Profiting from Seaweed Farming

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BIM
Today's presentation

- The main countries / species / Volumes.
- The West must catch up.
- European competition / Early innovators.
- The opportunity.
- Irish red and brown seaweed production, results and economic analysis.
Production of aquatic plants FAO 2012

- The production of aquatic algae, mostly seaweeds, reached 24.9 million tonnes in 2012.
- Of which aquaculture produced 23.8 million tonnes (96 percent).
- Value is $5.5-6Bn per annum (€4.3-4.7Bn)
- Worldwide macroalgae production (includes brown, red and green seaweeds) increasing by 6% every year
World production of farmed aquatic plants (algae) by major species or species group (FAO 2012)
Six main species

Laminaria japonica (Kombu)
Undaria spp. (Wakame)
Hizikia (Sargassum) fusiforme
Porphyra sp. (Nori)
Gracilaria lemaeiformis
Kappaphycus sp.

China, Indonesia, Philippines, S. Korea, N. Korea, Japan, Malaysia.

Farmed seaweed production 99.4% from seven countries in Asia (FAO)
World seaweed production, by capture and aquaculture, by country (2012) FAO
European seaweed production, by capture and aquaculture, by country (2012) FAO

<table>
<thead>
<tr>
<th>Country</th>
<th>Capture</th>
<th>Aquaculture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>525</td>
<td>2</td>
<td>527</td>
</tr>
<tr>
<td>Portugal</td>
<td>801</td>
<td>0</td>
<td>801</td>
</tr>
<tr>
<td>Italy</td>
<td>1,200</td>
<td>0</td>
<td>1,200</td>
</tr>
<tr>
<td>Denmark</td>
<td>18,079</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Iceland</td>
<td>29,500</td>
<td>9</td>
<td>29,509</td>
</tr>
<tr>
<td>France</td>
<td>41,229</td>
<td>350</td>
<td>41,579</td>
</tr>
<tr>
<td>Norway</td>
<td>140,336</td>
<td>0</td>
<td>140,336</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>231,670</strong></td>
<td><strong>5,361</strong></td>
<td><strong>237,031</strong></td>
</tr>
</tbody>
</table>

**European capture aquatic plants 2012 FAO**

- Norway: 61%
- France: 18%
- Iceland: 12%
- Ireland: 8%
- Denmark: 2%
- Italy: 0%
- Spain: 0%
- Portugal: 0%

**Total European production aquatic plants FAO**

- Norway: 59%
- France: 18%
- Ireland: 12%
- Iceland: 8%
- Denmark: 0%

**European aquaculture aquatic plants 2012 FAO**

- Denmark: 93%
- Norway: 7%
- France: 18%
- Ireland: 13%
- Iceland: 8%
- Spain: 0%
- Portugal: 0%
- Italy: 0%
## Irish Wild Seaweed Harvest

<table>
<thead>
<tr>
<th>Species</th>
<th>Annual Harvest (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ascophyllum nodosum</em></td>
<td>25,000</td>
</tr>
<tr>
<td><em>Fucus serratus</em></td>
<td>200</td>
</tr>
<tr>
<td><em>Palmaria palmata</em></td>
<td>&lt;100</td>
</tr>
<tr>
<td><em>Chondrus crispus/Mastocarpus stellatus</em></td>
<td>&lt;100</td>
</tr>
<tr>
<td><em>Laminaria digitata</em></td>
<td>&lt;150</td>
</tr>
<tr>
<td><em>H. elongata, S. latissima, L. hyperborea,</em></td>
<td>&lt;10 each</td>
</tr>
<tr>
<td><em>Ulva rigida, Porphyra spp, F. vesiculosus,</em></td>
<td>&lt;10 each</td>
</tr>
<tr>
<td><em>A. esculenta</em></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25,000 t</strong></td>
</tr>
</tbody>
</table>
Danish Windmill Parks (Susan Holdt – The Seaweed Network (Denmark))

European Innovators

- Red circles: existing
- Green circles: planned

www.bim.ie
Danish Seaweed Network.

‘Commercial production of seaweed would be a good supplement to current long-line mussel farming in the Limfjord’
• (1) www.netalgae.eu – France, Ireland, UK, Spain, Portugal, Norway.

• (2) Nordic Algae Network: Iceland, Denmark, Norway and Sweden

• (3) University of Wageningen, NL Recent Report (available on the web)
Massive marine potential

Underutilised Oceans

• More than 70% of seaweed is used to make food.
• Alginate, carrageenan and agar use 15-20% world seaweed production.
• Oceans cover 70% of the earth but yield only 120million mt (1.5% of our food) (Chen Jiaxin)
• 1bn employed in world agriculture today (FAO). 1/7 of the planet’s people.
• Marine Potential is massive

This is where farmed seaweed must be For profit
Why Farm Seaweed?

The EU market for sea vegetables is growing by about 7-10% per annum (Organic Monitor).
Project PBA/SW/07/001 – The Seaweed Hatchery Project.

- Development and demonstration of viable hatchery and ongrowing methodologies for sea weed species with identified commercial potential.

- A BIM led project with NUIG, QUB and 6 SME’s.

- Project carried out under the Sea Change Strategy with the support of the Marine Institute and the Marine Research Sub-programme of the National Development Plan, 2007-2013.

- Project operated from 2008-2011.

- To farm three commercially important species, *Palmaria palmata*, *Laminaria digitata* and *Porphyra sp.*
The Seaweed Hatchery Project.  
Project Aims

• Produce algal biomass at pilot or commercial scale.

• Share knowledge of cultivation techniques between three purpose-built hatcheries.

• Develop cultivation manuals for each species to help develop the cultivation sector (www.bim.ie).

• Economic and marketing strategies.

• Desk based assessment for cultivation site suitability.
The Irish seaweed Sector

- Ireland’s seaweed/biotechnology sector worth €18M PA (Morrissey et al. 2011)

- Target for 2020 is €30M (Sea Change Strategy). This will be achieved.....

- Challenge to expand wild resource harvest and farming of higher value species.

- High volume, low value products, animal feeds, plant supplements, specialist fertilisers and agricultural products. Nearly 100% RM, 86% value. €15.5M

- Foods, cosmetics and therapies. 1% of the RM, 14% value. €2.5M.

- 7 seaweed aquaculture licences in place and 23 applications with the DAFM (November 2014)
Product Value

- Agricultural products. 20,000 tonnes PA. Worth €2/L

- Exports to 30 countries, bulk to South America, Europe, Middle East and Asia.

- Most in horticultural industry, fruit, veg, flower production, grass products, sports surfaces. Outlook good. Organic agricultural sector.

- 3-6 tonnes edible seaweed consumed in Ireland PA.

- Increasing demand from Spain and France eg *P. palmata* €16-€19/kg bulk dry quantities ex. Ireland

- Cosmetic products. Therapy centres, seaweed baths, branded consumer products.

- Domestic market largely saturated so focus on the export market.

www.bim.ie
Why are we looking at kelp / Can we farm Kelp?
Yes

- Laminaria (equivalent Saccharina – Kombu / sugar kelp)
  - FAO 2010 derived data
  - €458 / tonne wet weight first sale Japan

- Undaria (equivalent Alaria – Atlantic wakame)
  - FAO 2010 derived data
  - €328 / tonne wet weight first sale Japan
Indicative cost of setting up a new seaweed longline farm Ireland (2014)

- Profitable at 5 years

### Cost breakdown of set up

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1 80 lines</th>
<th>Year 2 160 lines</th>
<th>Year 3 160 lines</th>
<th>Year 4 160 lines</th>
<th>Year 5 160 lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs</td>
<td>245k</td>
<td>104k</td>
<td>40k</td>
<td>40k</td>
<td>40k</td>
</tr>
<tr>
<td>Labour</td>
<td>100k</td>
<td>160k</td>
<td>160k</td>
<td>160k</td>
<td>160k</td>
</tr>
<tr>
<td>Seed</td>
<td>67.2k</td>
<td>134.4k</td>
<td>134.4k</td>
<td>134.4k</td>
<td>134.4k</td>
</tr>
<tr>
<td>Fees</td>
<td>12k</td>
<td>12k</td>
<td>12k</td>
<td>12k</td>
<td>12k</td>
</tr>
<tr>
<td>Sub total</td>
<td>424.2k</td>
<td>410.4k</td>
<td>346.4k</td>
<td>346.4k</td>
<td>346.4k</td>
</tr>
<tr>
<td>Harvest T</td>
<td>0</td>
<td>300</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Sales</td>
<td>0</td>
<td>300k</td>
<td>600k</td>
<td>600k</td>
<td>600k</td>
</tr>
<tr>
<td>Profit /loss</td>
<td>-424.2k</td>
<td>-534.6k</td>
<td>-281k</td>
<td>-27.4k</td>
<td>226.2k</td>
</tr>
</tbody>
</table>
Brown weed (*Laminaria digitata*) grow-out at sea
Multi-species hatchery set up costs (seaweed and bivalve) and production potential. The Seaweed Hatchery Project

- *Alaria* hatchery work June to Oct.
- Deployments to sea Nov to Feb.
- Adapt an insulated container. (12.19x2.7x2.43m).
- 16.2m³ tankage.
- 240 collectors (240x30m – 7,200m string).
- 10 collectors per tank.
- Two production runs PA.
- Yield 7kg/metre.
- Harvest at sea is 50.4T x 2
- Total harvest 100.8T.

### Hatchery Costs (€)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x insulated room with AC and control panel</td>
<td>8,500</td>
</tr>
<tr>
<td>Autoclave</td>
<td>14,000.00</td>
</tr>
<tr>
<td>Microscope</td>
<td>1,500.00</td>
</tr>
<tr>
<td>Precision balance</td>
<td>1,500.00</td>
</tr>
<tr>
<td>Pipework</td>
<td>2,000.00</td>
</tr>
<tr>
<td>Tankage 16.2m³</td>
<td>14,000.00</td>
</tr>
<tr>
<td>UV</td>
<td>1,000.00</td>
</tr>
<tr>
<td><strong>Consumables</strong></td>
<td></td>
</tr>
<tr>
<td>Glassware</td>
<td>1,500.00</td>
</tr>
<tr>
<td>fluorescent tubes</td>
<td>500.00</td>
</tr>
<tr>
<td>Nutrients</td>
<td>750.00</td>
</tr>
<tr>
<td>Collectors 480 (240x2 €5/ea)</td>
<td></td>
</tr>
<tr>
<td>Laminaria</td>
<td>2,400.00</td>
</tr>
<tr>
<td>Nets 48 (48x1 @€10/ea)</td>
<td>480.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48,130.00</td>
</tr>
<tr>
<td>Electricity per annum</td>
<td>30,000.00</td>
</tr>
<tr>
<td>Labour per annum</td>
<td>60,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>138,130.00</td>
</tr>
</tbody>
</table>
The Seaweed Hatchery Project.

• Case Study 1. A new seaweed hatchery with a new grow-out site.

• Case Study 2. A new seaweed hatchery and an existing mussel site partially used for seaweed grow-out.

• Case Study 3. A new seaweed and scallop combined hatchery with a new seaweed grow-out site.

• Case Study 4. A new seaweed and scallop hatchery with an existing mussel site partially used for seaweed grow-out.
## The Seaweed Hatchery Project – cost structure.

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Description</th>
<th>Break even price Laminaria €/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seaweed hatchery and new seaweed grow out farm.</td>
<td>€2.15</td>
</tr>
<tr>
<td>2</td>
<td>Seaweed hatchery and existing mussel site.</td>
<td>€1.65</td>
</tr>
<tr>
<td>3</td>
<td>Seaweed and scallop hatchery and new seaweed grow out farm.</td>
<td>€1.63</td>
</tr>
<tr>
<td>4</td>
<td>Seaweed and scallop hatchery and existing mussel site.</td>
<td>€1.12</td>
</tr>
</tbody>
</table>
Why are we looking at Porphyra / Nori?

- Most profitable of all fisheries in Japan (FAO)
- Japan 400,000T, Korean Republic 270,000T and China 210,000T
- Rich in protein, free AA. Favourable taste
- Protein content of 30-50 percent, and about 75 percent of that is digestible.
- Japan 60,000 fishermen and 10 million nets.
- Railway stations, hotels, sandwich substitute, sushi, Nori in biscuits, ‘sweets’, ingredient for cooking soups etc.
- Ave Japanese consumes 50-60 sheets Nori p/a.
- No more expansion – no more suitable sites.
- Market demand stable, slow popn growth.
- Growth at 3-5% pa.

### Japan

<table>
<thead>
<tr>
<th>Japanese Nori Production T / value €</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnage wet</td>
<td>400,000</td>
</tr>
<tr>
<td>€/T wet</td>
<td>745</td>
</tr>
<tr>
<td>sheets</td>
<td>10bn @ 3.75g</td>
</tr>
<tr>
<td>Tonnage dry</td>
<td>37,500</td>
</tr>
<tr>
<td>wet:dry yield</td>
<td>9.38%</td>
</tr>
<tr>
<td>€/T dry</td>
<td>11,538</td>
</tr>
<tr>
<td>€/T sheets</td>
<td>30,769</td>
</tr>
</tbody>
</table>

FAO 2012

Where on the value chain? Presume wholesale?
Price of NORI Ireland

- €2 for a 5g pack Nori (from Korea) sold Dublin.
- 1T dry packaged Nori retail price €400K
Can we farm Porphyra? No, Not yet

- Attempts have been made to cultivate *Porphyra* on the west and east coasts of the USA. Will hear about the East coast US results later from Professor Susan Brawley. Irish tank trials will be discussed briefly by Freddie O’ Mahony.

- Irish tank trials have proven inconclusive and we are not able to recommend a sure-fire tank cultivation protocol with our own strains.

- Using tanks with aerated water and nutrient we are able to grow *Porphyra* for just two weeks before the weed deteriorates.

- Work is to continue on the manipulation in the laboratory of the conchocelis stage of the lifecycle.
Production cycle of *Porphyra* spp.
Can we farm Palmaria / Dulse? Yes, with limitations

- Spore crashes after settlement
- Fouling at sea
- Lack of success
- So looked at tank cultivation
Palmaria grow-out at sea

Palmaria in-tank trials
At S.D. of 4kgm\(^{-2}\) 
*Palmaria* doubles in weight every 4 weeks.

Annual total production from 40 tanks will be 1,920kgs. 
From 80 tanks will be 3,840kgs. 
Barely viable at €16/kg dry. IMTA Possibility to improve growth?
Conclusion

- The price for brown seaweed ex farm needs to be in the region €1,000/wet tonne to be profitable.
- The market is specialised and demand is increasing by 7-10 percent per annum (Organic Monitor).
- Provenance/organic product /marketing.
- Ireland is a good place to farm the brown seaweeds.
- More work needed on the red weeds.
- Sites, skillset, knowledge and expertise.
- Ireland is innovating from the point of view of European seaweed initiatives.
Thank you for your attention