Jaarrapportage 2019 PPS Proseaweed voor TKI-A&F en LNV

PPS-nummer	AF-16202 (BO-59-006-001)
Titel	Seaweed for Feed and Food / Proseaweed (MIP Zeewier)
Thema	Tot 2019 Klimaatneutrale productiesystemen. Vanaf 2020 en verder: Klimaatakkoord
Uitvoerende kennisinstelling(en)	Alle onderdelen van Wageningen Research: Wageningen Plant Research, Wageningen Livestock Research, Wageningen Marine Research, Wageningen Food Safety Research, Wageningen Food & Biobased Research, Wageningen Economic Research, Wageningen Environmental Research
Programmacoördinator	Ineke Ammerlaan. Wageningen Research (ineke.ammerlaan@wur.nl)
Penvoerder	Noordzeeboerderij, Koen van Swam Koen@Noordzeeboerderij.com
LNV-contactpersonen	Nathalie Scheidegger (LNV-SKI), Evelien Valk (LNV-SKI), Nico Buytendijk (RVO) Marjan v. Creij (LNV-SKI), contactpersoon voor het contaminantenproject
programmawebsite	www.proseaweed.eu
Startdatum	1-7-2017
Einddatum	31-12-2021

Goedkeuring penvoerder/consortium De jaarrapportage dient te worden besproken met de penvoerder/het consortium. De TKI's nemen graag kennis van eventuele opmerkingen over de jaarrapportage.	
De penvoerder heeft namens het consortium de jaarrapportage	X goedgekeurd
Eventuele opmerkingen over de jaarrapportage:	

Inhoudelijke samenvatting: probleemomschrijving en doel

Er is veel te doen rond de Noordzee. Er lopen verschillende beleidstrajecten met doelen voor zowel de korte als de lange termijn. De ministeries EZK, I&W, LNV en BZK zijn hierbij betrokken. Het Planbureau voor de Leefomgeving (PBL) heeft een scenariostudie opgesteld voor de Noordzee voor 2030 en 2050. Doel van de studie is om antwoord te geven op de volgende vraag: Wat zijn de mogelijke ruimtelijke en ecologische gevolgen van plausibele ontwikkelingen op de Noordzee en specifiek het Nederlands Continentaal Plat? Kansen voor een bijdrage aan de energietransitie, robuuste natuur en toekomstbestendige voedselvoorziening staan hierbij centraal.
De Noordzee kan voor Nederland en omringende landen een grote rol spelen bij het bereiken van een duurzame energievoorziening. Uitbreiding van het aantal windmolens wordt dan ook in alle scenario's voorzien. Windmolenparken bieden ook kansen voor het creëren van natuurnetwerken, duurzame visserij en een duurzame aquacultuur waaronder zeewierteelt. Op dit moment is de Nederlandse zeewierteelt een kleine sector met enkele bedrijven die voornamelijk langs de kust gesitueerd zijn. Internationaal zijn er veel bedrijven actief waarbij er veelal sprake is van wildoogst. Het volume aan gecultiveerde wieren in Europa is nog zeer beperkt. In Europa is Frankrijk de grootste verwerker van zeewier maar verreweg de grootste gecultiveerde productie vindt plaats in Aziatische wateren.

Doel van het onderzoekprogramma is met Wageningse kennis bij te dragen aan het oplossen van vraagstukken verbonden aan het ontwikkelen van een grootschalige, rendabele en duurzame zeewierteelt op de Noordzee. Dit vergt nog een groot aantal stappen waarbij naast de overheid ook het bedrijfsleven nadrukkelijk aan zet is. Het bedrijfsleven kan aanhaken door onderzoeksvoorstellen in te dienen bij het programma. Voorwaarde hierbij is dat het bedrijf zelf 40% van het onderzoek meefinanciert. Het programma bestaat uit 7 publiek-privaat-samenwerkingsprojecten en 5 LNV-projecten. De PPS-en zijn projecten die worden medegefinancierd door bedrijven. De onderzoeksvraag is mede vanuit deze bedrijven ingevuld. Elke PPS heeft een eigen consortium van bedrijven waarmee contracten getekend zijn. De LNV-projecten zijn gericht op vraagstukken die vooral voor het LNV-beleid relevant zijn en worden 100% gefinancierd van het programmabudget.
De belangrijkste onderzoeksvragen vanuit LNV voor het programma zijn:

1. Kan zeewier een duurzame eiwitbron vormen voor menselijke of dierlijke consumptie als alternatief van bijvoorbeeld soja?

2. Wat zijn voedselveiligheidsaspecten van zeewier wanneer het wordt gebruikt als voedsel of diervoeder?
3. Wat zijn de effecten van zeewierteelt op de Noordzee op het mariene ecosysteem?
4. Hoe kan zeewierteelt op de Noordzee een rendabele bedrijfstaak vormen?

Bij deze onderzoeksvragen spelen aspecten mee zoals de selectie en veredeling van hoogproductieve Nederlandse zeewiersoorten, de ontwikkeling van nieuwe en robuuste teeltsystemen die geschikt zijn voor de Noordzee, bewerkingstechnieken van geoogst materiaal om zoveel mogelijk waardevolle componenten te winnen en toepassingsmogelijkheden van zeewier en zeewierproducten in voedingsproducten voor mens en dier, en in producten voor bijvoorbeeld de farmaceutische en cosmetische industrie.

Activiteiten en highlights

PPS-en

Er zijn 7 lopende PPS-en. De meeste PPS-en richten zich op toepassing van zeewier in diervoeder. Daarbij wordt gekeken naar nutritionele effecten, gezondheidseffecten en effecten op de reductie van methaanproductie. Met de betrokken bedrijven is afgesproken dat de resultaten worden gepubliceerd na afronding van het project. De resultaten van de PPS-en worden in de loop van 2020 en 2021 verwacht. De resultaten worden gepubliceerd in wetenschappelijke publicaties en rapporten, en worden gedeeld met de sector. Daarbij wordt o.a. gebruik gemaakt van het zeewierplatform van Noordzeeboerderij. In dit platform zijn circa 75 stakeholders (bedrijven, kennisinstellingen, overheden, NGO's) actief.

Overzicht PPS-en:

1. Seaweed cultivation in the Northsea 2018-2021, i.s.m. Stichting Noordzeeboerderij.
   Projecleider: Reinier Nauta, Wageningen Marine Research i.s.m. Wageningen Plant Research
2. A. Cultivation and chemical composition of Oosterschelde Seaweed 2018-2021 i.s.m. Olmix.
   Projectleider Adrie vd. Werf, Wageningen Plant Research i.s.m. Wageningen Marine Research
   B. Holistic extraction of green and red seaweed for feed 2018-2021 i.s.m. Olmix
   Projectleider Floor Boon, Wageningen Food and Biobased Research en Jeroen Kals Wageningen Livestock Research.
   C. Impact of seaweed on plant health 2018-2021 i.s.m. Olmix
   Projectleider Rommie van der Weide, Wageningen Plant Research
3. Health promoting effects of seaweeds in young piglets, calves, broilers and pets 2017-2019 i.s.m. Bio Atlantis, Vobra Special Petfoods, Hortimare, Omega Green. Microganic, Lambers-Seghers, Neovia Group. Projectleider : Wouter Muizelaar Wageningen Livestock Research
4. Health effect of seaweed extracts for fish 2018-2021 i.s.m. Olmix, palingkwekerij Koolen, De Heus Animal Nutrition, Skretting Aquaculture Research Centre Norway
   Projectleider: Jules Petit, Wageningen University, leerstoel Aquacultuur en Visserij
5. FSSC 2200 certification of seaweed production in the Oosterschelde 2018-2020 i.s.m. Zeewaar en Control Union Certifications. Projectleider Siebren van Tuinen, Wageningen Food Safety Research
6. Effect of Asparagopsis on methane production by cows 2018-2019 i.s.m. Blue Grass
   Projectleider: Wouter Muizelaar, Wageningen Livestock Research
7. Effect of Dutch seaweeds on methane production by cows 2018-2020 i.s.m. BlueO2, LTO Noord, Hortimare. Projectleider: Wouter Muizelaar, Wageningen Livestock Research

LNV-projecten

Er zijn 5 beleidsprojecten die zich richten op voor het beleid relevante vraagstukken die nog niet door het bedrijfsleven worden opgepakt. Deze projecten worden volledig gefinancierd vanuit het budget van Proseaweed. In 2020 en 2021 komen de resultaten beschikbaar in de vorm van rapporten en wetenschappelijke publicaties. Ook deze zullen gedeeld worden met de sector.

Overzicht LNV-projecten:

1. Gehaltes aan zware metalen en andere contaminanten in zeewier gekweekt in de Nederlandse wateren. 2018-2020 in samenwerking met de NVWA),
   Projectuitvoering: Siebren van Tuin en Mirjam Klijnstra, Wageningen Food Safety Research
2. Bio-activiteit van jodium in zeewier (opname in het lichaam), 2020-2021
   Projectuitvoering: Alida Melse, Wageningen University afdeling Humane Voeding
3. Draagkracht van de Noordzee voor grootschalige zeewierproductie 2019-2021
   Projectuitvoering Renier Nauta Wageningen Marine Research i.s.m. NIOZ en Deltares
4. Zeewier als eiwitbron, een literatuuronderzoek 2019-2020
   Projectuitvoering Addie van der Sluis, Wageningen Food and Biobased Research
5. Een life cycle analyse van de duurzaamheid van de toepassing van zeewier in voeding 2019-2020
   Projectuitvoering Sander van den Burg, Wageningen Economic Research.

Nieuwe activiteiten in 2020 en 2021

1. Samenwerking met 3 grote Noordzee-pilots

In 2020 wordt samenwerking gezocht met 3 zeewier pilots in de Noordzee die in 2019 zijn gestart of in 2020 gaan starten. Het betreft

(1) Zeewierboerderij Haringvliet. Dit project start met een 2 ha groot veld in de monding van de Haringvliet. Het betreft een consortium van Deltawind, Seaweed Harvest Nordsea en machinebouwer Murre. De verwachting is dat het productieveld eind 2020 operationeel zal zijn. De Haringvliet boerderij produceert zeewier voor de extractie van functionele eiwitten en de productie van groen gas. Vanuit Proseaweed wordt bijgedragen aan de ontwikkeling van de extractie-technologie. Tevens wordt het productieveld gebruikt voor het doen van veldmetingen (o.a. nutriënten-uptake en biomassa productie). Hierbij wordt samenwerkt met TNO Maritiem. De data worden benut voor het draagkracht onderzoek (LNV-project 3)

(2) North sea innovation lab van stichting Noordzeeboerderij. Binnen het NSIL worden in 2020 en 2021 productiepilots – al dan niet in combinatie met mosselkweek – gestart als onderdeel van de EU-projecten Impaqt en United. Vanuit Proseaweed worden additionele veldmetingen gedaan, o.a. om data te verzamelen voor ahet draagkrachtproject (LNV-project 3)

(3) Wier&Wind. In dit project wordt een grootschalig en geautomatisceerd zeewierteeltsysteem ontwikkeld op de Noordzee dat kan worden ingezet binnen een windmolenpark. Het betreft een consortium van Seaweed Harvest Nordsea, AtSeaNova, Murre Technologies, GEOxyz en Stichting Noordzeeboerderij. Het onderzoek wordt uitgevoerd door de universiteit van Gent en Hogeschool Zeeland. Ook dit proefveld wil Proseaweed benutten voor het uitvoeren van additionele veldmetingen om input te genereren voor het draagkracht onderzoek (LNV-project 3)

De pilots zijn op 3 verschillende locaties gelegen in de Noordzee: 2 offshore en 1 near-shore. De veldmetingen voor het draagkrachtproject worden in elke pilot op vergelijkbare wijze verzameld. Hierdoor ontstaat een interessante dataset waarmee het mogelijk is om draagkrachtmodellen (van Deltares en NIOZ) te valideren.

2. Bouwen van consortia gericht op de realisatie van een grootschalige multi-use offshore pilot(s)

De ambitie van de Nederlandse overheid is om grote delen van de Noordzee geschikt te maken voor energieproductie (o.a. middels windenergie). Dit zal leiden tot een sterke inperking van de Noordzee-ruimte voor visserij. Een mogelijk alternatief voor de visserijsector kan de ontwikkeling van grootschalige aquacultuur (combinaties van zeewier, schaal-&schelpdieren, krabben&kreeften, visteelt) op de Noordzee zijn. Voorwaarde daarbij is dat dergelijke vormen van aquacultuur op verantwoorde wijze gecombineerd kunnen worden met de aanleg en exploitatie van windmolenparken. Er is op dit moment een sterke behoefte bij betrokken sectoren en overheden aan grootschalige proefvelden op de Noordzee. Dergelijke proefvelden moeten ontwikkeld gaan worden binnen publiek-private-samenwerkingsverbanden. Hierbij zijn forse investeringen nodig vanuit zowel het bedrijfsleven, diverse overheden (nationaal en provinciaal) en bij voorkeur ook de EU. Eén van de nieuwe Proseaweed-activiteiten in 2020 en 2021 zal gericht zijn op het “bouwen” van dergelijke consortia.

Publicaties en rapporten

PPS-1 Consortium Noordzeeboerderij:

- Jansen et al (2020). Development of Offshore Seaweed Farming: Ecology & Cultivation. Synthesis report 2019. Draft
- Jansen et al (2019) Development of Offshore Seaweed Cultivation: food safety, cultivation, ecology and economy. Synthesis report 2018. https://doi.org/10.18174/470706 (Doelgroep: overheid, bedrijfsleven (kweek en verwerking), consumenten)
- Tonk & Jansen (2018) Zeewier, niet alleen maar lekker bij de vis. Visserij nieuws
- Tonk & Jansen (2018) Zeewier, niet alleen maar lekker bij de vis. AQUAcultuur

Onderliggende rapportages:

- Van der Werf A & I van der Meer (2018). Productivity and chemical analysis of kelp – season 2018. Internal note
- Tonk L, P van Dalen, HM Jansen (2018). Bepaling van de larvendynamiek en mossel broedval bij de Noordzeeboerderij ten behoeve van optimalisatie oogstmoment zeewier. WMR report number (C097.18) https://library.wur.nl/WebQuery/wurpubs/fulltext/466266
- Tonk L & HM Jansen (2019). Notitie: Potentiële effecten van duurzame zeewierproductie op de biodiversiteit in de Noordzee. WMR report number C013/19. https://doi.org/10.18174/470707
- Jansen HM & L Tonk (2019). Factsheet: Zeewierproductie en biodiversiteit - Ecosysteem diensten en/of ecologische impacts.
- Tonk L & HM Jansen (2019). Co-cultivation of the seaweed *Ulva sp*. and *Mytilus edulis*. WMR report number C011/. https://doi.org/10.18174/470705
- Van den Burg S.W.K,, C Wakenge & P Berkhout (2019). Economic prospects for large-scale seaweed cultivation in the North Sea. WEcR memorandum (2019/12). https://doi.org/10.18174/470257

PPS-2 Consortium Olmix
Productiviteit Ulva:

- Ppt-presentatie Seasonal and genotypic variation in productivity and chemical composition of sea lettuce, Symposium Seagriculture, Galway, 2018

Diergezondheid:

- Marinus van Krimpen (2018) Opportunities of seaweeds in animal production. Oral presentation at Technisch Seminar Olmix: Algentherapie in de moderne Varkenshouderij, Velp (Nederland) 28 augustus 2018.
- Marinus van Krimpen (2018) Opportunities of seaweeds in animal production. Oral presentation at technical meeting Olmix, Vallarta (Mexico) 28-30 November 2018

Plantgezondheid

- Spreadsheet – overzicht inhoudsstoffen, werkingsmechanismen en ervaringen met zeewierproducten voor plantgezondheid – vooralsnog vertrouwelijk werkdocument voor bedrijf en betrokken onderzoekers WUR
- Conceptrapportages experimenten zeewierproducten voor plantgezondheid – vooralsnog vertrouwelijk voor bedrijf en betrokken onderzoekers – op te nemen in op de duur openbare rapportage “Seaweed products for plant health”
- Excursie langs veldexperiment en presentaties in de klankbordgroep/projectmeeting van de verschillende projecten rond en met Olmix.

PPS-3 t/m 7: nog geen publicaties

LNV-project 1 Gehaltes aan zware metalen en andere contaminanten in zeewier gekweekt in de Nederlandse wateren.

- WFSR-rapport 2019.524 Contaminanten in Nederlands Zeewier. Eerste resultaten van de pilot : najaar 2018 t/m voorjaar 2019. Els Faassen en Siebren van Tuinen. Vertrouwelijk rapport om privacy redenen t.a.v. de bedrijfsspecifieke informatie
- Monsternameprotocol voor vers zeewier 2019 (wordt vertaald in het Engels)

LNV-project 2 t/m 5: nog geen publicaties

Factsheets/dossiers

- Technical upscaling of seaweed cultivation (A. vd Werf, 2018)
- Sustainable seaweed value-chains (S. van den Burg, H. Dagevos en R. Helmes, 2018)
- Zeewierproductie en biodiversiteit (H. Jansen & L. Tonk, 2018)
- Seaweed diseases and pest (M. Bernard, 2018)
- Processing of seaweed for food, aspect to take into account for food applications (A. Janssen, 2018)
- “Seabreeze”, the fishy seaweed flavour, off-taste of seaweed for Western customers (A. Janssen, 2018
- Toekomstscenario’s 2030, Opschalen van duurzame zeewierteelt op de Noordzee (K. van Swam, J. Veraart, 2018)

https://www.wur.nl/nl/Onderzoek-Resultaten/Onderzoeksprojecten-LNV/Expertisegebieden/kennisonline/MIP-Seaweed-for-food-and-feed.htm

https://topsectoragrifood.nl/project/af-16202-seaweed-for-food-and-feed/

Bijlage

ProSeaweed Mid-term Program Day

Preliminary results of the ProSeaweed projects

Date: 9-12-2019
Location: Wageningen

Attendance list

1. Nathalie Scheidegger (LNV)
2. Evelien Valk (LNV)
3. Koen van Swam (NZB)
4. Ineke Ammerlaan (WUR)
5. Jules Petit (WLR)
6. Marinus van Krimpen (WLR)
7. Wouter Muizelaar (WLR)
8. Rommie van de Weide (WPR)
9. Adrie van der Werf (WPR)
10. Siebren van Tuinen (WFSR)
11. Floor Boon (WUR)
12. Judith Vos (NZB)
13. Lotte Stokvis (WUR)
14. Eef Brouwers (NZB)
15. Lotte Bronswijk (NZB)
16. Marlies Draisma (NZB)
17. Job Schipper (Hortimare)
18. Zairah Khan (Blue O2)
19. Alida Melse (Humane voeding WUR)
20. Marielle Koks (Vobra)
21. Marnix Poelman (WUR)
22. Jessie Guyader (ADM)
23. Nienke Meijer (NZB)
24. Nick Verhoef (Lab associates)
25. Mirjam Klijnstra (WUR)
26. Marjan van Crij (LNV)
27. Marca Schrap (NVWA)
28. Sander van den Burg (WUR)
29. Jurriaan Mes (WUR)
30. Jakob Asjes (WUR)
31. Nico Buytendijk (RVO)
32. Mark Soetman (Seaweed Harvest North Sea)

Introduction Mid-Term Program Day – Ineke Ammerlaan (Wageningen Research)

The goal of ProSeaweed is to contribute to innovations required for large-scale, viable and sustainable seaweed production in Dutch waters. At the start of ProSeaweed the focus was on the initiation of public-private partnership on food and feed applications of seaweed. At the start of the programme there was in particular interest from companies in the animal feed sector. Several PPP's on feed applications have started in 2017 and 2018. New projects including ecological and food safety topics were initiated in 2019 at the request of the Dutch Ministry of Agriculture, Nature and Food Quality (LNV). These topics are of societal importance but companies are not yet inclined to invest in these issues. Therefore the projects on these topics are fully financed from ProSeaweed. Currently, the programme consists of 7 PPPs and 5 LNV-projects. The projects can be divided in three categories; cultivation, processing and application of seaweed.

Some new activities in 2020 and 2021 are scheduled. Collaboration opportunities with large North Seaweed pilots are currently investigated. One of them is Seaweed Farm Haringvliet (coordinator Mark Soetman). This pilot will start in 2020 with a 2 hectare nearshore production site along the Dutch coast. Another new project is the realisation of a trend report on the Dutch seaweed sector, which will report on developments and results of (research) projects on Dutch seaweed. As we are halfway during the programme, we are discussing the opportunities of a follow-up after ProSeaweed has ended with our contacts of the Ministry of LNV. It is clear that scaling up to large pilots in the North Sea is considered as a necessary next step, also because this in line with the climate change agenda of the Dutch government.

Remarks, questions or suggestions from the audience:
A remark was made whether ProSeaweed has plans to collaborate with other large scale pilots as well for example the Wier & Wind project. A collaboration with this project has not been foreseen yet but it is an interesting idea which will be investigated.

Trend report on the Dutch seaweed sector – Koen van Swam (Noordzeeboerderij foundation)

A new part of ProSeaweed will be a trend report which will show the status of the current Dutch seaweed sector and showcase ongoing developments. The focus of the report will be the Dutch seaweed sector, however relevant developments and broader trends that occur on a global level (and which are of relevance for the Dutch sector as well) will be taken into the report. From the beginning of 2020 the trend report will become a yearly deliverable within ProSeaweed. The first concept is due to be published at the end of January 2020.

In 2020 and 2021 the report will address new topics such as ProSeaweed result updates, results from other seaweed programs and pilots and possibly market data. In this way at the end of 2021 the trend report will entail a complete and integral overview of the seaweed sector in the Netherlands, relevant developments and the impact of ProSeaweed.

The report currently focusses on the Dutch sector; however, it is understood that developments and research programs in other EU-countries are of great relevance for the trend

report as well. Therefore, in the following reports all relevant developments in the EU will be more explicitly be incorporated into the report.

Remarks, questions or suggestions:
The ministry of Agriculture tells that there has been a meeting on the Norwegian embassy to create relations and being able to exchange knowledge between countries more easily.

Project presentations: preliminary results

1. Health promoting and nutritional effects on fish - Jules Petit (WUR – chair Aquaculture and Fisheries)

The global demand for animal protein is increasing and as such the pressure on the current way of aquaculture production is increasing alongside. We have looked into the possibilities of using marine based solutions for challenges that aquaculture is currently facing; reduction in water quality, increased fish-to-fish contacts and others, all impacting fish health. A need arises for a method to boost the non-specific immune system of fish, improving fish health and thereby decreasing the use of antibiotics or vaccination strategies.

A well-known method to do so is with the use of immuno-modulatory feed additives. For example , β-glucans have shown to reduce stress and increase pathogen resistance in fish. Marine sulphate polysaccharides (MSPs) are extracts from marine algae like seaweed, and have already been shown to have bioactive properties in humans, for instance they can stimulate health and can reduce effects of asthma. The current research investigates whether MSPs have similar effects on fish health compared to β-glucans. Common carp, Nile tilapia and rainbow trout are used in this research as representatives for important aquaculture species.

The preliminary findings show comparable effects between MSPs and β-glucans on fish immune cells. First findings suggest that certain seaweed extracts can be used as an alternative for β-glucans. To prevent researcher bias, the researcher is currently "blinded" and not aware of the composition of the different extracts or the seaweed species from which the different extracts are extracted. After the research is completed the researcher will be unblinded, in order to be able to make correlation between seaweed species or processing method and the effects of the different extracts. This will be when the *in-vitro* studies are all performed, and is planned for halfway 2020.

2. Seaweed processing for feed – Floor Boon (Wageningen Food and Biobased Research)

In the existing seaweed processing industry side streams are present of which the potential is not yet fully used. This research investigates the processing of pressed seaweed residue towards animal feed, as a whole or in an enriched protein fraction. The pressed seaweed residue is provide by Olmix, the industrial partner in this project. For the processing of this pressed seaweed residue as a whole there are three challenges: moisture content, demineralisation, and total digestibility. Reasons for demineralisation is the fact that there is a target mineral content when extracts are used for feed applications and it causes corrosion of the equipment. To have a wide application range and to be able to mix the seaweed extract, it should have a max. content of certain minerals. Sodium, potassium, chloride are the minerals which are aimed for to remove.

For processing the pressed seaweed residue towards an enriched soluble protein fraction, the main challenges are a high protein yield and purity. The approach focusses on increasing the protein solubility. Alkaline treatment of the pressed seaweed residue is the benchmark and is not economic viable. Enzymatic treatments are explored taking into account the interaction between proteins and carbohydrates.

When these processing challenges are overcome, it is investigated whether these are economical viable.

Currently there is no focus on specific minerals such as arsenic and iodine. It is suggested to include the analyses of the specific minerals during the developed process to determine the behaviour of these minerals and to know in which process stream they end up and if they are concentrated.

3. Seaweed as protein source and health promotor in monogastric animals - Marinus van Krimpen (Wageningen Livestock Research)

This research investigates the potential of seaweed as a protein source and a health promotor in monogastric animals. The content and the digestibility of the proteins in seaweed are low, however the research shows potential for the use of seaweed when extracted as protein source. Data-analysis is still on-going; therefore, no hard conclusions can be made on the suitability of seaweed as protein source. The preliminary results look promising for companies.

Literature shows the potential health promoting effects of seaweeds extracts due to e.g. high antioxidant capacity and reduction in pathogen adherence. This research focusses on the health promoting effects of seaweed extracts on animals. Example of research parameters are nutrient digestibility and gut health performance. The in-vitro tests shows promising results, and in specific promising results for *Ascophyllum*. Seaweed supplementation in piglets (in vivo) showed some improvement in piglet performance and relative improvement of veterinary treated animals.

Concluding; the first preliminary results are promising, however not all data is processed yet.

4. Methane reduction in dairy cattle - Wouter Muizelaar (Wageningen Livestock research)

Two studies investigate the possibilities of seaweed for methane reduction in dairy cattle. A positive outcome for methane reduction would be a reduction in methane without negative effects on the animal, for example feed intake, milk yield, milk composition etc.

Seaweed & Diary, a winning team.

This study investigates the possibility of adding North West European seaweed species to the cow's feed in order to reduce enteric methane production. Some seaweed species only reduced in vitro the methane production and not the total gas production, these were promising results for continuation with an in vivo trial. Currently, the seaweeds have been tested in cows. There are no final results from this second (in-vivo) phase.

Preliminary results show no negative effects on the feed intake of the cattle. Challenges that are part of this study are; the consistency of seaweed quality, the availability of seaweed and the heavy metals present in seaweed.

BluGrass for dairy cows

Bromoform present in *Asparagopsis spp.* seaweed has the capacity to block a crucial enzyme in the pathway for methane production in cattle. Pure bromoform is not allowed to add to animal feed, however 'dried seaweed' in general is a registered feed material in European legislation.

This study is sub-divided in two phases, the first phase studies the safety and transfer of bromoform in *Asparagopsis spp.* in the animal. If in the first phase no negative effects are found on the animal or any of its products, the second phase can start in which a trial is foreseen to study the methane reduction potential. At the current stage the data of the first phase is being processed, so no funded conclusions can be made. It is unknown where bromoform ends up, this could be in the milk, urine, manure or tissues of the cow. Only the bromoform compound is measured and possible metabolites of bromoform are not investigated.

Prospects are focussed on the law and regulation aspects that may come along with the use of this seaweed for methane reduction. The researcher expresses that an objective evaluation of this product is necessary in order to study the relevant and potential negative effect for the cows.

In general, a 10% reduction in enteric methane is seen as a potentially interesting reduction to enter the market with. However, lower reductions can be expected and the exact use of the product often needs optimisation. General considerations for the ProSeaweed follow-up are more focus on the animal health and safety. Moreover, more ideas needed on how the line of product approval should/ must go regarding this product. During the product development there should be a focus on law, consumer and end product user as well.

5. Seaweed products improving plant health and performance - Rommie van de Weide (Wageningen Plant Research)

There is a necessity for more sustainable crop production (natural products, healthy plants and reuse of minerals). Seaweed extracts have been shown to positively affect plant health. There are indications for the mechanism of seaweed as a bio stimulant from literature. Mainly the polysaccharides from seaweed are involved and they induce the plant defence mechanism. Concerning the root systems, the microbiome is involved. Moreover, there are plant hormones present in the seaweed products

This research investigates the possibilities of seaweed extracts as a plant stimulant. The research is initiated by Olmix & Melspring, with a final goal to maximise valorisation of macro algae and their extracts for plant growth and plant health.
Extracts used in this research are a mixture of Ulva and Soliera species. However, there is no concrete insight yet on the exact chemical composition of the extract.

During two years experiments, different doses of the product have been tested in onion in a field experiment. The extracts did not have a significant effect on yield or onion quality.
In a pot experiment with broccoli plant a 33% to 37% yield increase was found when seaweed was added, in both saline and non-saline environment.
In another pot experiment the effects of seaweed extracts on Phytophthora resistance in tomatoes was tested. Tomato is a model plant for this potato disease. An increase in blight resistance was observed when seaweed extracts were added. In organic cultivated potatoes half of the yield can be lost due to Phytophthora infections. Treatment with seaweed extracts can reduce the loss of harvest yield. In 2019 the seaweed extract was used in a field experiment

with potato infected with Phytophthora. It was proven that treatment with seaweed extract lowered the infection rate. This experiment will be repeated in 2020.
The researcher believes that the use of seaweed extracts as a biostimulant in potato cultivation could become very promising but better insights into the market potential are necessary. Effects of seaweed extracts on soil microbes were not yet investigated. From a commercial point of view the demonstration of a positive effect of seaweed extracts on soil microbes could be interesting. Therefore this is topic could become a subject for future research.

New international regulations on the use of seaweeds as a plant stimulant apply from 15 July 2019. Seaweed is currently classified as a pesticide. These new regulations may cause extra hurdles for the legalization of plant health products based on seaweed. This may demotivate companies to investigate in the further development of this business model.

Remarks, questions or suggestions

- the question was asked whether it would be sensible to apply seaweed extracts for the control of some crop diseases instead of technical solutions in some developing countries. This depend on the costs and the effectiveness of both methods. The production of seaweed extracts can be expensive but it doesn't necessarily have to be more effective.
- Another comment suggested the researcher to get in contact with Bio4Safe, which is also a research program on the utilisation of seaweed as a bio stimulant.
- A suggestion was made to address the potential side effects of seaweed extracts in crop growth, to be ahead of critics. The researcher indicated that there are no negative side effects of the use of seaweed extracts as bio stimulants reported in literature so far.

6. Productivity and chemical composition of Ulva & Saccharina – Adrie van der Werf (Wageningen Plant Research)

The current research investigates the productivity and the chemical composition of Ulva and Saccharina strains at different cultivation sites, thereby being able to select the best strains for commercial seaweed cultivation.

Ulva
For the productivity a variation of a factor of more than 5 was observed between strains. Moreover, variation in productivity in different seasons was found. Regarding chemical composition; starch was high in summer, low in winter. Proteins were low in summer, high in winter. The research showed that the nitrogen conversion factor of 6,25 can not be used to assess the true amount of protein for Ulva. Based on the sum of amino acids a conversion of 4.6-4.8 should be used to estimate true protein content, and this factor is independent of season. Therefore, the researcher suggests using sensors in the field/ farm that can detect nitrogen and thereby are able to tell when to harvest for maximal protein content. Amino acid composition, expressed as g amino acid/100 g protein met the WHO standards and remained constant over the season and nutritional value of amino acids composition is comparable to that of soy.

In 2019 there were "disappointing" yields for the Ulva. It is suggested that this was due to the extremely high temperatures (>40 0C) during the 2019 summer period.

Saccharina

Saccharina plants were grown on vertical ropes up to 7 meters of depth in the North Sea. Data showed that there is ample biomass production below 3 meters.

Contrary to Ulva the nitrogen conversion factor to true protein varied strongly over the period May-June, being only a mere 2.3 in May and 4.7 in June. In May more than half of the total nitrogen concentration was not incorporated in amino acids.

Concluding notes by the researcher were that we have to get insights in the variation, and if possible lower the variation of chemical composition. Chemical composition will determine the value of the product.

7. Concentration of contaminants in *Ulva* and *Saccharina* – Siebren van Tuinen (Wageningen Food Safety Research)

This research focussed on food safety aspects of fresh Dutch seaweed. The aim of the study was to determine contaminant levels in Dutch seaweed and to assess the variability of these contaminants within and between locations, as well as in time. Moreover, a sampling protocol was developed which described how seaweed production locations can be sampled in a representative way. At the moment there is little legislation on the maximum allowed contaminant concentrations in seaweed intended for human consumption. Therefore, contaminant concentrations were in this study mainly compared to legislation for feed and food supplements.

In the first year of this two year study, fresh samples were taken at the Dutch seaweed production locations. First, it was assessed whether the samples taken for analysis were homogenous in contaminant composition. Moreover, the contaminant variability within seaweed production sites was estimated.

In the fresh *Ulva* samples, most contaminant concentrations were below the maximum allowed levels as used in this study. Iodine concentrations exceeded the used guidelines at most production locations, lead concentrations exceeded the guidelines only on one location.

High levels of iodine were found in all *Saccharina* samples. Total arsenic, lead and mercury concentrations (frequently) exceeded the limits used in this study. The concentrations of these contaminants differed per production site, but to what extent this can be attributed to chance, location or time of sampling will be assessed during the second year of the study.