research groups comprise approximately 23 researchers in seaweed research (Table 2.15). By far the most active Institute is NUIG, with three of the six research groups. Current topics of seaweed research within the third-level sector include seaweed culture, seaweed resource assessment, identification and extraction of novel compounds, and the use of seaweed for bioremediation.

A further 10 research groups and a number of individual researchers have the capacity to contribute to the future RTDI requirements and objectives for the development of the seaweed sector. Much of this expertise is within the areas of marine biology, ecology and ecosystem functioning; and marine biodiversity conservation, and, as such, is of importance within the context of developing a sustainable seaweed harvest industry. Expertise also exists in the fields of pigment extraction, harvesting technology and polyculture.

**Table 2.15** Overview of Current Seaweed Research in the Third-level Sector

Institutes	No. Research Groups	No. Researchers*	Research Focus
NUIG UCD WIT	4 Medium Groups 2 Small Groups	23	<ul style="list-style-type: none"> <li>&gt; Seaweed culture</li> <li>&gt; Development of algae as fish feed</li> <li>&gt; Development of edible seaweed products</li> <li>&gt; Bio-purification/remediation uses for seaweed</li> <li>&gt; Kelp resource assessment and management</li> <li>&gt; Mechanical harvesting</li> <li>&gt; Impact assessment</li> <li>&gt; Algal biodiversity</li> <li>&gt; Investigation and identification of novel/potential bioactive compounds of algal origin and their uses</li> <li>&gt; Isolation and structure determination of polysaccharides from seaweeds</li> <li>&gt; Iodine content in seaweed</li> <li>&gt; Use of seaweed extracts for animal nutrition</li> <li>&gt; Seaweed growth optimisation and biochemical studies</li> <li>&gt; Seaweed genetic studies</li> </ul>

Large: >10 researchers; Medium: 5–10 researchers; Small: <5 researchers

\* In some cases, research groups may focus on more than one theme and the total number of researchers in these groups is greater than indicated here. The total number of researchers in the groups identified is approximately 90.

### State Sector

Arramara Teo., a commercial state company, is actively involved in the ongoing development of new products for the agriculture, horticulture and cosmetic industries. It is also involved in collaboration with NUI Galway (Biochemistry Dept.) in the evaluation of high-value, novel biotechnological applications for seaweed extracts.

### Industry

A range of established and start-up companies are actively involved in the development and innovation of new compounds/extracts from seaweed for human consumption, agriculture/ horticulture, cosmetics, thalassotherapy and the biopharma sector. Many of these companies receive funding from Údarás na Gaeltachta or Enterprise Ireland.

### Identification of Research Skills/Competencies to Meet Future RTDI Requirements

A summary, based on the identified future RTDI requirements, of the competencies required to meet the 2013 Objectives is presented in Table 2.16. Also included in Table 2.16 is an assessment of whether there are current strengths (S), areas that require strengthening (R), or gap areas (G), in relation to the identified requirements, within the existing research community.

**Table 2.16** Competencies Required to Meet Future Research & Innovation Requirements for the Seaweed Sector

Objectives 2013	Competencies Required	Assessment
1 Agree regulatory framework and management plan for sustainable harvest of wild seaweed with NPWS, DCMNR & research agencies.	<ul style="list-style-type: none"> <li>&gt; Mechanical harvesting</li> <li>&gt; Monitoring/impact assessment</li> <li>&gt; Integrated marine planning</li> <li>&gt; Resource assessment</li> </ul>	<ul style="list-style-type: none"> <li>G</li> <li>S</li> <li>R</li> <li>S</li> </ul>
2 Develop integrated systems for seaweed aquaculture, including polyculture methodologies and seed hatchery production.	<ul style="list-style-type: none"> <li>&gt; Seaweed culture methodologies</li> <li>&gt; Seaweed hatchery techniques</li> <li>&gt; Polyculture</li> <li>&gt; Re-circulation technology</li> <li>&gt; Carrying capacity models</li> </ul>	<ul style="list-style-type: none"> <li>R</li> <li>G</li> <li>R</li> <li>R</li> <li>G</li> </ul>
3 Develop a screening programme for potential seaweed products (including nutritional & biochemical analysis) across the range of candidate species.	<ul style="list-style-type: none"> <li>&gt; Human nutrition</li> <li>&gt; Biotechnology/biodiscovery</li> <li>&gt; Market research</li> </ul>	<ul style="list-style-type: none"> <li>S</li> <li>R</li> <li>R</li> </ul>
4 Improve availability and dissemination of applied R&D outputs to potential new industry entrants.	<ul style="list-style-type: none"> <li>&gt; Commercialisation/technology transfer</li> </ul>	<ul style="list-style-type: none"> <li>R</li> </ul>

\* S – Current Strength; R – Requires Strengthening; G – Gap Area.

The competencies required to develop a sustainable seaweed harvesting sector are largely available. However, what is clearly lacking is experience in mechanical harvesting and the formulation and application of management plans for the seaweed resource.

Seaweed culture in Ireland is clearly in its infancy and the research competencies required to develop a successful industry are either lacking or will require strengthening to meet the 2013 Objectives. Similarly, research competencies required to promote integrated polyculture require strengthening. An important aspect of the development of successful polyculture is the development of carrying capacity models. Although there are research strengths in the areas of physical modelling, carrying capacity modelling requires input from a number of disciplines and it is considered a gap area.

The competencies required for the identification/isolation and development of new seaweed-derived products fall within those identified for the wider biotechnology/biodiscovery programme. Clearly, there are research strengths in many of the relevant disciplines that could easily be applied in the investigation and development of interesting biologically-derived compounds from algae.

Finally, research effort is just the first step towards developing a viable seaweed sector. The commercialisation of research outputs is a vital step and is an area that requires strengthening.

Current Strengths	Require Strengthening	Gaps
<ul style="list-style-type: none"> <li>&gt; Resource assessment</li> <li>&gt; Monitoring/impact assessment</li> <li>&gt; Human nutrition</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Integrated marine planning</li> <li>&gt; Seaweed culture methodologies</li> <li>&gt; Polyculture</li> <li>&gt; Market research</li> <li>&gt; Biotechnology/biodiscovery</li> <li>&gt; Commercialisation/technology transfer</li> <li>&gt; Re-circulation technology</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Mechanical harvesting</li> <li>&gt; Carrying capacity models</li> <li>&gt; Seaweed hatchery techniques</li> </ul>

Figure 2.14 Research Competencies Required to Meet 2013 Objectives for Seaweed.

### 2.5.8 Prerequisites for Achieving Objectives

The following are considered as some of the prerequisites for the successful delivery of the objectives for the seaweed research programme:

- > Consensus on a regulatory framework for sustainable harvest of wild seaweed;
- > State policy support for technology transfer, diversification and new product development; and
- > Entrepreneurs to commercialise the R&D.