

A Triple P review of the feasibility of sustainable offshore seaweed production in the North Sea



A review of the state-of-the-art in seaweed production and its applications revealed that North Sea seaweed is a potential sustainable resource for feed and non-food applications. Various economic, ecological and social challenges are identified, which need to be addressed to utilise this potential.

Aim of the study

This study focused on the potential of seaweed, cultivated in the North Sea, as a sustainable and profitable resource for feed and non-food applications. Seaweed production can take place as part of multi-use platforms at sea (MUPS). The aim of this study is twofold. First, to present the state-of-the-art knowledge about different elements of the seaweed chain: production, either in separate production systems or in combination with fish farming, processing and use in diets for farm animals and fish. Hazards for feed and food production are presented as well as non-food applications of seaweeds. Second, to assess the feasibility of North Sea seaweed production from a Triple P perspective, addressing economic, ecological and social feasibility.

State-of-the-art

The review of scientific publications and experimental data reveals that seaweeds can be grown in the North Sea. Ongoing research examines how production in combination with mussel and fin fish aquaculture can be realised. The produced seaweed can be used as a source of proteins and polysaccharides to be used in feed and non-food applications. Research shows beneficial effects on adding seaweed components to the feed mix. Various biorefinery techniques are available to produce green chemical building blocks from seaweed.

Feasibility from a Profit perspective

Based on the review of expected production costs and revenues, an economically viable seaweed production is possible provided that high value products can be obtained. At this moment, there is no commercial

seaweed production in the North Sea. There is uncertainty about future value chains of offshore production and it is uncertain how to organise offshore production and value chains.

The market for seaweed products is diverse. High value products include feed additives, chemicals and alginates. Direct consumption by animals offers low value. The use of seaweeds for the production of biofuels seems unlikely due to the low prices that are paid for biofuel material. To match production costs and the value of the produce, biorefinery is necessary to make multiple products from the basic material. Technical innovation and the design of systems that enable multiple harvests per year can reduce production costs.

Feasibility from a Planet perspective

To be a sustainable resource for feed and non-food applications, seaweed production should not have negative impacts on the ecosystem. To assess eco-sustainability of marine seaweed production within MUPS, the applicability of different approaches and models is reviewed. Nutrient models provide quantitative biological information about growth and nutrient assimilation efficiencies as a function of environmental variables (nutrient availability, oxygen, temperature, light intensity). Cumulative Effect Assessment (CEA) and Eco-dynamic Development and Design (EDD) models identify the most severe risks and pressures, and thereby define the most vulnerable ecosystem components. In addition, these models may help to design effective production systems that make optimal use of ecological conditions, and minimise adverse ecosystem effects. MUPS systems are complicated since they include multiple production lines and have open connections with the surrounding aquatic system. A more advanced variant of Life Cycle Analysis will be needed to evaluate the eco-sustainability of MUPS.

Feasibility from a People perspective

At present there is no manifest interest among stakeholders to develop MUPS, due to the necessary high economic and social investment, including the legal procedures involved. The concept of MUPS needs to mature so that it becomes possible to develop a realistic and reliable business case, attractive for the potential partners from the energy and aquaculture sector. A successful business case requires an optimal governance and planning mix, instigated by different actors. This planning mix needs to support the development of such business cases. Legislation needs to change but this is not the most important obstacle. Bridging the worlds of different offshore business sectors (e.g. fisheries, aquaculture and wind energy) is a more challenging issue. It would be a major step if the current small-scale experiments in seaweed farming can be followed by an experimental MUPS to facilitate learning.

Methodology

This report combines new research with knowledge and expertise from various research projects Wageningen UR is involved in. It integrates various disciplines, such as plant science, chemistry, economics, animal science, process technology and social science. This integrated approach offers new insights for the specific field of marine production. The report addresses all the issues involved, providing a bird's eye view on the subject matter, combining the collective expertise and gaining synergy.

Overview of the report

A state-of-the-art overview of knowledge is provided in the first part of the report. The following issues are addressed:

- Basic information on botany and chemistry of the major groups of seaweed (marine macro algae) → Chapter 1
- Production of seaweeds in the North Sea, addressing growth potential of various species → Chapter 2
- Production of seaweeds in integrated multi-trophic aquaculture (IMTA) systems, combined with production of shellfish and fish → Chapter 3
- Processing of seaweeds using biorefinery, as a first step towards various applications → Chapter 4
- Potential of seaweeds a source of animal feed and feed additives, for both livestock and aquaculture → Chapter 5
- Relevant food and feed risk regulation that should be taken into account when utilising seaweeds → Chapter 6

- Possibilities to use seaweeds for non-food applications, in particular for production of green chemical building blocks → Chapter 7

The potential of seaweed production is then evaluated from a Triple P perspective. The development and exploitation of seaweed needs to be feasible in line with Profit, People and Planet requirements. In the Chapter 11, conclusions from this research are presented and future research challenges are identified.

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