Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA20106

Grantee name: Karina Balina

<u>Details of the STSM</u>

Title: **Enhancing LCA for Ulva Aquaculture: Integrating Environmental Interactions and Ecosystem Services**

Start and end date: **17/05/2025** to **30/05/2025**

<u>Description of the work carried out during the STSM</u>

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

(max. 500 words)

The STSM took place at GreenCoLab in Faro, Portugal, under the supervision of Dr. Lais Galileu Speranza. The mission aimed to explore how nutrient exchange and biogenic carbon flows could be integrated into Life Cycle Assessment (LCA) of *Ulva* cultivation systems. During the first week, I reviewed existing seaweed-related LCA studies with a particular focus on how marine ecosystem services, such as nitrogen removal and carbon uptake, could be addressed through impact categories like marine eutrophication and climate change. Special attention was given to the work of researchers, including research done by Jean-Baptiste Thomas, Marianne Thomsen, and Michelle Seghetta. This helped to identify possible system boundaries, functional units, and methodological gaps relevant for future seaweed-based assessments.

The first week also included a team meeting at GreenCoLab, where I presented my research and introduced the SeaWheat COST Action, as well as the opportunities available within the COST network. Additionally, I participated in an online meeting with GreenCoLab's sustainability partners, which provided an opportunity to share the STSM objectives and engage in discussions about other ongoing projects and initiatives.

During the second week, I participated in several hands-on workshops together with GreenCoLab Sustainability group: Dr. Lais Speranza, Sofia Navalho, and Alexandre Lima, focusing on practical experience using SimaPro and OpenLCA. We explored how each tool supports modelling of environmental systems, with particular emphasis on their flexibility and user experience. SimaPro was perceived as more intuitive and user-friendly, while OpenLCA allowed more customisation in handling background datasets and adjusting characterisation and normalisation factors, which are important features when dealing with less conventional systems such as macroalgae aquaculture.

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[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

Although the original application included the intention to work with empirical data from ongoing *Ulva* cultivation trials in Faro, this data was not yet available during the STSM due to unexpected delays. Therefore, no LCA modelling using original data was performed. Instead, the work focused on developing a conceptual framework, including the definition of key inventory needs, boundary assumptions, and methodological approaches for representing ecosystem services such as nutrient removal and carbon dynamics. The time spent on literature review, discussion, and tool comparison provided a strong base for follow-up modeling once the relevant data is accessible.

Overall, the STSM created space for focused methodological development, interdisciplinary dialogue, and deeper understanding of the challenges and opportunities in applying LCA to seaweed systems, particularly in the context of the SeaWheat COST Action.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

(max. 500 words)

The STSM provided an opportunity to advance methodological thinking around the integration of nutrient exchange and carbon balance into LCA for seaweed cultivation systems. One of the key achievements was the development of a conceptual framework that outlines how *Ulva's* contribution to nutrient uptake and biogenic carbon sequestration could be more systematically included in environmental assessments. Although it was not possible to build a complete model due to the unavailability of local empirical data, the groundwork was laid for future work once data becomes accessible.

A key contribution was the hands-on comparison of two leading LCA software tools – SimaPro and OpenLCA. This helped to identify the strengths and limitations of each for marine system modelling. OpenLCA offered greater flexibility for customising background data and impact methods, while SimaPro provided a smoother user experience for structuring conventional models. This insight will be valuable in selecting the most suitable tool for future modelling tasks involving novel impact pathways.

The mission also established valuable connections to broader European initiatives, notably the EABA LCA Task Force. The outcomes of this STSM will directly contribute to the ongoing development of the Task Force's white paper, which aims to summarise and harmonise current LCA practices across different algae production systems. Findings on ecosystem service modelling and software choice will help inform that effort. Continued collaboration with EABA members is planned, including joint discussions on methodological challenges, allocation strategies, and marine-specific impact categories.

Furthermore, the STSM has reinforced the need for a dedicated COST Action focused on algae LCA. While interest in algae-based products is growing rapidly, there is currently no coordinated European network that addresses the methodological complexities of assessing environmental impacts across diverse algae types, production conditions, and product applications. An algae-specific COST Action would fill this gap by creating a stable platform for interdisciplinary collaboration, method development, data sharing, and stakeholder engagement. The conceptual insights and network contacts developed during the STSM will help frame this proposal and facilitate the gathering of potential partners across academia, industry, and policy.

In the short term, I plan to continue collaborating with GreenCoLab's sustainability group to explore further the methodological challenges associated with LCA applications on seaweed. I also plan to present the results of this STSM at the final conference of SeaWheat to contribute to LCA-related activities within the Action. Overall, this STSM catalyzed strategic cooperation, yielding technical, institutional, and policy-relevant impacts that extend well beyond the two-week visit.