Potential of local seaweed production for biostimulants

Deliverable 1.1.3.

Part of Bio4safe WP1 Market analyses

Executed by Stichting Noordzeeboerderij / North Sea Farm Foundation

July 2018

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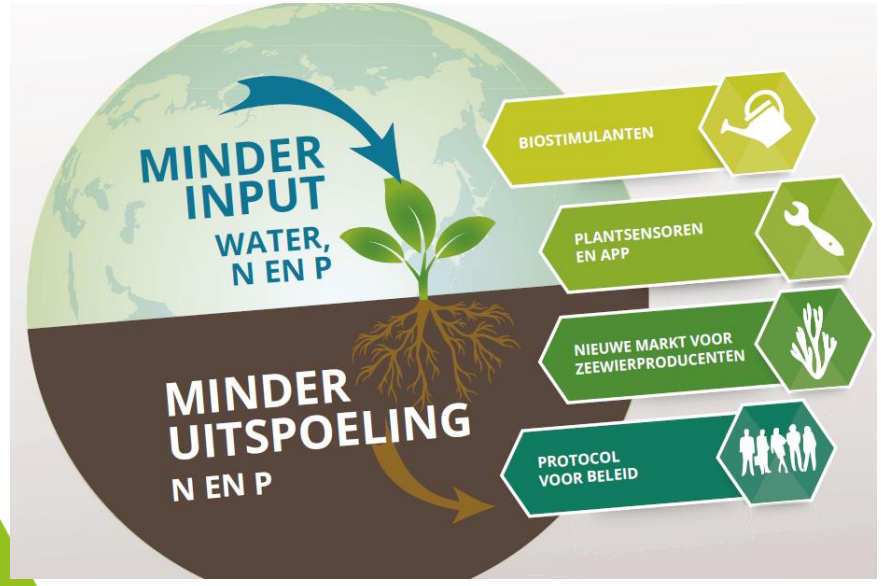
Potential of local seaweed production for biostimulants
Preface

This report is part of the Interreg 2 seas project Bio4safe. The project is coordinated by PCS Ornamental Plant Research (Belgium) and includes 7 other partners including Research Station Proeftuin Zwaagdijk (NL), North Sea Farm Foundation (NL), Yncréa Hauts de France, establishment ISA Lille (France), Vegetables Pole Region North (France), NIAB (UK) and Dove Associates (UK) and Ghent University (Belgium). The Bio4safe-project runs for a period of four years, started in 2017 and is funded by Europe via the Interreg 2 Seas Programme.

Contact information

Questions and remarks about the report and the project can be shared with Marlies Draisma (marlies@noordzeeboerderij.nl) from the North Sea Farm Foundation.



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Potential of local seaweed production for biostimulants

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Potential of local seaweed production for biostimulants
List of abbreviations

D	Deliverable
WP	Work package
Mln	Million
Bln	Billion
T-wet	Wet weight in tonnes
MT	Metric tonnes

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Potential of local seaweed production for biostimulants
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1 | Introduction & methodology

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Introduction & methodology

Introduction to the project and report

This market study is part of the Bio4safe Interreg project for the European Union. This project aims to reduce water use and fertilizer use in horticulture by using biostimulants and innovative tools. This combination will result in up to 20% reduction of water and 10% of fertilizer usage, depending on the crop. By specifically including biostimulant based on seaweeds, economic opportunities for seaweed producers will be explored and developed.

The project comprises of 6 work packages:

Work Package 1: Market study: development of business models for producing biostimulants from seaweeds

Work Package 2: Demonstration, implementation and adoption of biostimulants and sensor tools

Work Package 3: Collecting and analysing cross-border data to develop information database and apps to access the information

Work Package 4: Policy protocol

Work Package 5: Project management

Work Package 6: Communication

This report is part of **Work Package 1: Market study: development of business models for producing biostimulants from seaweeds** and as such constitutes the required **deliverable D1.1.3 potential of local seaweed production for biostimulants** as part of activity **WP1.1 - Determination of existing market of biostimulants**

The following sheets briefly demonstrate the relation between these various elements.

Introduction & methodology

Activities and deliverables for Work Package 1

From niche to commodity

WP1.1 Determination of existing market of biostimulants

- ✓D1.1.1: Identification of the seaweed biostimulants market
- ✓D1.1.2: Identification of the market potential of various seaweed biostimulants
- D1.1.3: Identification of market potential of local seaweeds for application in biostimulants
- D1.1.4: Stakeholder identification and assessment

WP1.2 Development and strategy for market penetration

- D1.2.1: Feedback round: workshop on goals & strategy towards increasing usage of seaweed biostimulants
- D1.2.2: Report on goals and strategy towards increasing usage of seaweed biostimulants
- D1.2.3: Roadmap and planning to achieve agreed goals: initial business cases for selected biostimulants
- D1.2.4: Workshop to present initial business cases

WP1.3 Implementation and impact: business case validation and adoption

- D1.3.1: Assessment report with conclusions and recommendations: business case validation
- D1.3.2: Final set of selected and amended business cases for SWBS presented in a workshop
- D1.3.3: Assessment report on seaweed biostimulant business case adoption by players in the value chain
- O8.1: Visibility study and market research for producers of biostimulants, producers of seaweeds, policy makers and other stakeholders

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Introduction & methodology

Deliverables and main questions for Activity 1.1

WP1.1 Determination of existing market of biostimulants

D1.1.1

- Title: Identification of the seaweed biostimulants market
- **Main question: What is the biostimulant market?**

D1.1.2

- Title: Identification of the market potential of various seaweed biostimulants
- **Main question: To what extent is it useful to invest in seaweed biostimulants?**

D1.1.3

- Title: Is it possible to use local seaweeds for the production and application of seaweed biostimulants?
- **Main question: What are suitable and cultivatable local (regionally) seaweeds?**

D1.1.4

- Title: Stakeholder identification and assessment
- **Main question: What are the relevant stakeholders of the biostimulant market and how to engage them in a positive way?**

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Introduction & methodology

Scope for Deliverable D1.1.3

D1.1.3: Identification of market potential of local seaweeds for application in biostimulants

- **Potential of local (regional) cultivatable seaweeds for the production and application of seaweed biostimulants**
  - Overview of locally produced seaweed in 2 seas region (species and producers).
  - Correlation of regional seaweed biostimulant market and local production of seaweed.
  - Detailed overview of local seaweed production drivers and barriers in the seaweed biostimulant market (logistics, knowledge, regulation, etc.)

2 | Seaweeds produced in the 2-seas region

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Seaweeds produced in the 2-seas region
Introduction

This chapter provides an overview of **seaweeds that are being produced in the 2-seas region** and this is includes the following elements:

- First, an overview of the **global seaweed industry** is provided in terms of volumes and revenues, then subsequently
- an overview of the entire **European continent**,
- an overview of **main seaweed producing countries**, including main parameters,
- an overview of the **2-seas countries** producing seaweed, and
- a detailed overview per country on seaweed production is provided.

The end of this chapter includes an overview with conclusions.

Seaweeds produced in the 2-seas region

World production of seaweed

Main parameters of the global seaweed industry:

- Indonesia and China produce > 75% of world production (23 of 28 mln t-wet) (Table 1)
- Japan 5th in volume (0,5mln t-wet), 3rd in value (<1 bln $) (Table 1)
- Revenues are estimated (global revenue/ volume)

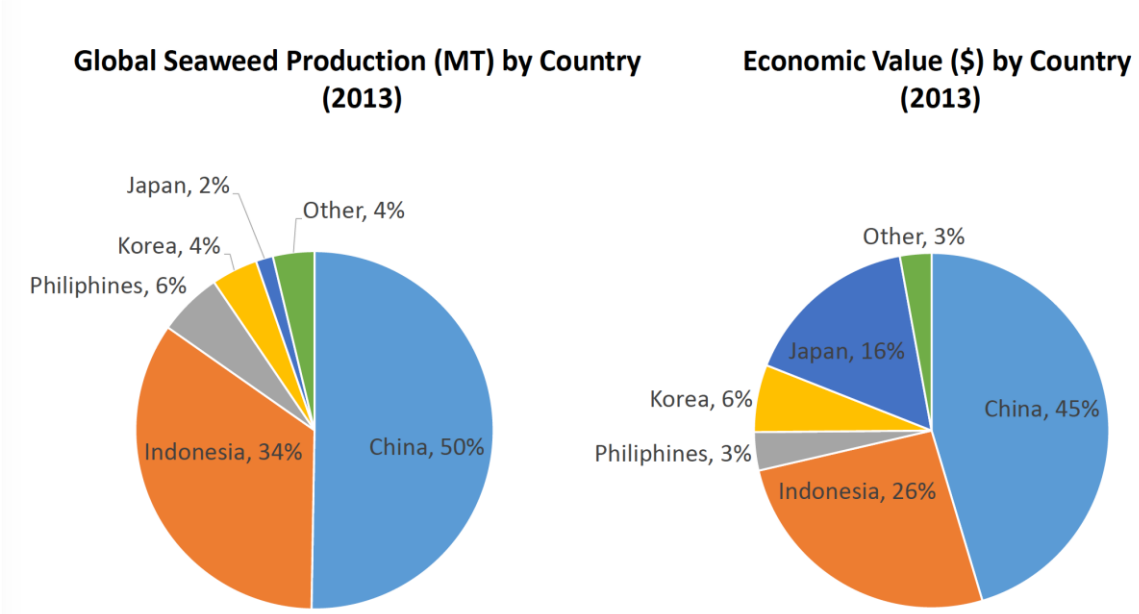

Figure 1: Global seaweed production in percentages of total production by country in 2013 and the corresponding economic value of seaweed production by country in percentage of the total economic value of seaweed production in 2013. [31]

Table 1: Annual seaweed production per country an its corresponding revenue [31]

	Country	Volume (1000 mt-wet)	Revenue (mln $)
1	China	13,572	2,700
2	Indonesia	10,148	1,560
3	Philippines	1,550	180
4	South Korea	1,097	360
5	Japan	455	960
6	North Korea	444	-
7	Chile	430	-
8	Malaysia	245	-
9	Norway	154	-
10	Tanzania	133	-

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Seaweeds produced in the 2-seas region

European countries producing seaweed

Main parameters of European seaweed production

- 14/30 countries: 46% of European countries produce seaweed (Figure 2):
  - Belgium
  - Denmark
  - France
  - Germany
  - Greece
  - Iceland
  - Ireland
  - Italy
  - Lithuania
  - Netherlands
  - Norway
  - Portugal
  - Spain
  - United Kingdom
- Total volume: +/- 300.000t-wet
- Total revenue: +/- $55mln

Figure 2: Main European seaweed producing countries [11]

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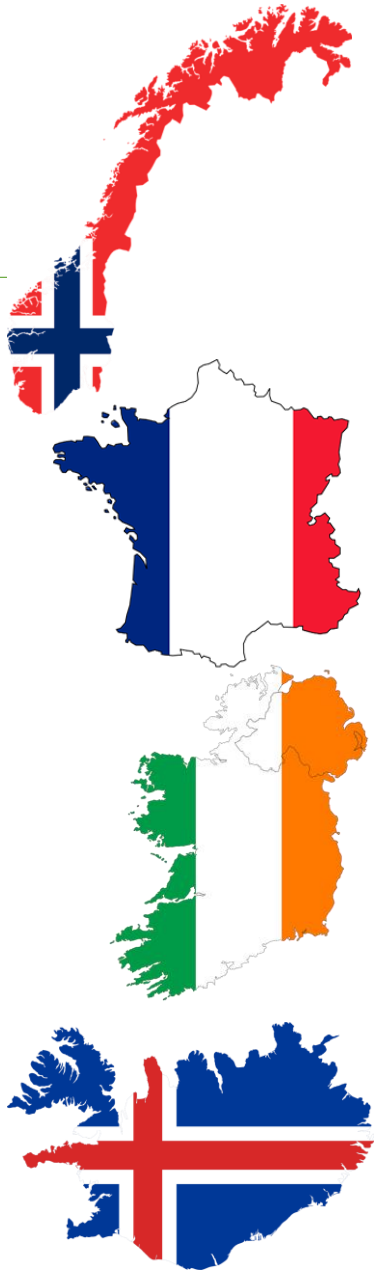
Seaweeds produced in the 2-seas region

Main producing countries in Europe

Table 2: Volume, Revenue, production type , main seaweed species and main type of application in Norway, France, Ireland and Iceland in 2014 [32], [11]

	Country	Volume (mt-wet)	Revenue (mln $)	Main production type	Type of seaweed	Main application
1	Norway	154,000	32.0	Wild harvest	*Laminaria hyperborea, Ascophyllum nodosum*	Alginate & diverse
2	France	59,000	12.2	Wild harvest	*Palmaria palmata, Porphyra umbilicalis, Undaria pinnatifida, Ascophyllum nodosum*	Health & well-being
3	Ireland	30,000	6.1	Wild harvest	*Palmaria palmata, Porphyra umbilicalis, Undaria pinnatifida, A. Esculenta, Ascophyllum nodosum*	Agri&horti
4	Iceland	19,000	4.0	Wild harvest	Not verified - mainly Kelp species	unknown
	Totals	262,000	$54.3			



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Seaweeds produced in the 2-seas region

Production of countries in 2-seas region

Table 3: Volume, Revenue, production type , main seaweed species and main type of application in France, United Kingdom, the Netherlands and Belgium in 2014 [32], [11]

	Country	Volume (mt-wet)	Revenue (mln $)	Main production type	Cultivated seaweeds	Main application
1	France	59,000	12.2	Wild harvest	*Palmaria palmata, Porphyra umbilicalis, Undaria pinnatifida*	Food, health & well-being
2	United Kingdom	6,000	1.3	Wild harvest	*Laminaria digitata Laminaria hyperborea Saccharina latissima*	Agri&horti
3	The Netherlands	300	<1.0	Wild harvest	*Laminaria digitata Saccharina latissima Ulva Lactuca*	Food
4	Belgium	No data	No data	Undetermined	*Saccharina latissima*	Food
	Totals	262,000	$54.3			

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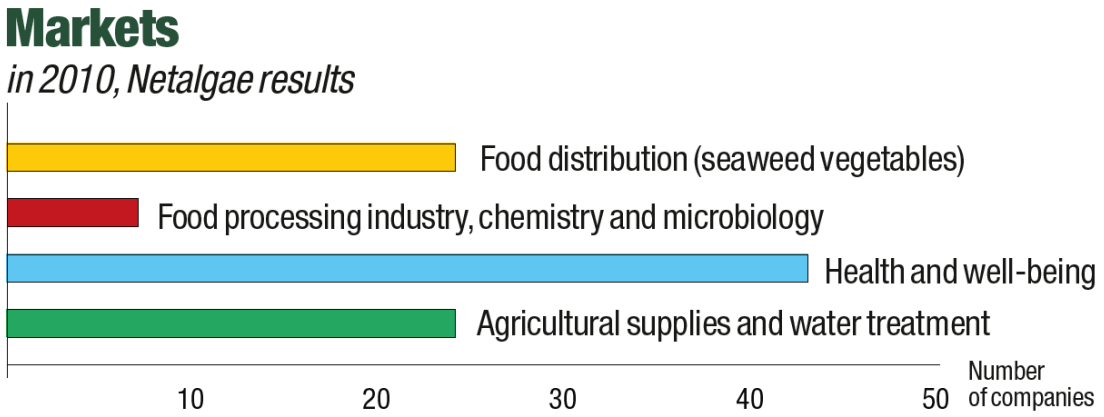
Seaweeds produced in the 2-seas region
France

Main parameters of French seaweed production:

- Mainly wild harvest
- Brittany main area of production (outside of 2 seas region)
- Diversified market
- Almost 25% on agriculture applications



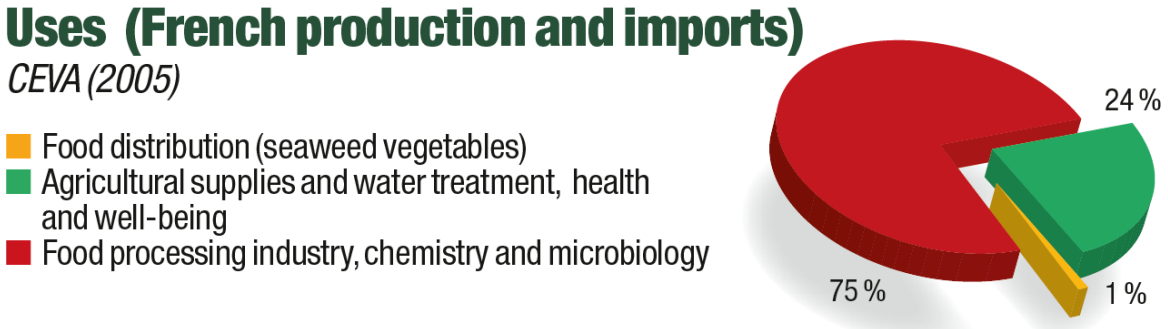


Figure 3: Upper graph: Seaweed market in France in 2010 & Lower graph: French production and import of seaweed by application in 2005 [11]

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Seaweeds produced in the 2-seas region
United Kingdom

Main parameters of United Kingdom seaweed production:

- Mainly wild harvesting
- Limited to no processing facilities
- Agriculture products have the most economic value in the UK's seaweed industry

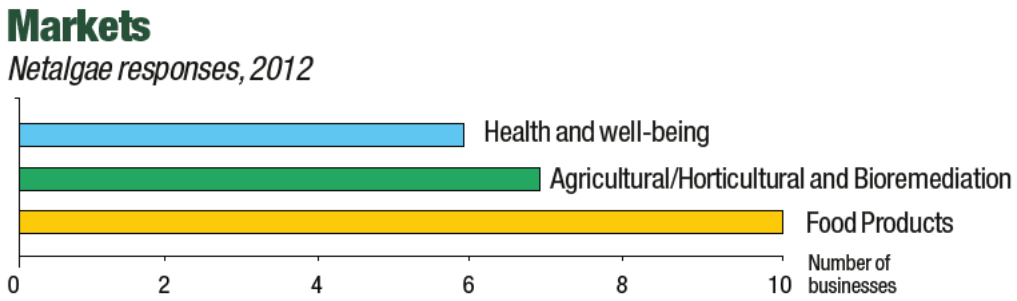

Figure 4: Seaweed market in the United Kingdom in 2012 [11]

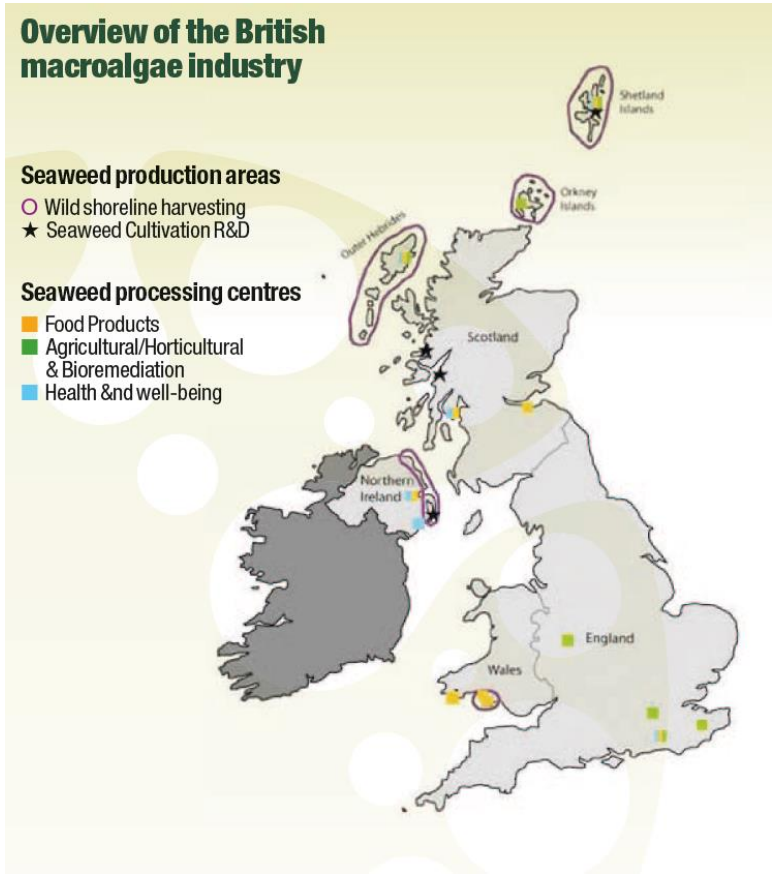

Figure 5: Overview of the seaweed industry in the United Kingdom [11]

Seaweeds produced in the 2-seas region
The Netherlands & Belgium

The Netherlands

- Small scale wild harvest - mainly for food applications, nothing for agricultural applications. Total quantity estimated at 100t-wet weight per year, various species
- Seaweed cultivation starting-up, mainly on-land and in sheltered areas (figure 6)
- Main species: *Ulva* & *Saccharina*

Belgium

- Very small scale at this stage, mainly pilot projects (Seaconomy) on offshore cultivation

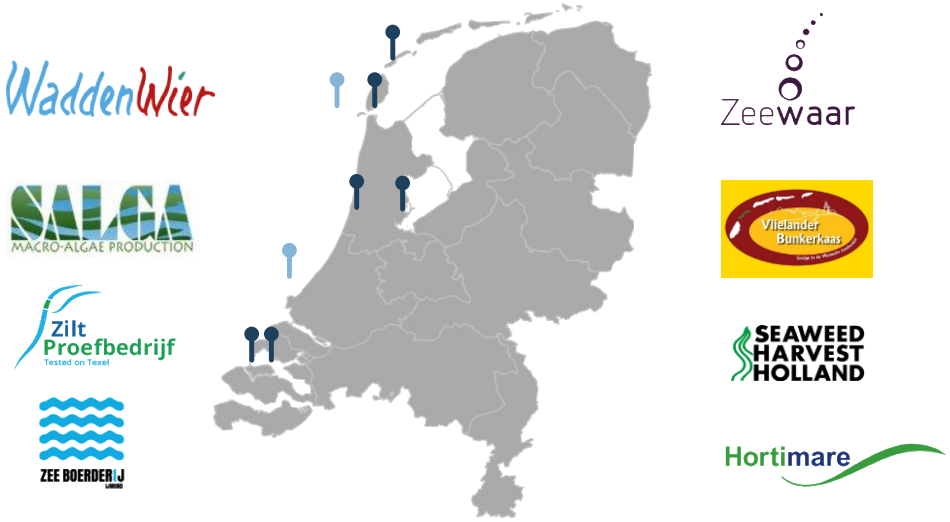

Figure 6: Main seaweed producing companies in the Netherlands

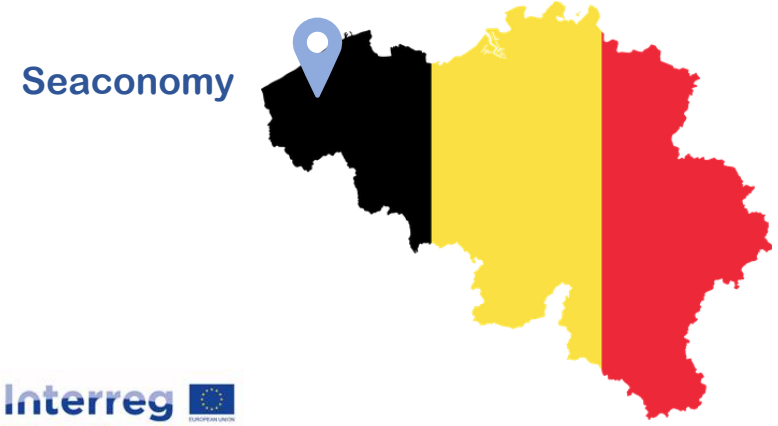

Figure 7: Seaconomy project has started in Belgium, more info on: http://www.fabriekenvoordetoekomst.be/seaconomy-kick-off

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Seaweeds produced in the 2-seas region
Conclusions

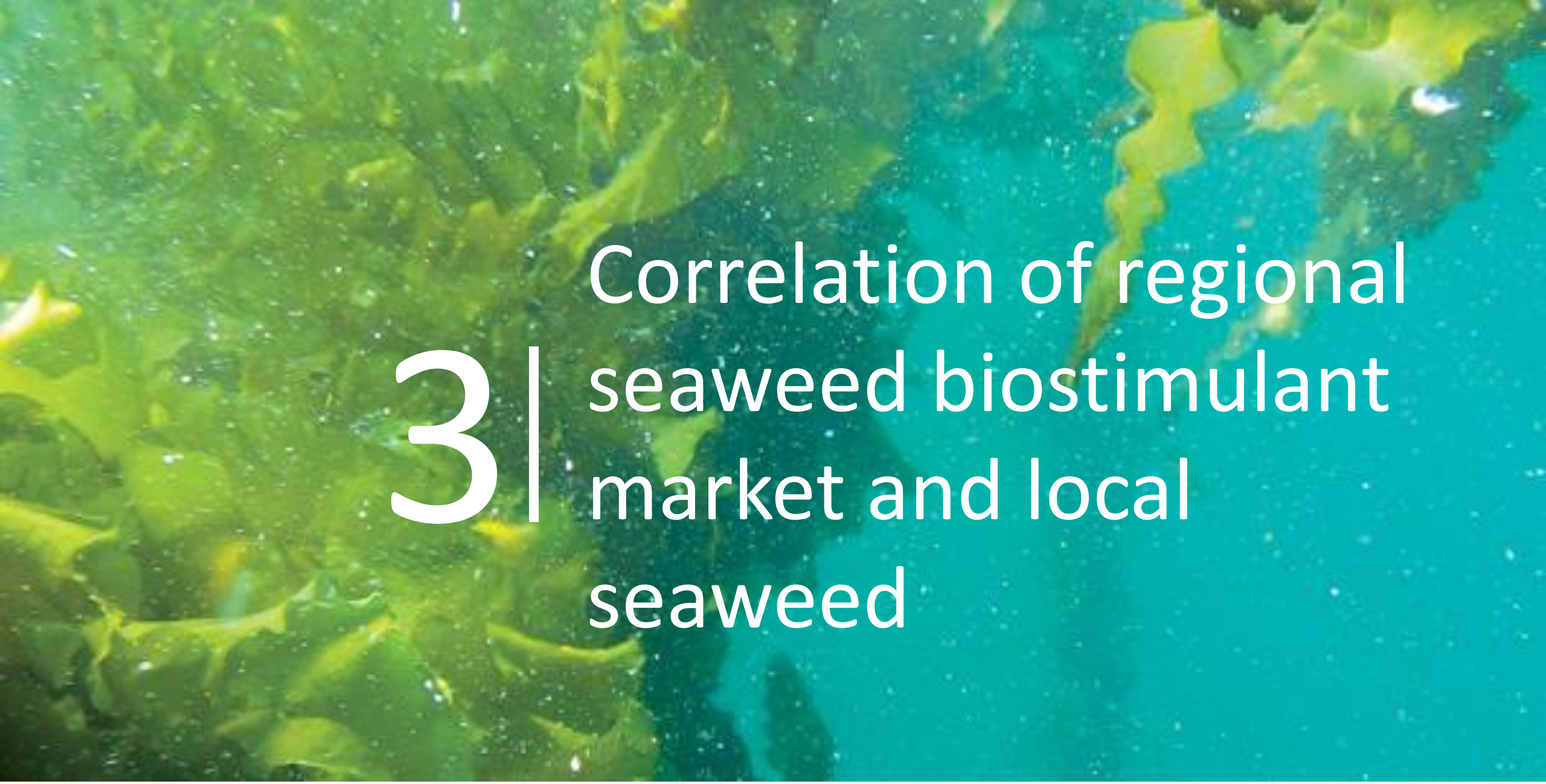
Conclusions:

- The global seaweed industry is an existing and quite a large industry with 80% of the applications within the food segment (please note: not fertilizers/biostimulants),
- The European industry represents only a small segment of that global industry +/- 1% where food applications also play an important role,
- Within Europe, the 2-seas region (Figure 8) is again a relatively small segment of the European industry. France is a large seaweed producer in Europe but the bulk of the production is in Brittany which is not part of the 2 seas region.

Note:

From the above it is clear that within Europe the 2-seas region plays an insignificant role in terms of produced seaweed volume. Therefore it has been decided that in the remainder of this report the focus will be on the European rather than an exclusive 2-seas region perspective as this would otherwise lead to less meaningful results. Please also note that the European continent is meant here and not the EU.

Figure 8: Map of the 2 Seas Region



3 | Correlation of regional seaweed biostimulant market and local seaweed

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Correlation regional biostimulants and seaweeds
Content of this chapter

- Introduction
- Seaweeds in Europe: overview of seaweeds being produced in this region (wild, harvest & cultivation)
- Seaweed biostimulants being used in this region
- Conclusions: correlation between regionally produced seaweeds and regional biostimulant use/production

Correlation regional biostimulants and seaweeds
Introduction

For this chapter we have looked at to what extent there is a match between the seaweeds that are being produced in the 2-seas region and are being/could be used for biostimulants products that are being used in the same region. We have realised quite quickly that this approach would be a quite narrow one and would therefore not provide any meaningful results. You can see this illustrated in the below diagrams (Figure 9) (based on a qualitative assessment). From right to left we see that biostimulant-use in the 2-seas region is quite a limited subset of the total biostimulant use (rightmost, blue figure). The same holds for seaweed production in the 2-seas regions compared to the total available (produced) seaweeds (middle diagram) in Europe as has been explained in the above chapter 2. Only a small number of these seaweeds is being used for biostimulant, i.e. the raw material usually comes from other European countries such as Ireland, France (outside 2-seas region) and Norway. The leftmost picture shows that cultivated seaweeds make up only 5% of the total European production, let alone if we would only focus on cultivated seaweeds from the 2-seas region. Therefore, for this chapter we have focussed on the entire European region as also indicated at the end of chapter 2.

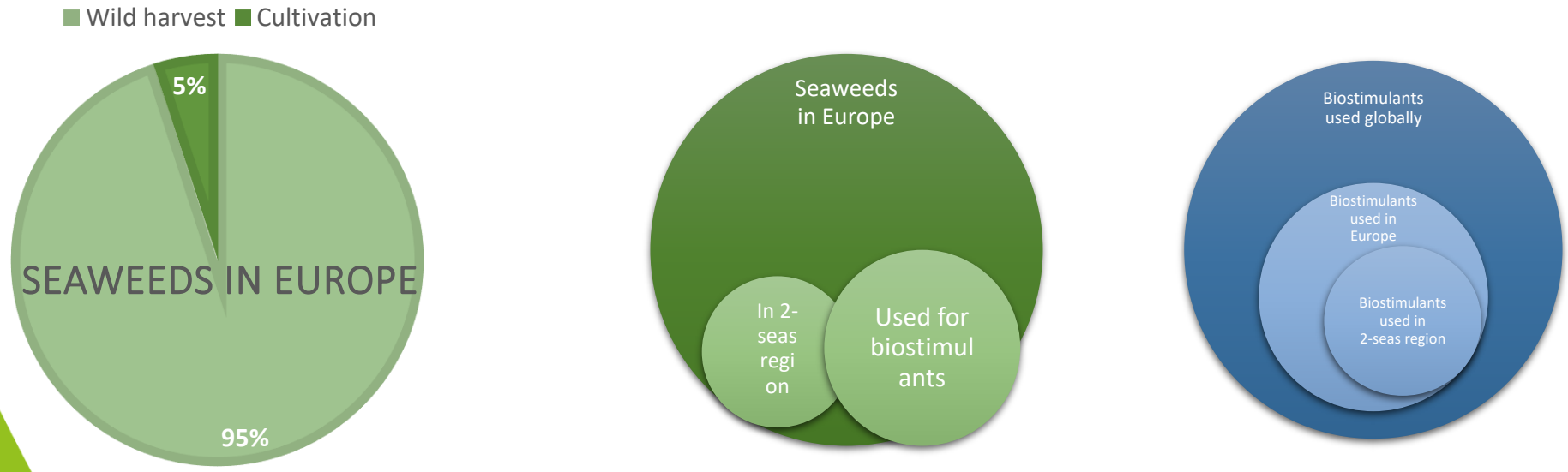

Figure 9:
Left: Distribution of methods of seaweed production in Europe
Middle: Part of total European seaweed production being produced in the 2 Seas Region and part of total European seaweed production which is used for biostimulants.
Right: Parts of global seaweed production used for biostimulants, which is produced in respectively Europe and the 2 seas region.

Correlation regional biostimulants and seaweeds
Introduction

Therefore this chapter will look at correlations between:

1. Any seaweeds produced anywhere in Europe, whether wild-harvested or cultivated (this means that imported seaweeds are excluded),
2. Any seaweed-based biostimulants used in Europe, grouped by type of seaweeds. This includes both wild-harvest and any cultivated seaweeds (where applicable),
3. This will be summarised in a comprehensive overview in this chapter that looks at the actual correlations based on the above chapters.

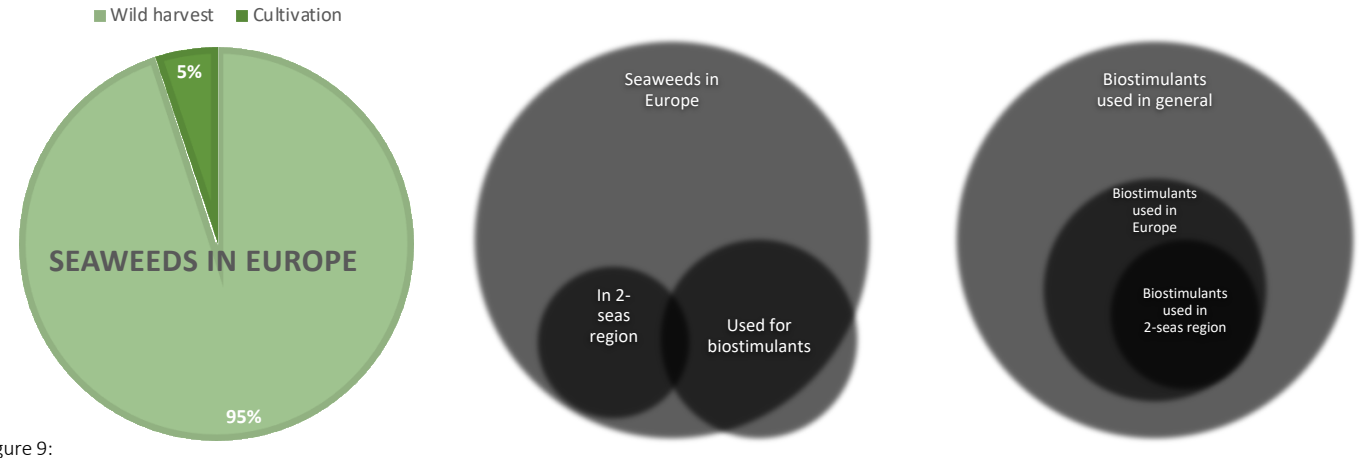

Figure 9:
Left: Distribution of methods of total seaweed production in Europe
Middle: Part of total European seaweed production, being produced in the 2 Seas Region and part of total European seaweed production which is used for biostimulants.
Right: Parts of global seaweed production used for biostimulants, which is produced in respectively Europe and the 2 seas region.

Correlation regional biostimulants and seaweeds
Seaweeds in Europe - general

Central seaweed production database

There are quite a number of seaweeds that are being produced in Europe. However, giving an accurate picture of this is quite difficult as there is no clear or central record of seaweed species being produced. Some sources, such as Algaebase [12] give an overview of species and their occurrence but this does not indicate whether the species is actually being harvested or cultivated for commercial purposes. Also, reports such as the FAO annual report only provide general, high-level numbers.

Including wild-harvested and cultivated seaweeds

For the wild-harvested seaweeds, this is where it becomes challenging and where the central database is clearly missing. For the purpose of this report we have focussed on wild-harvested seaweeds that are being used for biostimulants at a large scale (e.g. *Ascophyllum Nodosum*) and for which we have been able to verify the data with the various stakeholders. We have also included seaweeds that have been reported as being used for biostimulants but for which we have not been able to verify their production location and/or usage by any biostimulant producer. For this last group, if we haven't been able to verify the production method then we have concluded they are being produced by means of wild harvesting.

For cultivated seaweeds it is somewhat easier to get an overview of the cultivated seaweeds. This is mainly because at the moment, at least in Europe, it is not being done at a large scale. The producers doing it are relatively well known as well as the species they're producing.

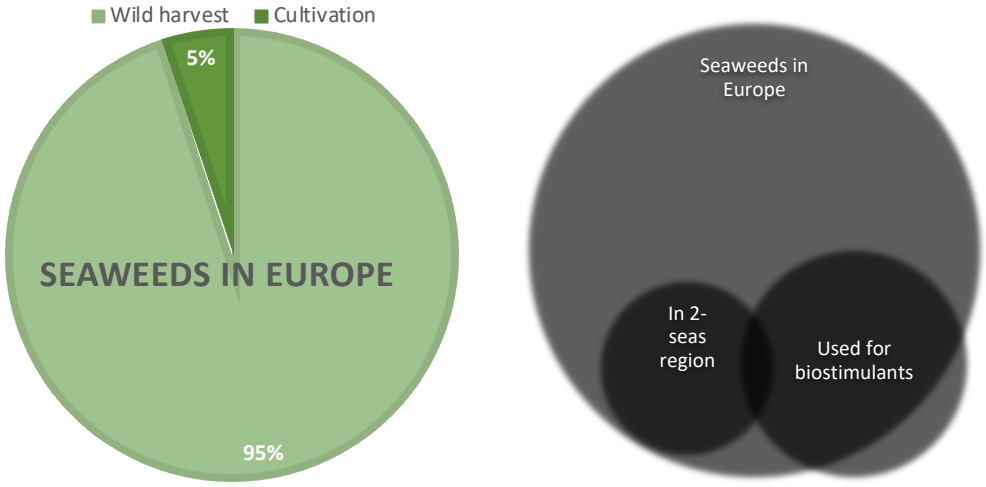

Figure 10:
Left: Distribution of methods of total seaweed production in Europe
Right: Part of total European seaweed production, being produced in the 2 Seas Region and part of total European seaweed prod
which is used for biostimulants.

Correlation regional biostimulants and seaweeds

Seaweeds in Europe - wild harvest (for biostimulants)

Of the seaweeds that are being produced by means of wild-harvesting, *Ascophyllum nodosum, Ecklonia maxima, Fucus vesiculosus and Solieria Chordalis* are the most important ones (at this stage) as we have been able to verify their use in biostimulant products from dependable sources (Table 4).

For the other species, these have been primarily been identified in a single research paper [10]. Please note that there is no overlap with the cultivated seaweeds overview in the next page although all of those seaweed species are also wild-harvested to some degree (Table 4).

At the point of writing this report we have interviewed approximately 10 biostimulant companies. It is really clear that a lot of biostimulant products use *Ascophyllum nodosum* as their main ingredient. At least this seems to be true for the North Atlantic biostimulant producers. The producer from South-Africa uses *Ecklonia maxima* that is wild-harvested off the coast locally.

Table 4: Seaweed species (wild harvest) which can be used for the production of biostimulants [10]

Wild harvested seaweed species (for biostimulants)	Seaweed family
Ascophyllum nodosum	Brown
Durvillea spp	Brown
Ecklonia maxima	Brown
Fucus vesiculosus	Brown
Macrocystis pyrifera	Brown
Padina spp	Brown
Sargassum spp	Brown
Caulerpa scalpelliformis	Green
Enteromorpha flexuosa	Green
Gelidium spp	Red
Hypnea musciformis	Red
Kappaphycus alvarezii	Red
Lithothamnium spp	Red
Solieria chordalis	Red

Correlation regional biostimulants and seaweeds
Seaweeds in Europe - cultivated

Cultivation of seaweeds is currently being done at quite a limited rate. In Europe, there are roughly 11 species that are currently known to be cultivated, reference is made to the table to the right (Table 5).

However, this is a formal review based on a number of written sources such as [11]. Species like *Ulva* and *Saccharina spp* are already cultivated in Europe.

Table 5: Cultivated seaweed species in Europe [11]

Cultivated seaweed species	Seaweed family
Alaria spp	Brown
Hymanthalia elongate	Brown
Laminaria digitata	Brown
Laminaria hyperborea	Brown
Laminaria sp	Brown
Undaria spp	Brown
Saccharina spp	Brown
Ulva lactuca	Green
Gracilaria spp	Red
Palmaria palmata	Red
Porphyra spp	Red

Correlation regional biostimulants and seaweeds

Biostimulants being used in the region

Overview of biostimulants producers in Europe

To be able to create an overview of what biostimulants are being used in Europe an initial assessment has been made of the main companies producing biostimulants. Then, usually by means of interviews, a further assessment was performed to create an overview of the associated biostimulant products. From that the biostimulant products based on seaweeds were filtered-out. Then finally, it was assessed in what region these seaweed biostimulants are being used. We have not been able to identify general/central records of the biostimulant products that are being purchased/used by farmers, horticulture professionals and end-consumers. Therefore, we have only indicated regions where the biostimulant producing companies are active. If they are active in Europe, i.e. sell their products on the European market, then we have assumed their products will be used in Europe as well. The overview of biostimulant producers in Europe as far as we've identified them is included in table 6.

Table 6: Overview of European biostimulant producers and their market regions

Company name	Market regions
Acadian Seaplants	Global
Arramara	Global
Bioatlantis	Global
Biotechnica	Global
BMS Micro Nutrients	Global
Danvos	The Netherlands
Ecostyle	Belgium, The Netherlands
Kelpak	Global
Koppert	Unknown
Lima Europe NV	Europe, Middle East
Olmix	Global
Roullier; GrasslandAgro	Ireland
Seasol International	Global
Tradecorp	Global
Compo Expert	Global

Correlation regional biostimulants and seaweeds

Biostimulants being used in the region

Overview of biostimulants product and seaweeds in Europe

In table 7 we have selected biostimulant producers that are active on the European market and for which we therefore have assumed their products are being used in Europe. For each of these producers we have listed their, up to now, known seaweed-based biostimulants including the seaweeds that are being used the active ingredients for these products. An overview of these companies, their biostimulant products and the seaweeds used in those products is included in table 7.

Table 7: Overview of European biostimulant products, corresponding company, species of seaweed used, origin of the used seaweed and if it is cultivated.

Biostimulant products	Biostimulant companies	Seaweeds used	Seaweed wild-harvested in Europe	Seaweed cultivated in Europe
1. Basfoliar	Compo Expert	*Ecklonia maxima*	No	No
2. Chelal Alga L	BMS Micro Nutrients	*Ascophyllum nodosum*	Yes	No
3. Ecolicitor	Bioatlantis	*Ascophyllum nodosum*	Yes	No
4. Fructol Bio	BMS Micro Nutrients	*Ascophyllum nodosum*	Yes	No
5. Kelpak	Kelpak	*Ecklonia maxima*	No	No
6. Phylgreen	Tradecorp	*Ascophyllum nodosum*	Yes	No
7. Phylgreen Kuma	Tradecorp	*Ascophyllum nodosum*	Yes	No
8. Phylgreen Mira	Tradecorp	*Ascophyllum nodosum*	Yes	No
9. Seamelpure	Olmix	*Solieria chordalis*	Yes	No
10. Super fifty	Bioatlantis	*Ascophyllum nodosum*	Yes	No
11. Titan Soil Conditioner	Arramara	*Ascophyllum nodosum*	Yes	No
12. Titan Top Dress Fertiliser	Arramara	*Ascophyllum nodosum*	Yes	No
13. Vidi Fortum	Koppert	*Ascophyllum nodosum,Fucus vesiculosus*	Yes	No
14. Vidi Parva	Koppert	*Ascophyllum nodosum*	Yes	No
15. Vitanica	Compo Expert	*Ecklonia maxima*	No	No

Correlation regional biostimulants and seaweeds
Conclusions

Biostimulant and wild-harvested seaweeds

There is a very good correlation between wild-harvested seaweeds and biostimulant use in the European region. Out of the 15 biostimulant products identified in this report, 12 can be produced from seaweeds that are locally available on the market for biostimulant producers. From the various interviews as well as publicly available product sheets it is apparent that *Ascophyllum nodosum* plays a dominant role. We assume that this is partly historical. The seaweeds have been abundantly available in for instance Ireland on sites that are easily accessible (tidal zones). Another explanation could be that this species is a tidal seaweed species and therefore has to be able to cope with drought stress at low tides. This feature also seems an advantage of the biostimulant products derived from them. It increases the drought stress resistance of the treated crops.

Biostimulant and cultivated seaweeds

As can also be seen in table 7 is that there is just no match between existing and used biostimulants in Europe and the seaweeds that are being cultivated in Europe. Given the limited amount of seaweed species that are being cultivated, this may be no surprise. Possible clarifications may again be both historical. Readily available and easily accessible seaweeds were the first to be investigated for their commercial use, leading to an head-start for for instance the above mentioned *Ascophyllum nodosum*. In addition, none of the cultivated species are tidal zone species. It may be that therefore they have no clear advantage when processed into biostimulants. There is still a lot to be learnt on mode of actions and responsible compounds in seaweeds for the purpose of biostimulants. These compounds may then also be present in cultivated seaweeds. Nevertheless, the conclusion for now remains that no locally cultivated seaweeds are being used for locally used biostimulants.

4 | Drivers & barriers seaweed biostimulant supply chain

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Drivers & barriers seaweed biostimulant supply chain

Content of this chapter

- Introduction
- Overview of the seaweed-based biostimulant supply chain
- Overview of drivers and barriers in the supply chain
    - Main categories
    - Description of drivers and barriers
    - Overview of drivers & barriers per main category

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Drivers & barriers seaweed biostimulant supply chain
Introduction

Where the previous chapter gave a more technical overview of the seaweed supply chain in general and how this relates to the seaweed-based biostimulant market, this chapter focuses on the general and seaweed specific drivers and barriers: knowledge, people and other forces that support and/or counteract developments in the seaweed biostimulant supply chain.

This chapter also builds further upon the four general drivers referred to in the conclusion of the phase 1 report of this market analysis. Information coming from different stakeholder interviews and the field trial visit of the Bio4safe program has been used to develop the insights in seaweed biostimulant supply chain drivers and barriers.

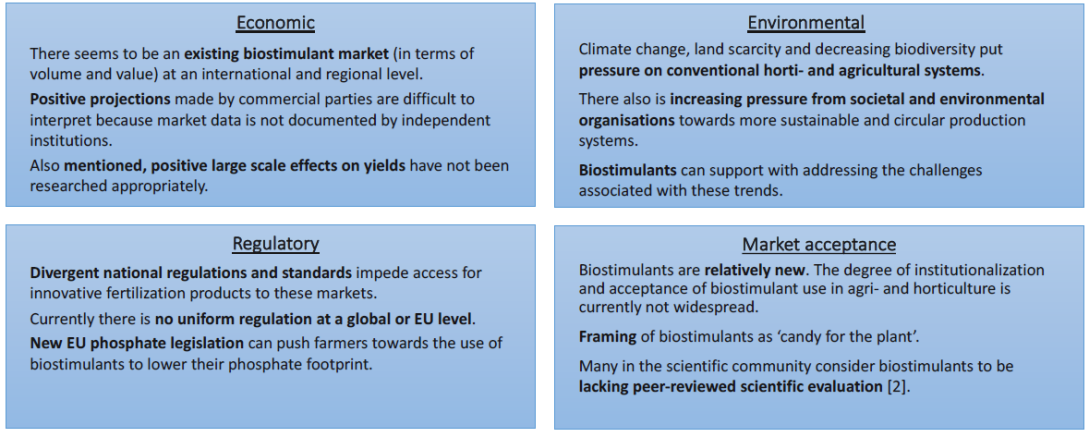

Figure 11: Overview of drivers as used in the phase1 report [30]

This chapter gives an overview of the drivers and barriers that primarily the seaweed farmers/producers are experiencing as part of the seaweed-based biostimulant supply chain. In this context these stakeholders are referred to as "biostimulant raw material suppliers". This is primarily focussed on seaweed cultivators rather than seaweed producers that are wild-harvesting. This is an important distinction as the drivers & barriers for each of the two seaweed production methods will be quite different. These insights are based on desk research as well as a number of interviews with various players in the value chain.

First we will give an overview of the seaweed biostimulant supply chain. Then we will provide an overview of the identified drivers and barriers. The final part of this chapter will include the most important conclusions as well as recommendations related to drivers & barriers for the seaweed biostimulant supply chain based on cultivated seaweed production.

Drivers & barriers seaweed biostimulant supply chain

Biostimulant supply chain overview

Table 8: Overview of the biostimulant supply chain, North Sea Farm Foundation, July 2018

					
Biostimulant supply chain	**Seaweed cultivation/ Wild harvest**	**Logistics, processing & biostimulant production**	**Distribution & trading**	**Sales to end-users**	**End-users**
	D 1.1.3 →			← D 1.1.2	
Description	Seaweed for biostimulants is mainly wild harvest	The main processing step includes liquid extraction and/or drying & grinding. This is then used for the biostimulant end-product	Then the intermediate or final product is shipped to sales channels and/or rebranders	The products are then sold directly via B2B contacts, wholesalers and/or retail	End users include farmers, gardening professionals or consumers
Involved stakeholders	• Biostimulant raw material supplier	• Biostimulant raw material supplier • Biostimulant end-product producer	• Biostimulant end-product producer • End-product repackaging/rebranding • Biostimulant trader/agent	• Biostimulant end-product producer • End-product repackaging/rebranding • Biostimulant trader/agent	• Farmers • Gardening professionals • Household consumers

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Drivers & barriers seaweed biostimulant supply chain

Drivers & barriers - main categories

Various sources have been used to identify the various drivers and barriers that are associated with the seaweed-based biostimulant supply chain. To enable a useful assessment on the impact of these, a number of categories have been defined that can be assigned to the individual drivers and barriers. Basically five main categories have been defined. Drivers and/or barriers that are:

- Economic;
- Environmental;
- Market acceptance;
- Regulatory; and
- Science & technology based.

The exact definition of each of these is provided in the figure to the right. In the below page an inventory is included of all drivers and barriers as identified as part of this study. These have been categorised in accordance with these 5 main categories. This categorisation is not unique, i.e. some identified drivers/barriers may be located in more than one category.

Economic

The competitive market demands constant improvements in production revenues, cost reductions as well as avoiding additional cost in order to comply with regulations.

Environmental

Climate change, land scarcity and decreasing biodiversity put **pressure on conventional horti- and agricultural systems**.

Market acceptance

The markets on which biostimulants are traded need to be ready and willing to accept any new production approaches and cost models.

Regulatory

Legislation associated regulations should enable application of biostimulants products for their intended use and create a level playing field as well.

Science & technology

Objective information available that verifies the product claims as well as further research to clarify mode of application and usage.

Figure 12:overview drivers and barriers that are associated with the seaweed-based biostimulant supply chain

Drivers & barriers seaweed biostimulant supply chain

Description of drivers and barriers

Organic and/or chemical free raw materials

End-consumers want fewer chemical products, primarily in their food productions and to a lesser extent also in their gardens. This change in attitude challenges food producers to look for new ways to produce with limited to no chemicals inputs. Within that context, biostimulants are becoming increasingly interesting with a further interest in seaweed based biostimulants. Either because seaweeds can be produced fully organically and also because they are easily associated by the general public as greener, more sustainable and healthier.

Scalability of seaweed supply chains

Wild-harvesting of seaweeds is not substantially scalable compared to seaweed cultivation on farms. Wild stocks are being increasingly regulated while at the same time the degree of sustainability is questioned by societal groups and NGOs. This drives the investigations for new sourcing of seaweeds.

New technologies, species and compounds for high quality raw materials

At the moment there is a lot of research and innovation being done on the cultivation of seaweeds. This will inevitably lead to new production methods, seaweed species, extraction methods and extracts / ingredients with added benefits for biostimulant products.

Status and trends in production costs of seaweeds

Currently cultivated seaweeds are more expensive than wild-harvested seaweeds. How their prices will develop has to do with market demand, legislation and production technology. By looking at agriculture, it is to expected that farming should easily be able to compete with wild-harvesting practices.

Difficulties of wild-harvested seaweed supply chain

Also, the current success of wild harvested compared to cultivated may prove to be their inhibiting agent. There is a natural limit to the supply from wild stocks. As the biostimulant market will grow (as anticipated in many sources) this will become a limiting factor and as such pose a market barrier.

Cultivability of required seaweeds

At the moment only a few species seem to be used as raw material for biostimulants. These species cannot be cultivated at the moment. It would be possible to look for similar mode of actions from seaweeds species that can be cultivated but here the market acceptance may prove to pose in strong barrier.

Challenging business model seaweed cultivation for biostimulants only

Seaweed farmers currently produce mainly for food applications. A grand shift towards producing solely for biostimulants is unlikely. Residual streams from seaweed farmers could be interesting to use as an input for biostimulant producers – when these streams are large enough in size.

Cultivated seaweeds not used in biostimulants before

Existing biostimulant producers may want to stick to products (and their formulations) that they know work for them. New formulations or non-proven biostimulant products (i.e. based on a newly cultivated seaweed species) may find the market acceptance in its way as the major barrier.

Drivers & barriers seaweed supply chain

Overview of drivers & barriers per main category

Table 9: Overview of market drivers and barriers of the general biostimulant market and seaweed in specific, North Sea Farm Foundation, 2018

Biostimulant supply chain	Economic	Environmental	Market acceptance	Regulatory	Science & technology
☺ Drivers	• Refinery of seaweeds [29]	• Availability of local, sustainable, scalable seaweeds • General availability of wild stock - not scalable [1] • Local availability of required seaweeds [1]	• Quality/ method of processing [28] • Organic and/or chemical free raw materials [1,4] • Supply of sustainable seaweed [3]	• Regulations to reduce the amount of chemicals [4] • Availability of local, sustainable, scalable seaweeds	• Supply of sustainable seaweed [3] • Quality/method of processing [28] • Cultivability of required seaweeds [1,4]
☹ Barriers	• Adequate price • High production cost of cultivated seaweeds • High sales price for non-biostimulant applications • Focus on high-value applications of seaweed (refinery) [29] • Competition from existing raw material suppliers (based on cheaper wild harvesting production)	• No direct barriers identified	• Quality/method of processing [28] • Cultivated seaweeds not used in biostimulants before [4] • No close-proximity to biostimulant producers - logistics missing [29]	• No direct barriers identified	• Quality/method of processing [28] • Cultivability of required seaweeds [1,4]

5 | Conclusions, recommendations & next steps

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Conclusions, recommendations & next steps

Potential of local (regional) cultivatable seaweeds for biostimulants?

Locally produced seaweeds in the 2-seas region

From chapter 2 it is clear that there is an existing and large global seaweed industry. In Europe the industry is relatively small (1% of the global produced seaweed volume) and mainly wild-harvest based. Currently there are a lot of research programs and initiatives related to the large scale cultivation and multiple extraction (biorefinery) of seaweeds. From an economic perspective seaweed is cultivated firstly for food and lesser extent feed applications. Nevertheless, using seaweed as an ingredient for biostimulants should not be framed as competing with using seaweed as food ingredient.

Correlation of regional seaweed biostimulant market and local production of seaweed

Two seaweed production methods make up the total local production of seaweeds. These two methods are wild harvested seaweed and cultivated seaweed. It can be concluded that local wild harvested species e.g. *Ascophyllum nodosum* appear to be dominant in the biostimulant market. Those seaweed species aren't produced in the 2-Seas Region at this moment. The seaweed based biostimulants are sold all over the world, so also in the 2-Seas Region.

The cultivated seaweed supply chain is non existing at this moment. This has to do with limited number of seaweed farmers, economic drivers for seaweed farmers to produce mainly for food and a limited number of seaweed species that can be cultivated commercially. There is a large list of seaweed species that can be locally cultivated due time. Whether this is relevant for the biostimulant market has to do with the composition of those species and whether refined compounds from seaweeds keep their effect.

Supply chain drivers and barriers

Scalability of supply chains and sustainability of the production process are important aspects that function as drivers or barriers of seaweed supply chains. A supply chain based on cultivated seaweeds should, by definition, be more sustainable, scalable and consistent in quality and composition than a supply chain based on wild harvested seaweeds. This can be deducted from general agricultural developments in the 20th century.

Economic feasibility and technological knowledge (mode of action, applicability of seaweeds) currently work as barriers in the development of local cultivated seaweed supply chains. New business models should be developed for seaweed farmers. Also research needs to be performed to gain more in depth insights in the applicability of cultivable seaweed species for biostimulants.

Conclusion

The current status of the seaweed supply chain in Europe is in order although the supply chain can easily be over demanded. With current positive estimations on the (seaweed based) biostimulant market growth, this status is very inconvenient. Local cultivable seaweed supply chains could form a solution but more research and information is needed as a basis to work from.

Conclusions, recommendations & next steps

Recommendations

Introduction

Based on the conclusions we have come to the following recommendations towards a seaweed-based biostimulant supply chain that is more sustainable, scalable and more resilient for biostimulant market dynamics.

Initially it was anticipated that there would be many options for biostimulant market entry by seaweed farmers with cultivated seaweeds. However, it appears that these options are limited. This is mainly due to the fact that the seaweed-based biostimulant supply chain has mainly evolved around readily available and wild-harvested seaweed. The below recommendations are therefore focussed on creating opportunities in the seaweed-based biostimulant supply chain with cultivated seaweeds.

Short term

Make a compositional analysis of cultivatable seaweeds (table 5 from chapter 2): it is recommended to gain insights on compositions and applicability of cultivatable seaweeds. This data can be compared with compounds used in existing seaweed biostimulants. This will enable identification of interesting seaweeds. This will also enable seaweed breeders to focus on enhancement/selection of species to include higher concentrations of specific component(s).

Follow up on short term recommendations:

Demonstrate effects of cultivated seaweeds in biostimulants: when specific cultivatable seaweeds are applicable to be used as input for biostimulants these ingredients should be tested. These tests can be performed at test sites (e.g. at Bio4safe test sites) and also in field trials at farmer's production sites . If possible it is recommended that these tests are transparent on what species and linked compound(s) are responsible/contributing to the observed positive effect in the crop. This would in theory make it easier to create a formulation with other seaweed species with same ingredients that will have similar effects. The results of these demonstrations can be disseminated to seaweed farmers, biostimulant producers and end-users.

Develop support with biostimulant producers to use new (cultivatable) seaweed species as input for biostimulant products: currently biostimulant producers only use a handful of seaweed species for their products. Using other species could prove to be a major step. To successfully make this step there should be support for this development towards using other, relevant, effective seaweed species.

Develop a viable business case for the holistic refinery of seaweed for food and other applications: currently seaweed farmers are mainly producing for food. To use their seaweeds also for other less expensive applications another business case is needed. A possible approach is to look at the supply chain of seaweed in a holistic way, in a sense that seaweed is being produced on farms for multiple applications (food, feed, plants). This means other logistics, processing methods and finance.

Conclusions, recommendations & next steps

Summary of next steps

D1.1.3: Identification of market potential of local seaweeds for application in biostimulants

- **Potential of local (regional) cultivatable seaweeds for the production and application of seaweed biostimulants**
  - ✓ Overview of local produced seaweed in 2 seas region (species and producers).
  - ✓ Correlation of regional seaweed biostimulant market and local production of seaweed.
  - ✓ Detailed overview of local seaweed production market drivers and barriers in the seaweed biostimulant market (logistics, knowledge, regulation, etc.)

D1.1.4: Stakeholder identification and assessment

- **Stakeholders in the (seaweed)biostimulant market**
  - ❑ Overview of relevant stakeholders (all active and observer partners involved)
  - ❑ The potential of the seaweed biostimulant market regional, national and EU (follow up SWOT)
  - ❑ Assessment of the results, conclusions and recommendations for next steps

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