EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Brussels, 25 May 2021

COST 046/21

**DECISION**

---

Subject: Memorandum of Understanding for the implementation of the COST Action "TOMORROW'S 'WHEAT OF THE SEA': ULVA, A MODEL FOR AN INNOVATIVE MARICULTURE" (SEAWHEAT) CA20106

---

The COST Member Countries will find attached the Memorandum of Understanding for the COST Action TOMORROW'S 'WHEAT OF THE SEA': ULVA, A MODEL FOR AN INNOVATIVE MARICULTURE approved by the Committee of Senior Officials through written procedure on 25 May 2021.

COST Association AISBL
Avenue du Boulevard - Bolwerklaan 21, box 2 | 1210 Brussels, Belgium
T +32 (0)2 533 3800 | office@cost.eu | www.cost.eu

Funded by the Horizon 2020 Framework Programme of the European Union

**MEMORANDUM OF UNDERSTANDING**

For the implementation of a COST Action designated as

**COST Action CA20106**
**TOMORROW'S 'WHEAT OF THE SEA': ULVA, A MODEL FOR AN INNOVATIVE MARICULTURE (SEAWHEAT)**

The COST Members through the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action, referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any document amending or replacing them.

The main aim and objective of the Action is to The main challenge is to make a step-change towards a green economy based on Ulva
mass production and utilisation within the European community and beyond. The ultimate goal is the development of Ulva-based blue-biotech industries and the promotion of Ulva as a model organism in European algaculture.. This will be achieved through the specific objectives detailed in the Technical Annex.

The present MoU enters into force on the date of the approval of the COST Action by the CSO.

## OVERVIEW

**Summary**
A growing interest in the development of oceanic coastal shores has arisen over the past decade, seeking alternative sustainable food sources and other valuable products. Our initiative aims at exploiting the potential of marine seaweeds in Europe. Building on the successes of previous EU and pan-European projects on seaweeds, and due the unique characteristics of the genus *Ulva* (Linnaeus, 1753), we have identified these green algae as the most suitable candidate and model organism for a novel kind of European mariculture. Much of the knowledge on *Ulva,* generated in diverse scientific disciplines and different communities, is not easily comparable nor is it shared among scientists, stakeholders, end users and the public. This COST Action proposes an innovative conceptual pathway to address these issues, significantly improving knowledge in the biology of the most promising *Ulva* spp., capitalising on their economic potential, and exploring commercial applications in the human food, animal feed, pharmaceutical industries and ecosystem service. The COST Action combines interdisciplinary approaches to the sustainable use of marine resources, encompassing all the facets of *Ulva* biology, ecology, aquaculture, engineering, economic and social sciences. This Action will lead to the development of advanced science, create business and job opportunities in the maritime and coastal economies, and have a significant impact on societal welfare. This COST Action fulfils the current 'Societal Challenges Priorities' of European Horizon 2020 strategy for food security, and its application will contribute to the UN Sustainable Development Goals 14 (UNSDG) to conserve and sustainably exploit natural resources.

| **Areas of Expertise Relevant for the Action** | **Keywords** |
|---|---|
| ● Agriculture, Forestry, and Fisheries: Aquaculture, fisheries<br>● Agriculture, Forestry, and Fisheries: Sustainable production<br>● Biological sciences: Environmental and marine biology | ● seaweed<br>● mariculture<br>● production<br>● ecosystem service<br>● food security |

**Specific Objectives**
To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination
● To create an efficient network that is active in all aspects and disciplines related to Ulva biology, biotechnology, engineering aquaculture, nutrition, bioactivity and social aspects. Stakeholders and end-users will establish all the conditions required for the development of Ulva-based blue bio-tech industries.

Capacity Building
● A European/international representative for each step of the production chain will take part in the Action. The Action will form a cooperation platform for scientists of different disciplines, stakeholders, marketing, decision-makers, and NGOs. Particular emphasis will be given to societal aspects for the successful development of Ulva-based blue biotechnologies.

EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

# TECHNICAL ANNEX

# 1. S&T EXCELLENCE

## 1.1 SOUNDNESS OF THE CHALLENGE

### 1.1.1 DESCRIPTION OF THE STATE-OF-THE-ART

Shrinking agriculture resources undermine the increasing global struggle to secure enough food to the swelling human population. A growing interest in the development of coastal and offshore marine water bodies as a sustainable alternative to food procurement and a source of other valuable substances has arisen over the past decades. The potential substrates for aquatic cultivation -water and coastal plains cover 75% of the planetary surface. Sustainable aquatic food production will come from lower trophic levels, mainly seaweeds through mariculture (Duarte et al., 2009; Olsen, 2015). This development can be achieved by establishing innovative, cost-effective production technologies which will guarantee food security and reduce the nutrients and carbon footprint of global food production through carbon sequestration. Seaweed culture has grown faster than any other marine food production sector in the last 20 years, experiencing an annual global growth rate of 7.7% (FAO, 2020). More than 96% of global seaweed yield (32.4 MT, FAO 2020) is via aquaculture, with a total production currently similar to the sum of marine molluscs, crustaceans and fish produced from aquaculture (Olsen, 2015). Seaweed is considered a food of high nutritional value (Holdt and Kraan, 2011; Bolton et al., 2016), but currently account for only 1.14% of the world's total plant food crops (FAO, 2020). Seaweed food production could be greatly and sustainably expanded to cover this current food deficit and meet the growing demand by farming the largely underexploited aquatic environment. **However, in Europe, seaweed production in 2018 was relatively low, around 41,600 tonnes, which is approximately 0.1% of seaweed world production (FAO, 2020), and the production in Europe was too marginal to match the local demand (FAO, 2020).** With its extensive coastal zone and wide climate ranges, European aquaculture can contribute significantly to global food security. Many initiatives to exploit this potential in the EU converge on marine algae. The industry has recently expanded and now includes the production of a commodity on an industrial scale. Other uses are also evaluated, including animal feeds and high-value bioactive molecules (e.g., nutraceutical, cosmetics and medicine), whilst always prioritising human wellbeing and fostering a circular economy (Akanksha et al., 2010).

**Building on recent EU and international research and peer-reviewed publications focused on seaweeds; the COST Action partners have identified the green algae of the genus *Ulva* (Linnaeus, 1753) as the most suitable organisms for biomass production and innovative blue biotech industries in European mariculture.**

The green algae *Ulva* spp. (class Ulvophyceae) belongs to a genus inhabiting shallow marine and brackish waters. Many of these algae - known as 'sea lettuce' are edible. *Ulva* spp. are ubiquitous throughout the world's oceans and constitute important primary producers. In Europe, 38 species of genus *Ulva* are known, eight species of which are endemic (Guiry, 2020). Species of *Ulva* have been extensively analysed for their value as food, feed, food ingredients (e.g., protein, carbohydrates, pigments, antioxidants), chemical constituents and medicinal properties (Yu-Qing et al., 2016; Mantri et al., 2020; Prabhu et al., 2020). In mariculture, *Ulva* can be cultured in either land- or sea-based facilities. An *Ulva* sp. produced more biomass per square metre than land plants - 25-40 tonnes dry weight per hectare per year, compared to 2.1, 4.1and 5.1 tonnes for soybean, wheat and maise respectively (Broch et al., 2012; Shpigel et al., 2015).

Production in sea-based systems provides a sustainable alternative to agriculture, as land availability remains a key issue for *Ulva* biomass production in Europe (Luguel et al., 2011). There are multiple features unique to *Ulva* spp., and their importance is indicated by the number of scientific publications involving RTD on these algae, which has increased from 1,140 papers in 2000 to 7,710 in 2019 out of a total of 84,900 Google Scholar entries.

**The decision to choose the *Ulva* genus was founded on the following *Ulva* spp. characteristics:**

● Worldwide distribution in the accessible intertidal zone, from the polar regions to the equator. Ease of collection from the wild to start a culture (www.algaebase.com/Guiry 2020).
● Faster growth rate (can double its dry weight per day) and larger areal yield throughout the year, whether in a sessile or free-floating system (Broch et al., 2012, Bruhn et al. 2011; Shpigel et al., 2015;Praeger et al., 2019). Easy reproduction, both vegetative (asexual) and by spores (sexual) (Praeger et al, 2019)
● Ease of culture in both sea- and land-based facilities (Bolton et al., 2016)
● A proven source of sustainable biomass production (fresh or dry) for human consumption, animal feed, and a reliable source of high-value by-products (Nutraceutical and cosmetic industries) (Bikker etal., 2016. Kidgell et al., 2019).
● Plasticity in biochemical composition, with numerous documented bioactive metabolites (primary and secondary) exhibiting antimicrobial, antiviral, antioxidant, anti-inflammatory, and anticancer activities (Mantry et al., 2020).
● Ability for microbiome engineering to trigger growth and enhanced production of specific algal constituents (Polikovsky et al. 2020)
● Excellent efficiency as an ecological biofilter for ecosystem services, supporting sustainability of the growing industry of land- and sea-based fish farming, preventing eutrophication in coastal waters (Msuya & Neori 2008, Neveux et al., 2017: Gao et al., 2018).
● Ability to assimilate carbon efficiently, contributing to reducing global warming and its deleterious implications (Gao et al., 2018).
● Potential biomass for biodegradable (bioplastic) packaging as an alternative to plastic and other alternatives to biodegradable synthetic polymers (Helmes, 2018; Zhang et al., 2019).
● *Ulva* is genome-sequenced and the only macroalgae which can be transformed for genetical modifications (Oertel et al. 2015; de Clerck et al. 2018, Blomme et al. 2021)
● Ideal model for clarifying fundamental aspects of seaweed biology (e.g. growth, metabolism, and algae-bacteria interactions; (Wichard et al., 2015).

**Based on the *Ulva* aforesaid unique characteristics, focusing on a single genus will provide us with high-resolution information and bring many species to the forefront of European algaculture.** This, in turn, will enable the industry to compete with Asian markets (which currently supply most of the global demand for seaweed to Europe), boost regional employment and income, promote climate mitigation and will improve the marine environment. Thanks to the available scientific know-how and combined knowledge of 76 experts from 22 European, 6 non-European countries, 17 SMEs and two large companies, the foresight is that *Ulva* is bound to become **tomorrow's "wheat of the sea",** i.e. a primary source of large-scale marine vegetable biomass within the European community and beyond.

### 1.1.2 DESCRIPTION OF THE CHALLENGE (MAIN AIM)

The main aim of the COST Action is to make a step-change towards a green economy based on *Ulva* mass production and utilisation within the European community and beyond. The ultimate goal is the development of *Ulva*-based blue-biotech industries and utilisation of *Ulva* as a model organism in European algaculture.

The *Ulva* COST Action will facilitate acquainting the traditional European diet and taste with *Ulva,* as a new, sustainable, and safe food item. The Action will profit from the world-renowned quality standard of European food production and from the nutritional value of *Ulva* toward using this alga in European human diet and animal nutrition. *Ulva* as an aquafeed ingredient can facilitate, in particular, a sustainable aquaculture expansion in Europe. The replacement of the protein components of fish meal by *Ulva* has been shown as an effective alternative to terrestrial proteins such as those obtained from soy. A high potential market also exists for new bioactive molecules that may provide innovative products in the nutraceutical and biomedical industries. Furthermore, ecosystem services (provisioning, supporting,
regulatory and economic) by *Ulva,* particularly nutrient recycling and removal and carbon fixation, will ensure environmental sustainability. Production of *Ulva* on a large scale is, however, a prerequisite for making *Ulva*-derived compounds market-competitive.

**The challenges to expanding *Ulva'*s biotechnological potential include**:
(a) developing cost-effective technologies for *Ulva* mass production in land- and sea-based systems (including control over *Ulva'*s whole life cycle, reproduction, seeding, outgrow and harvest).
(b) developing commercial applications in the human food and animal feed industries.
(c) assessing *Ulva'*s ecosystem services (provision, support, regulatory and economic) by biomass production for social welfare.
(d) developing new bioactive products for the nutraceutical, pharmaceutical, and cosmetic industries
(e) enhanced production of algal constituents through unique microbiome engineering.
(f) enhancing acceptance of *Ulva* as food, feed and source of bioactive products by society, and drawing regulations for *Ulva*-based industries.
(g) introducing new career opportunities in the academia and various seaweed industry sectors; educating and training of cutting-edge S&T for the next generation of scientists.
The challenges will be achieved through the activation of all COST Action networking tools and by consolidating and unifying the current scattered S&T knowledge from different geographical regions, scientific areas, technological and social disciplines. **The Action will bridge the scientific, regulatory and social practical gaps still existing in *Ulva,* paving the way to the commercial production of this seaweed in the blue-biotech industries**.

## 1.2 PROGRESS BEYOND THE STATE-OF-THE-ART

### 1.2.1 APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE-OF-THE-ART

This Action's network will adopt a transdisciplinary approach directed towards one single macroalga genus and will be focusing on four **main topics**, to be tackled by **six closely** connected Working Groups (WGs) **(Figure 1).** Data received from the WGs will be processed and coordinated. A 7$^{th}$ WG will then distribute this updated, comprehensive knowledge and disseminate it among third parties. The stakeholders (i.e. SMEs, policymakers, NGOs and end-users) will be invited to participate in the conferences and WGs' activities. Not only will they be invited but be integrated and bound to each step of the production chain and process. This ensures that the stakeholders can better meet the Action aims. They will be updated directly or via technical reports and publications.
**First topic: *Ulva* biology: WG 1** will investigate several basic aspects of *Ulv*a biology, including **a)** clarifying still-debated questions about *Ulva* taxonomy, **b)** bridging knowledge gaps still existing with regard to life-cycle stages of different *Ulva* species (which will help **WG 2** in the exploitation of full the potential of biomass production), **c)** identifying high-performance strains for industrial use, optimising the production of particular substances and developing sustainable production chains (Figure 2) (which will facilitate the tasks of **WG 3 and 4**), **d)** acquiring knowledge on epibiotic microbial interactions, which has been shown to be crucial for *Ulva* cultivation (**WG 2 task**), product development (**WG 3, 4 tasks**) and mitigation of environmental impact**.**
**Second topic: *Ulva* mass production, food, feed and additional by-products. WG 2, 3** and **4** will focus on **a)** the development of technologies and engineering for *Ulva* biomass cultivation and the establishment of viable *Ulva*-based industries. A challenge for **WG 2** will be the adaptation of traditional aquaculture techniques to the specific requirements of a particular *Ulva* sp. While maintaining close contacts with each other, the WGs will explore *Ulva* for its potential in human consumption, as animal feed and as a source of bioactive products such as nutraceuticals, medicines, and cosmetics.
**Third topic: Valorising the ecosystem services** (provisioning, supporting, regulatory laws, including economic issues) that mass cultivation of *Ulva* will bring about. **WG 5 and 6** will devote particular attention to the removal and recycling of nutrients and the related effects on the environment.
**Fourth topic: Societal acceptance and regulatory Action. WG 6** will be concerned with: **a)** societal acceptance of *Ulva* products as food, including cultural aspects, **b)** economic aspects of *Ulva* industries and risk assessment in different scenarios and geographical locations, **c)** government regulations of *Ulva* mass production and its marketing products (safety regulations and food quality), **d)** conflicts of

interest regarding spaces for large scale *Ulva* production vs. other users of the sea. These issues require close cooperation with the entire group of stakeholders, a task supported by **WG 5, 6, 7.**

**The progress beyond the state-of-the-art includes**:
● Increasing the fundamental knowledge of *Ulva* spp. Biology and ecology and filling the gaps that impede further development of sustainable *Ulva* mass production (e.g. the geographical and seasonal environmental impact on *Ulv*a species/strain growth and productivity). The new data will be transferred to the end-users and the public.
● Availability of new, cost-effective technologies for the sustainable production of *Ulva* biomass (the entire life cycle, from reproduction to harvest) in land- and sea-based facilities.
● Production of *Ulva* as sustainable food, feed and source of high-value bioactive products (for nutraceutical, cosmetic and medical uses), considering site selection, ownership and economics.
● Evaluation of the role of *Ulva* aquaculture mass production within the framework of ecosystem services (including nutrient capture path, uptake of excess CO2, water acidification and eutrophication).
● Getting traditional Western diet and taste acquainted with *Ulva*. The Action will make the market familiar with sustainable and safe *Ulva*-based food. The Action will make a parallel market familiar with sustainable and safe *Ulva*-based animal feeds.

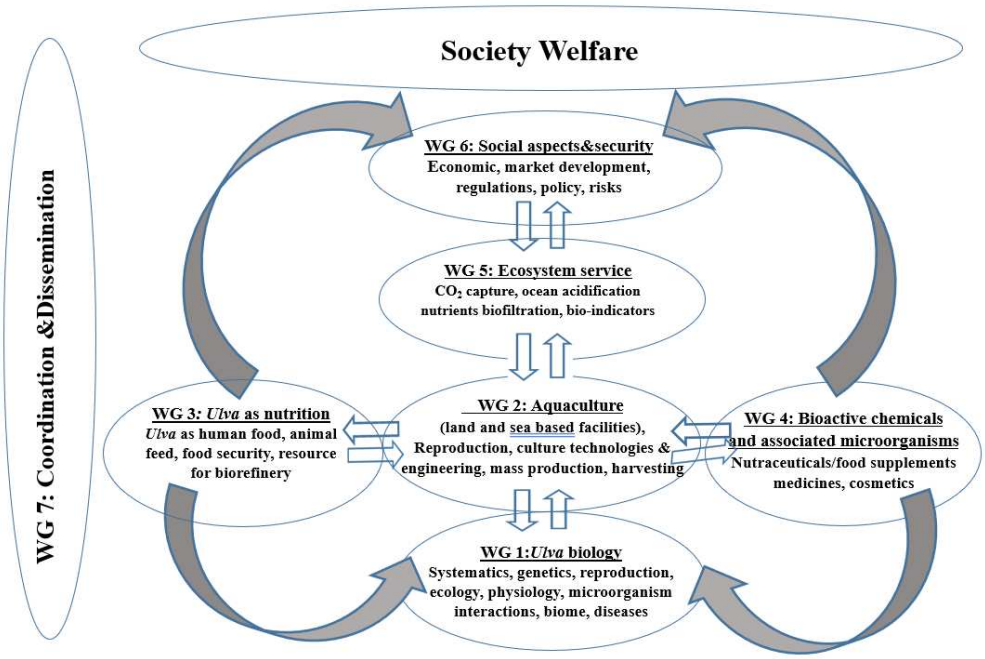


**Figure 1: Scheme of the WGs in the COST Action and their linkages**

## 1.2.2 OBJECTIVES

### 1.2.2.1 Research Coordination Objectives

1. **To create an efficient network**, active in all aspects and disciplines related to *Ulva* biology, biotechnology, engineering aquaculture, nutrition, bioactivity and social aspects. **Stakeholders and end users will be part of it to create all the conditions required for the development of *Ulva*based blue biotech industries**.
2. **To manage core activities** in a way to ensure the essential sharing of information.
Arrangement of newly acquired knowledge with known data and their re-evaluation will be made available to all the partners. Comprehensive cooperation consortia will be created to avoid parallel activities and maximise efficiency.

3. **To facilitate assimilation and broaden the dissemination of the COST Action results**. Transferring of the acquired knowledge and technologies to the decision makers, regulatory bodies, NGO and end-users will support sustainable aquaculture and create by-products and ecological services.
4 Assist in the **career development of Early Career Investigators(ECIs) and students** by introducing new opportunities in academia and various seaweed industry sectors.
5. To ensure the essential sharing of information. The newly acquired knowledge will be available to all the partners (scientists, end-users, policymakers, NGOs, and the public).
6. **To lay the foundations for future commercial applications** (including cooperation with private enterprises).

#### 1.2.2.2 Capacity-building Objectives

The composition of the COST Action encompasses all the disciplines dealing with the *Ulva* genus. European/international representative of each step of the production chain (figure 2), from scientists to decision-makers, NGO, *Ulva*-based industries and end-users. **For efficient transfer of the achievements into practice, the COST Action will form or cooperation platform not only for scientists of different disciplines but also for stakeholders, marketing, decision makers and NGOs**. Particular emphasis will be given to societal aspects, which are essential for the successful development of *Ulva*-based blue biotechnologies.

The network participants will learn from each other, unify their data, identify the most relevant scientific, technical and social gaps and synergistically create a comprehensive S&T database to bridge the main knowledge voids. This will occur either directly or through R&D projects that will be initiated by the participants as the gaps are recognised. The consequent opening of new applications and advanced cultivation and production technologies will fulfil the European laws and regulations for blue biotech in Europe. To this purpose, dedicated workshops, Training Schools (TS), Short-Term Scientific Missions (STSMs) and conferences will be organised, and direct exchange of information will take place among all participants. Being involved directly in the development of technologies and their harmonisation while drafting safety and best-practice protocols will secure the long-term perspective of the network.

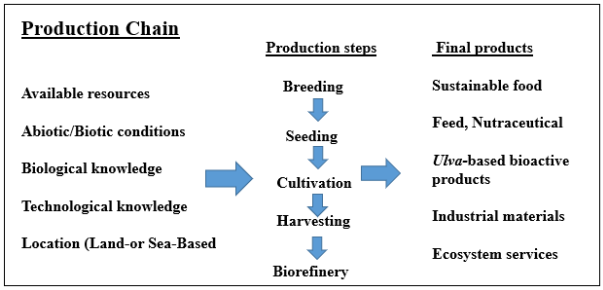

Figure 2: *Ulva* biomass production chain

# 2. NETWORKING EXCELLENCE

## 2.1 ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

### 2.1.1 ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

This COST Action will build from the information previously acquired (described previously in the Introduction) across 7 European seaweed projects, 2 national projects in North Europe, international projects, and 7,500 publications dealt with related topics (e.g., *Ulva* production chain, *Ulva* harvest as habitat restoration, and a Nature-based Solution to the improvement of marine ecosystem status and climate, *Ulva* as feed, food, bioactivity, and food security, as 18 academic and industrial partners new and form earlier projects are involved in the Action and identified the main gaps to be solved.

**The network added value of the Action, in addition to existing efforts, are:**
1. The COST Action's network will produce a comprehensive overview of the state-of-the-art and ongoing research, followed by the definition of research topics that regional consortia will be required to address.
2. Given the wide geographical coverage and scientific expertise of the network,Action:
2.1.1 will have sufficient flexibility to respect national and local regulations and make site-specific production adaptations.
2.1.2 will address overarching questions such as, e.g., seaweed cultivation in connection to land-based fin-fish aquaculture; under conditions of global warming, possible changes brought about by pandemics and the resulting restricted labour, transport and processing routes in domestic and international markets, and social-economic impact of *Ulva* cultivation on different kinds of coastal communities (ranging from developing rural to industrialised urban ones).
2.1.3 will allow stakeholder and end-user to devise proper coastal spatial planning.
2.1.4 will bring about a collaboration among different scientific disciplines (including ECIs) and geographical areas. They will exchange know-how and new ideas and lay the foundations for future cooperation and the development of common standards.
3. The success of the Action will lead to more jobs, higher income, awareness of important environment indices, food security (in a pandemic world), new industries, and a varied commodity
4. Through the Action, many opportunities to enhance ECIs careers and opportunity building in the WS and STMS activities will link young researchers to SMEs throughout Europe.5.
5. The COST Action will enforce some of the current "Societal Challenges Priorities" of European Horizon 2020 Strategy for Food Security. The Action will contribute to the environmental policy of Europe by assisting in implementing Assessment Directive-85/37 EEC, the Integrated Pollution Prevention Control Directive (96/61 EEC) and reach the UN Sustainable Development Goals 14 (UN SDG), the latter which targets conservation and sustainable exploitation of the oceans.

## 2.2 ADDED VALUE OF NETWORKING IN IMPACT

### 2.2.1 SECURING THE CRITICAL MASS AND EXPERTISE

Representatives from all relevant disciplines (biology, aquaculture, chemistry, nutrition, bioactivity and social aspects) and **each step of the value chain** are represented in the network. Our consortium includes leading European and international scientists and industry partners, which means that a substantial part of this knowledge already exists, however, scattered within the partnership. The challenge of our Action is to bring together the key elements of these diverse areas and redistribute them into transdisciplinary research streams, each with well-defined aims and a strong focus on practical applications. The Action consists of 76 partners from 28 countries spread over a large geographical area, from the North Atlantic (42%) to the Mediterranean (46%) and Black Sea (3%). Of these, 22 are from EU countries and include 69 partners. Of these EU countries, 11 (50%) are from inclusiveness target countries (ITC), with 8 partners from 6 non-European countries. Among the network, 60% are from 46 academic institutions and R&D institutes, 25% are SMEs and two large companies. Experienced scientists are predominant (80%), but a significant number (15%) are ECIs and graduate students (20).

ECIs will be encouraged to take leading roles in the management activities. Additional ECIs will be recruited. Our gender ratio is 61.8:38.1 male-to-female and the Management Committee (MC) will continue to give priority to equalising gender balance. The COST Action will create an interdisciplinary, interactive network of leading European and international scientists and associated partners (industries, government, NGOs and public at large). This variety of expertise (Systematics: 4%; Ecophysiology: 18%; Biochemistry /Ultrastructure: 4%; Aquaculture/IMTA: 20%; Biomass-Food/Feed: 13%; Bioactive products: 10%; Technological applications: 15%; Microorganisms-Biome: 2%; Ecosystem service: 6%; Economics/Social aspects: 6%and marketing 2%) will have a complementary and synergistic effect and will be able to address the challenges identified in the COST Action. This comprehensive interdisciplinary group of partners will encompass all the facets of *Ulva* covered by WGs (WG1 – Biology: 16%; WG2 – Aquaculture: 26%; WG3 – Nutrition: 13%; WG4 – Bioactive chemicals and associated organisms: 13%; WG5 – Ecosystem services: 23%; WG6 – Social, legal and regulatory

aspects: 6%). The COST Action will actively encourage the inclusion of new countries and make sure that the finest expertise is available in each field. The critical mass needed to achieve cutting-edge scientific knowledge is, therefore, present. To ensure the full involvement of both the ITC representatives and the ECIs, the Management Committee will attempt to designate the ITC partners as key members of the WGs. The ECIs will be intricately involved or leading the workshops, STSMs, and Training Schools held throughout each grant period. Regarding gender balance, the MC will attempt to improve upon our current ratio of 60:40.

### 2.2.2. INVOLVEMENT OF STAKEHOLDERS

Academics investigating the potential of *Ulva* industries and related stakeholders often do not efficiently work together. Therefore, the COST Action is a bottom-up initiative that will strengthen these network components and link them to key stakeholders to define specific needs and the corresponding research to be undertaken. This is required in order to translate scientific knowledge into technological advances for aquaculture end-users.
The Action includes universities, R&D institutes, SMEs (17), large companies (2), NGOs (3) and government departments which run general public services (3). The SMEs partners involved belong to the aquaculture sector (fish and seaweed) and seaweed-related industries (food, feed, bioactive products) and marketing. The network gave an SME the task to study risk assessment for both evaluations of the relevant activities, products of the consortium's Action, and activities. The involvement of stakeholders will include three elements:
1. **Prior activities**: part of stakeholder partners played an important role in writing the COST Action. They identified the main practical gaps for *Ulva* cultivation and related industries which are barriers to progression.
2. **Throughout the COST Action timeline**, stakeholders, will have active roles in conferences, workshops, STSMs and TS. These activities will bring together academic and industry sectors for knowledge exchange and its rapid transfer to industrial end-users. Direct interaction with industrialists will be guaranteed by setting up an **SME platform.**
3. **Involvement of stakeholders with ECIs** is synergistic and symbiotic. The SME platform will be used to introduce ECIs to the industries and foster possible careers. This will be achieved by organising a 'SME day', so SME partners related to seaweed industries can present their activities to the future scientists and leaders of relevant sectors.

### 2.2.3 MUTUAL BENEFITS OF THE INVOLVEMENT OF SECONDARY PROPOSERS FROM NEAR NEIGHBOUR OR INTERNATIONAL PARTNER COUNTRIES OR INTERNATIONAL ORGANISATIONS

The inclusion of nine International Partner Countries from six non-European countries (China, South Korea, Brazil, India, South Africa and Mexico) all leading in seaweed (including *Ulva*) aquaculture, will add valuable input and knowledge that will be acquired from other regions with different political, cultural, and climatic spheres. It will also contribute to the visibility and worldwide acceptance of the expected results and will pave the way to future activities in this field in Europe. Gaining international experience through knowledge exchange will provide opportunities to take on leadership roles and will benefit in particular, SMEs, stakeholders and other entities outside academia. This guarantees the geographical coverage necessary to initiate a trans-boundary, European-wide dimension of the Action.

# 3. IMPACT

## 3.1 IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAK-THROUGHS

### 3.1.1 SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

Impact on target groups/end users, which will benefit from the activities of the COST Action are:
● **The general public** will benefit from healthy seafood (including food additives from *Ulva*), which will improve the nutritional habits and even the gastronomic preferences of European citizens. Pollution of coastal waters will be reduced, benefitting both the ecosystem and the human community as a whole. By having access to the updated knowledge through the conferences, website and outreach activities, the public will gain a better understanding of the health benefits of *Ulva* and related products such as food and the ecological benefits of *Ulva* as animal feed.
● **Governmental and policymakers**: The data provided by the Action (WG 5 and 6) will become an integral part of coastal regulatory and management frameworks. This will enable the policymakers to formulate effective marine legislation, which will become an integral part of coastal regulatory and management policies. The results will reduce policy barriers and facilitate the implementation of better directives.
● **Seaweed growers** will have easy access to the information assembled by the Action (WG 1, 2). Methods for strain selection, reproduction, cultivation and harvesting, economic and social data will be available to start or improve their businesses (WG 5 and 6).
● **Seaweed-related industries**: Industries will be free to explore *Ulva* potential for human consumption, animal feed, and high-value by-products (food additives, substances for cosmetics, and bioactive products) (WG 3, 5 and 5).
● **Fish aquaculture industries**: fish aquaculturists have already been involved in R&D on Integrated Multi Trophic Aquaculture (IMTA) and Marine Biotechnology. They will benefit from a deeper understanding of *Ulva* biology and technological developments brought about by this Action's RTD (WG 1, 2, 3).
● **European aquaculture markets:** companies involved in supporting industries such as engineering and construction companies. Suppliers of machinery and equipment, processing the products and distributors industries and marketing will benefit from the COST Action.
● **Scientific communities**: Seaweed biologists (developmental, reproduction, genetics, etc.), seaweed biochemists (nutraceuticals, cosmetics, bioactive products etc.), marine ecologists (ecological impacts, ecosystem services, etc.), and aquaculture scientists will also be significant beneficiaries.
● **Career development:** ECIs and graduate students will benefit by learning cutting-edge technologies in their fields of interest. The Action will provide training opportunities (workshops, TS, STSM) and allow the exchange of ECIs, lasting far beyond the horizon of this specific Action**.**
**Short term impact:**
● A comprehensive body of state-of-the-art fundamental knowledge on *Ulva* ecology, biology, genetics, taxonomy, life cycle will be acquired and shared. Open access information will be of great value to academics, culturists and industrialists, whether involved in this Action or not.
● State-of-the-art protocols on *Ulva* biomass cultivation in land- and sea-based systems will be developed and shared.
● An increased interest in and awareness around the nutritional benefits of *Ulva* as food and feed is expected in EU countries (where, except in limited localities, seaweeds have not historically been a staple
ingredient, unlike Southeast Asian populations).
● Increased contact and scientific interactions between **distant areas** in pure and applied fields related to the *Ulva* genus are expected to facilitate the transfer of expertise and the development of joint projects.

● Integration of ITCs into strong European research networks will be achieved.
● Training ECIs and students on new techniques (modern seaweed aquaculture) or encouraging them to specialise in specific topics (e.g., seaweed biome, i.e., plant-microorganism interactions) will improve the students' mobility and employability.

**Long-term impact:**

● Innovative practices in *Ulva* production (from reproduction to harvest), technological and upscale engineering and management will be developed, leading to breakthroughs in biomass production and the creation of cost-effective large-scale farms both on land and at sea.
● Availability of healthy seafood will improve the nutritional requirements and gastronomic preferences of European citizens.
● Thanks to the efficient uptake of nutrients (N, P) and C by *Ulva* in large-scale farms, pollution of coastal waters will be reduced, benefitting both the ecosystem and the human community as a whole. In addition, lowering pressure on fisheries will help the recovery and conservation of the marine ecosystem.
● Coastal communities will benefit from directives on how to best control the nuisance of algae mats/blooms on tourist beaches.
● Expected additional jobs linked to the *Ulva* industries will be created (direct and indirect).
● Identification of chemical constituents in different *Ulva* species and the development of strains with peculiar features will enhance the production and viability of the farms.
● A deeper understanding will be acquired of bioactive molecules and primary and secondary metabolite mechanisms. A European stronghold in the cultivation and utilisation of *Ulva* as marine biomass will be established.

## 3.2 MEASURES TO MAXIMISE IMPACT

### 3.2.1 KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

**Knowledge creation**: The COST Action will consolidate and increase the knowledge on *Ulva*, from basic biology through identifying critical factors for *Ulva* mass production and valuable by-products to social and environmental impacts. By collaborating with senior and young scientists, SME/industries, NGO, and European/international organisations, the Action will establish a network that transcends borders and disciplines and stimulates resource-pooling and knowledge-sharing. This blending of a large variety of expertise will have complementary and synergistic effects.
**Knowledge transfer**: The knowledge collected and created will be transferred to all the target groups including the general public directly in the short term via conferences and workshops and publications and final protocols after the Action. Direct interactions with industrialists throughout the Action will be guaranteed via SMEs platform. The Action will generate a dynamic and productive network with entirely open lines of communication to enable efficient data sharing and knowledge transfer via the internet (e.g., web page, social media). This body of collaborations has a scope that extends far beyond the point impact of the COST Action.
**Career development**: The Action is fully committed to the next generation of scientists and graduate students and will take care of involving ECIs in the participation, organisation and evaluation of the workshops and TS. Their involvement will also be very effective in all WGs via the instrument of STSMs.
**Two tools will be applied for career development:**
a. **Training Schools (TS)** are an essential tool to inspire the next generation of scientists to focus on advanced interdisciplinary research within the WGs. These TS will address the relevant topics of the Action and will rely on additional senior members of the scientific community outside the network. The TS will organise lectures on key technologies and advanced hands-on training in novel methodologies.
**Practical activities of the TS are described in section 3.2.2**
b. **Short-Term Scientific Missions (STSMs**) will strengthen the mobility and collaborations among partners in various scientific disciplines and will allow the development of novel research projects. They will also promote and coordinate new applications for research funding. ECIs will be involved and will

be an integral part of their PhD dissertation or post-doctoral projects. **Practical activities of the STSMs are described in the section.**

### 3.2.2 PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

**Knowledge creation**: The COST Action will consolidate and increase the knowledge on *Ulva*, from basic biology through identifying key elements for *Ulva* mass production and valuable by-products to social and environmental impacts. By collaborating with senior and young scientists, SME/industries, NGO, and European/international organisations, the Action will establish a network that transcends borders and disciplines and stimulates resource-pooling and knowledge-sharing. This blending of a large variety of expertise will have complementary and synergistic effects.
**Knowledge transfer**: The knowledge collected and created will be transferred to all the target groups including the general public directly in the short term via conferences and workshops (in-person and online), and via publications (minimum of 2 policy briefs (1 specifically regarding aquaculture regulatory issues, at least 12 publications (whenever possible, open access) and several grey publications depending on target group) and final protocols published as a handbook for both scientist and stakeholders at the end of the Action. Direct interactions with industrialists throughout the Action will be guaranteed via SMEs platform. The Action will generate a dynamic and productive network with entirely open lines of communication to enable efficient data sharing and knowledge transfer via the internet (e.g., SEAWHEAT webpage, other linked pages, social media). This body of collaborations has a scope that extends far beyond the point impact of the COST Action.
**Career development**: The Action is fully committed to the education of the next generation of scientists, graduate students, and undergraduate students and will take care in particular of involving ECI in the participation, organisation and evaluation of the workshops and TS. Their involvement will also be very effective in all WGs via the instrument of STSMs.
**Two tools will be applied for career development:**
a. **Training Schools (TS)** are an essential tool to inspire the next generation of scientists to focus on advanced interdisciplinary research within the WGs. Various TS will address the relevant topics (such as, e.g., algal aquaculture/life cycle control [WG1,2], food chemistry/metabolomics [WG 3,4] and ecosystem services/regulatory issues [WG 5,6]) of the Action and will rely on additional members of the scientific community outside the network (e.g., academic staff working with the representative). The TS will organise lectures on key technologies and advanced hands-on training in novel methodologies. **Practical activities of the TS are described in section 3.2.2**
b. **Short-Term Scientific Missions (STSMs**) will strengthen the mobility and collaborations among partners in various scientific disciplines and will allow the development of novel research projects. They will also promote and coordinate new applications for research funding. ECIs will be involved, and will be an integral part of their PhD dissertation or post-doctoral projects. **Practical activities of the STSMs are described in section 3.2.2.**

# 4. IMPLEMENTATION

## 4.1 COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

### 4.1.1 DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

The objectives of the COST Action will be achieved through the vital work of seven WGs. Each WG will control its own advancement stages and deliverables, submitting progress reports to the Action Chair and MC every 12 months. The WGs will not work independently but interactively with other WGs without losing sight of the Action objectives and in constant coordination with the MC. This will avoid similar

activities and maximise efficiency. In addition, the links among the WGs (described in Figure 1) will take place in the Workshops representative of each step of the production chain and attended by scientists, *Ulva*-based industry environmental NGO policymakers and end-users. The expertise of the core participants in the COST Action enables the establishment state of the art WG and to foster collaborations within the Action to tackle the following tasks:

**WG 1. *Ulva* biology**: the collective knowledge on the different aspects of *Ulva* biology, including systematics, genetics, reproduction, microbiome, diseases, and ecology, will be identified and prioritised. This will fulfil challenges **(a,b).** The WG activities include the following tasks:

**Task 1.1** The inconsistent systematics and phenotypic plasticity of the *Ulva* genus will be clarified.

**Task 1.2** The microbiome (bacterial - seaweed interactions) will be identified at the molecular level; **D 1.1**

**Task 1.3** The seasonal and environmental impact factors on *Ulva* reproduction, growth, biochemical composition, and productivity (including nutrients, light, temperature, etc.) will be identified; **D 1.1.**

**WG 2. *Ulva* in Aquaculture**: collective knowledge on culture technologies (land and sea-based), strains selection, fertilisation, seeding, biomass production, abiotic and biotic culture factors and harvesting of *Ulva* will be consolidated. This will fulfil challenge **(a).** The WG activities include the following tasks:

**Task 2.1** Engineering and design concepts for cost-effective, large-scale biomass, land-based cultivation for high-value products, and sea-based facilities for food and feed, which will permit better control on growth in relation to environmental and operational conditions; **D 2.1.**

**Task 2.2** Reproduction control will be established; seeding and preservation techniques will be improved and optimised;

**Task 2.3** The potential impediments (biological, technological, and economical) for *Ulva* biomass production (including IMTA) will be evaluated and minimised; **D 2.1.**

**Task 2.4** Facilitating bacterial-algal interaction to increase biomass production and maintain sustainable growth.

**WG 3. *Ulva* as food and feed**: The collective knowledge on *Ulva* food for human consumption, animal
feed, and use of Ulva as a source of biomaterials (e.g., food supplements) will be consolidated. The nutritional value of *Ulva* and its safety as food will be validated. The existing knowledge of *Ulva* biology and mariculture (WG 1, 2) will be identified concerning the food and feed production industries. This will fulfil challenge **(b).** The WG activities include the following tasks:

**Task 3.1** The applications and nutritional values of *Ulva* spp. in humans and animal nutrition, including food processing, will be identified; **D 3.1.**

**Task 3.2** *Ulva* as a source of new biomaterials will be investigated; **D 3.1.**

**WG 4. Bioactive chemicals and *Ulva*-associated microorganisms:** The collective knowledge on
bioactive chemicals and *Ulva*-associated microbial (primary and secondary) metabolites, such as nutraceuticals, medicines, cosmetics, will be consolidated. The positive and negative impacts of microorganisms on the seaweed will be elucidated. This will fulfil challenge **(b).** The WG activities include the following tasks:

**Task 4.1** The potential of extractable substances from *Ulva* to be utilised as food additives, in cosmetics and for various other purposes will be identified; **D 4.1.**

**Task 4.2** The potential of *Ulva* bioactive extracts (primary and secondary metabolites) having antioxidant, antibacterial and antiviral activities will be identified; **D 4.1.**

**WG 5. Ecosystem Services:** The role and value of *Ulva* mass production within ecosystem services will be evaluated. Particular attention will be devoted to the removal and recycling of eutrophication nutrients from the water and climate-related effects (reduction of climate gas emissions and mitigation of ocean acidification). The negative aspects of *Ulva* (e.g., biofouling, epiphytic infestation of other organisms, *Ulva* 'green tides', etc.) will also be taken into consideration. This will fulfil challenge **(c). The WG activities include the following tasks:**

**Task 5.1** The supporting services, such as uptake and recycling of nutrients and carbon; **D 5.1.**

**Task 5.2** The provisioning services of *Ulva* as food, feed and novel biomaterials; **D 5.1.**

**Task 5.3** The regulating services - carbon capture and climate regulation; **D 5.1.**

**Task 5.4** Environmental challenges associated with negative aspects of *Ulva*; **D 5.1.**

**Task 5.5** Cost-benefit economic aspects related to the ecosystem services provided by *Ulva* biomass

production will be valorised. **D 5.1**

**WG 6: Social, legal, and regulatory aspects:** The government regulations will be summarised and the related social aspects will be consolidated. The Action will examine regulations relevant to *Ulva* production on a large scale, the acceptance of *Ulva* products by society, and the economic aspects, including **risk assessment** in different scenarios and geographical locations. This will fulfil challenge **(e).**

**The WG activities include the following tasks:**

**Task 6.1** Government regulations on *Ulva* mass production (land- and sea-based) and algae marketing as food, feed and a source of valuable secondary metabolites (safety regulations and food quality control for different uses of *Ulva*) will be studied**; D 6.1.**

**Task 6.2** The impact of *Ulva* cultivation, processing and marketing on various communities concerning social aspects (social acceptance of *Ulva* as food, improved nutrition in the communities as well as job creation, increasing community income and education) will be evaluated; **D 6.1.**

**Task 6.3** Conflicts of interest regarding space for large scale production of *Ulva* vs. other maricultured organisms and with other users of the sea (shipping, fishing, leisure, etc.) will be tackled and the information will be transferred to related governments with suggestions for possible amendments; D **6.1**.

**Task 6.4** The economics of *Ulva* farming (land and sea-based), processing (e.g., biorefineries), marketing including **risk assessment** in different systems or scenarios will be analysed; **D 6.1.**

**WG7: Coordination and result dissemination**: WG7 will manage the core COST Action activities. It will acquire, coordinate and re-evaluate known and new data and will ensure that essential information is shared with partners, end users, and other interested parties. Administrative and scientific data will be exchanged every six months through regular meetings with the MC. WG7 will organise conferences, workshops, TS and STSMs **(D7.2-7.3)**. It will also disseminate the COST Action's conclusions through social media (Skype, FB, etc.), scientific papers, and SME platform for professionals and public events **(D7.4-7.9).** Cutting-edge technologies, methods and conceptual approaches for the culture of selected *Ulva* spp. will be adopted and presented to participants through workshops and conferences. End users will be provided with advice and support services, toward the development of new ventures related to *Ulva* production and marketing. WG 7 will oversee assembling all the information acquired by this COST Action and summarising it in a conclusive "*Ulva*: Tomorrow's Wheat of the Sea" publication **(D7.9)**

### 4.1.2 DESCRIPTION OF DELIVERABLES AND TIMEFRAME

**WG 1: *Ulva* biology:** Deliverable: D 1.1 (a, b, c). Report on the following topics:

a. *Ulva* spp. Systematics and their identification; clarifying inconsistencies afflicting traditional taxonomy.

b. *Ulva* microbiome, interactions with bacteria on and in the seaweed fronds, affecting *Ulva's* growth and development.

c. Environmental and seasonal environmental factors affecting *Ulva* strains' growth and productivity (nutrients, light, temperature, hydrodynamics, green tide events, etc.).

**WG 2: *Ulva* in aquaculture:** Deliverable: D 2.1 (a, b, c). Protocol (a, b) and report (c) on the topics:

A guideline of engineering concepts for large-scale cultivation in land and sea-based facilities.

b. Cultivation protocol of spore collection and *Ulva* preservation, seeding, cultivation and harvesting in land and sea-based facilities.

c. The potential impediments (biological, technological, economic and political) for *Ulva* biomass production.

**WG 3: *Ulva* as food and feed, Deliverable**: D 3.1 (a, b). Report on the following topics *Ulva* for human consumption, animal feed and use of inedible fractions as a source of biomaterials (e.g. nutraceutical) will be consolidated.

a. Applications and nutritional values of *Ulva* for human *and animal* food, including food processing.

b. A list of inedible fractions of Ulva as a source of biomaterials.

**WG 4: Bioactive products:** Deliverable: D 4.1 (a, b). Report on the following topics**:**

a. Extractable substances from *Ulva*, utilised as food additives, in cosmetics and for various other purposes.

b. The potential of *Ulva* strains extracts as natural antioxidants, antibacterial and antiviral activities and isolation of bioactive molecules.

**WG 5: Ecosystem services:** Deliverable: D 4.1 (a, b, c). Report on the following topics:

a. They are providing and supporting ecosystem services of *Ulva* spp., nutrient and carbon removal and recycling.

b. Regulating services, the effect of biomass culture on reducing climate gas emissions and mitigating ocean acidification.

c. An economic cost-benefit analysis of biomass production and harvesting of *Ulva* spp. for ecosystem services.

**WG 6: Social, legal, and regulatory aspects:** Deliverable: D 6.1 (a, b, c). Report on the following topics

Updated recommendations for policies of official bodies and NGOs about seaweed culture regarding environmental issues and conflicts of interest (e.g., on land space).

a. Government regulations on seaweed mass production and its marketing as food, feed and valuable secondary metabolites.

b. The impact of *Ulva* cultivation on various communities concerning social aspects.

**c.** *Ulva* as food and feed, nutrition, job creation, community income and education.

**WG 7: Coordination and dissemination:**

D7.1 **Reports by the MC, WG** will be submitted by the leaders during meetings for the coordination and management of the administrative and scientific topics of the COST Action.

D7.2 **Six workshops** will consolidate the collective knowledge dispersed in the scientific community and will be disseminated through various media (e.g., publications, the *ULVA* COST Action social networks).

D7.3 **Four Training Schools** (TS) will work in combination with the workshops.

D7.4 **Eight STSMs** will be organised per year.

D7.5 **Two conferences** (open to the public) will occur: opening and a final conference (grants allocated to eligible ECIs and graduate students).

D7.6 **Publications** – several articles will be published in scientific journals and 'grey literature' on sustainable aquaculture on seaweeds.

D7.7 **A web page** – '*ULVA* – Tomorrow's Wheat of the Sea' will be established and social network accounts (FB, Instagram, ResearchGate and Twitter) will be created.

D7.8 **Two public events**: A 'cooking day' in which *Ulva* will be used in the preparation of nutrient-rich food and will acquaint the European public with its taste. A 'school day' will involve school students in seaweed farming, ecosystem services and nutritional benefits.

D7.9 **A final report** titled '*ULVA* – Tomorrow's Wheat of the Sea' will be the ultimate publication, including all the reviews, protocols and reports which should become 'gospel' for students, scientists, producers of *Ulva*, and other seaweed stakeholders.

### 4.1.3 RISK ANALYSIS AND CONTINGENCY PLANS

The following risks were considered: (a) Faulty management and administration: This is not expected to be an issue due to the experience of several Action participants and their gravitas. The CM will regularly assess the progress of the Action annually, and, if necessary, corrective and incentive measures will be taken to ensure the achievement of the goals. (b) Failure of the network to achieve a sufficient critical mass and impact: The proposers and their large associated network will act in concert to prevent that. (c) Nonperforming leaders: a warning will be issued, but a failure of one or more WG leaders to deliver the tasks of their WG in due time will bring about their prompt replacement by the MC. (d) Lack of buy-in from stakeholders: Stakeholders will be involved in all the activities. Their connection with scientists will ensure that the science-oriented tasks have outputs tailored to the stakeholders' requirements. (e) Technical obstacles to progress: The involvement of expert scientists will minimise this issue. (f) Organisational difficulties and financial issues: These will be lessened by the organisational structure described in Section 3.2.2, with the MC overseeing progress and dealing promptly with any problems that may arise. (g)Maintenance of IP: Proactive measures will be taken to improve IP rights,

confidentiality, and plagiarism awareness. Memorandums of Understanding (MOUs) will be distributed among the partners to make sure that the IP issues are clearly understood.
A risk assessment of other factors that could prevent the success of the Action will be periodically carried out. That will include acting against any development of financial difficulties, notable underestimated problems during production and product processing, transportation questions, economic and commercial issues (including marketing), pollution, natural disasters (storms, etc.), and public health issues. The network has incorporated an SME which specialises in risk assessment and failure mitigation to ensure prompt dealing with any troubleshooting.

### 4.1.4 GANTT DIAGRAM

M.1 – MC meeting to elect Chair and Core Group members (Month 4); biannual meetings in 1st and 3rd quarter
M.2 – Final definition of the concrete objectives for the Core group leaders; biannual meetings in 1st and 3rd quarter
M.3 – Construction and maintenance of the website, Facebook, Twitter, and completion within 8 months from the COST Action being announced on June 23
M.4 – Two annual conferences (in the 4th quarter of year 1 and 4) and proceedings to be published within 3 months of conference summation.
M.5 – Six workshops to be held during the conferences and six reports consolidating knowledge and identifying knowledge gaps, to be drafted after 3 months of the workshops.
M.6 – Four Training Schools, lasting two days each, at regular intervals starting at the end of year 1 of the COST. Reports of TS after 3 months of completion of the activities
M.7 – Six STSMs per year in the 2nd to 3rd quarter of each year. Reports of TS after 3 months of completion of the activities.
M.9 – Public Days ("Cooking day" and "School's day") in the 3rd quarter of the final 4 years of the COST. Publication in local pamphlets and in various media outlets within two months of completion of the activities.
M.10 – Yearly reports to be submitted at month 2 of each year.
M.11 – Various publications: scientific articles and articles in 'grey literature' on Ulva will be published from month 36-48.
M.12 – Establishing an annual meeting of the SME platform for each grant period to foster collaborations among scientists, ECIs and end users.

| Task | 2021 | | | | | | | | 2022 | | | | | | | | | | | | | | 2023 | | | | | | | | | | | | 2024 | | | | | | | | | | | | 2025 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N |
| **M.1 MC meetings** | | | | | | 1 | | | 2 | | | | | | | 3 | | | | | | | 4 | | | | | | | 5 | | | | | | 6 | | | | | | | 7 | | | | | | 8 | | | | | | | 9 | | | |
| **M.2 WG leader meeting** | | | | | | | | | 1 | | | | | | | 2 | | | | | | | 3 | | | | | | | 4 | | | | | | 5 | | | | | | | 6 | | | | | | 7 | | | | | | | 8 | | | |
| **M.3 Website construction** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **M.3 Website maintainance** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **M.4 Conferences** | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **M.5 Workshops & report (R)** | | | | | | | | | | | | | | | | | | | 1 & 2 | | R | | | | | | | | | | | | | | | | 1 & 2 | | | | R | | | | | | | | | | | | | | | | | |
| **M.6 Training Schools & report (R)** | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 2 | | | | | | | | | 3 | | | | | | | 4 | | | | | | | | | | | | | | | | | |
| **M.7 STSMs & report (R)** | | | | | | | | | | | | | | | | | | | | | | | | | | R | R | | | | | | | | | | | | | | | R | R | | | | | | | | R | R | | | | | | |
| **M.9 Public days** | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **M.10 Yearly review/ final report (F)** | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | F |
| **M.11 Publications** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **M.12 SME platform meeting** | | | | | | | | | | 1 | | | | | | | | | 2 | | | | | | | 3 | | | | | | | | | | | | 4 | | | | | | | | | | | | 5 | | | | | | | | | |