**Object of research:**

**Title: Life MUssel Sustainable production (re)cyCLES**

**Activities: Business Plan and Socio Economic Report**

**Executive Summary of the project**

Marine litter is a global threat, affecting the seas all over the world. Every year, millions of tons of litter end up in the seas, causing environmental, economic and human health problems. Most of this litter is made of plastic and it is estimated that more than 150 million tons of plastics have accumulated in the world's oceans, while 4.6-12.7 million tons are added every year (Jambeck et.al., 2015). Polypropylene (PP) nets (socks) used for mussel (Mytilus galloprovincialis) farming are considered the first cause of sea based plastic marine litter in the Mediterranean Sea. World mussels’ production reached 2.14 million tons in 2016, a quarter of which in Europe. Officially (FAO), annual production in Italy is ≈ 80,000 tons and 700/1000 tons of PP socks used for grafting and breeding are yearly consumed. Mussels are produced by means of a “long-line” system where mollusks are kept in PP tubular socks soaking in the sea, where animals can filter microalgae. This aquaculture activity does not require feed and is extremely environmentally friendly. However, with the intensification of the productions, the use of PP socks has become an increasingly environmental threat. During mussels’ life cycle, PP socks are replaced at least twice and during this on-site operation, part of them are often lost at sea. 4,470 mussels socks were found in 27 out of 60 monitored beaches by Legambiente in 2017. According to DeFishGear "Marine Litter Assessment in the Adriatic and Ionian Seas", in Italy mussel socks were the 3rd most abundant item recorded on the seafloor (8.4%). The long degradation time of PP makes socks lasting in the sea for hundreds of years turning from macro to micro and nanoplastics with severe impacts on marine fauna. Due to the organic material adhered to PP socks, these are classified as special "non-hazardous" waste with the CER code (020104) making their correct disposal expensive for farmers. Thanks to a recent laboratory scale project (TRL4-5) carried out in 2019 by ENEA and AMA, a treatment process was developed for the removal of organic material and recycling used PP socks. Recovered PP has proved having same mechanical and chemical properties as the virgin one and can be used in any production chain. The process consists of socks shredding, oxidizing the adhered organic material, washing and finally reusing the recovered PP (tiny fragments or pellets) in any production chain. First results show that the process can also be applied to biopolymer (BP) socks. A further development on a pilot scale is needed to optimize process parameters and to make it adoptable on an industrial level (TRL7). The development BP for mussel socks has proven to be a technically feasible alternative to PP provided that they are properly recovered and composted due to their long degradation time at sea. Novamont has developed innovative biodegradable and compostable formulations which have been tested in cooperation with Rom Plastica by realizing first prototypes of mussels socks (TRL5-6). Tests were made in La Spezia, showing good performances; however, durability needs to be further improved. Within the project, an enhanced formulation of BPs will be up-scaled leveraging Novamont's experience and demo scale equipment to fulfill final applications requirements; Rom Plastica will use the enhanced formulations to realize new prototypes of mussels socks, testing their enhanced performances in open sea while keeping biodegradability and non-toxicity (TRL7).

The main objective of LIFE MUSCLES project is to contribute to the reduction of the impact linked to the use of Polypropylene (PP) socks for mussel farming, promoting and creating an more sustainable mussel production value chain that minimize the dispersion of PP socks in the marine environment, encouraging the recovery and recycling of polymers for the production of new socks and/or other items.

**Specific objectives (Sp Obj.):**

1) Starting the transition to a circular economic model within the mussel production sector in the targeted areas through the recovery and recycling of polypropylene (PP) socks used for mussels farming;

2) Increasing the sustainability of the mussel farming sector in the targeted areas by promoting both the replacement of PP socks with ones made of biodegradable and compostable biopolymer (BP) and validating the feasibility of mechanical and organic recycling of biopolymeric (BP) socks.

3) Providing the italian mussel farmers with a mobile Recycling Plant (300 kg/day) able to operate directly at mussel farms facilities;

4) Characterization of the recycled PP and BP material in order to ensure its applicability within the "mussel farming" supply chain and other production chains/sectors;

5) Promote the development of new business among the companies in the mussels farming sector;

6) Awareness raising of key different target groups and stakeholders such as farmers, distributors and consumers, on the sustainability of mussel production sector;

7) Definition and transfer of good practices to reduce the dispersion/abandonment of PP socks at sea.

According to an informal survey conducted by Rom Plastica, through interviews with mussel farmers in the Chioggia area, an average of 25-30% of mussels and therefore of PP socks, are lost at sea every year in the northern Adriatic for natural causes (sea storms). Not considering voluntary abandonment at sea of PP socks that certainly occurs but no data are available, we can estimate an annual dispersion at sea between 7.88 and 9.45 tons of PP socks in the 2 project areas.

**Activities to be carried out during the period**

**C2 Business Plan and Socio Economic Report.** The Business plan will contain a clear strategy for maintaining project results through commercialization and industrialization of the proposed solutions after the end of the project. The socio-economic impact of the project on key target groups (mussel farmers, large-scale distribution, etc.) will be monitored in terms of their perception on the proposed solutions, possible problems, real and potential economic advantages (costs/benefits), disadvantages (hostile procedure);

The information retrieved by LCA studies and activities carried out in the project will provide inputs to implement this phase of evaluation of the different environmental and socio-economic impacts. The collected data will be enough to write down a complete and detailed Business Plan. It will draft a Business Plan for the market application of the technology solution implemented. Furthermore, grounding on a detailed SWOT analysis, the Business Plan will therefore highlight the potential innovative gains by carefully stressing the environmental, technical and economical improved performances introduced, the technical and economic feasibility, the sustainability and the replicability of the proposed solution. At this stage, a preliminary numerical comparison, in terms of economic sustainability of making new interventions, indicates a saving of at least 70% of purchase costs PP socks and all the disposal costs for used socks (to date, the estimated costs for PP socks disposal is around 0,03€/kg), thanks to the Recycling Plant action. In other words, PP socks recovery will turn to be economically convenient for mussel farmers enhancing the long-term positive impact of the proposed solution. Additionally, environmental benefits should be able to increase the value of the intervention, by greatly reducing the impact of the sector (between 1 and 1.8 ton CO2 eq/ton of plastic reduced only in the pilot sites during the project’s activities and 5 years after its end).

Quantitative answers from Cost Benefit Analysis (CBA) will be complemented by a Positional Analysis (PA) in order to take into account, the local context, the interconnected elements and the environmental ecosystem.

**Activity Plan**

* Review of results from previous tasks
* Creation of the database for data analysis
* Data analysis
* Definition of the business plan, use of a SWOT matrix
* Conducting a cost-benefit analysis of the introduction of the new technology
* Final drafting of socio-economic report