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Pilot Action: *Experimentation of innovative biodegradable materials for mussel farming*

VENETO REGION
FINAL REPORT SUMMARY

INTRODUCTION

Veneto Region's pilot action in Project Dory was aimed to answer the need for a simple method for reducing the environmental impact of the plastic waste produced by mussel farms: the goal was to identify an alternative material for the mesh bags, that must be totally biodegradable so to eliminate the plastic waste, while ensuring the same performance of plastic mesh and requiring no change in the production process, expertise required and/or gear employed.

PROJECT IMPLEMENTATION

The pilot action was so designed:

- OBJECTIVE: to carry out a complete mussel-farming production cycle, using at least two different types of biodegradable mesh "socks", with regular on-board and underwater monitoring to assess the performance of the experimental materials as opposed to the traditional polyethylene "socks". A complete mussel-farming production cycle consists of the following phases:
    - *"Socking" of the mussel seed (autumn)*
    - *First harvest and re-socking (late spring)*
    - *Final harvest (late summer)*
- LOCALISATION: a longline mussel-farming plant in the Po River delta area
- EXTENSION OF THE PILOT ACTION AREA: at least 1 km
- MATERIALS TO BE TESTED: at least 2, certified as biodegradable or compostable, and compliant with EU regulations on materials suitable for food contact.
- MONITORING ACTIVITIES: on-board observations during the three production phases described before, plus 5 underwater surveys performed in-between those phases, to check the behaviour of the experimental materials in-field. In addition, exposure tests had to be carried out to test the behaviour of the experimental materials in the most likely scenario, i.e, fragments of net washed ashore and buried by the sand. They were performed by attaching 3 samples of the test materials to bamboo sticks, at fixed distances from one extremity. The sticks were then partially buried so that one plastic sample was just below the surface, and the other 2 at 5 and 20 cm of depth.

The awarded contractor was *Cooperativa fra pescatori dell'Adriatico*, based in Scardovari (province of Rovigo), who operates a mussel-farm in the eligible area. The tested materials were:

- *Bio-net*, by ROM Plastica of Chioggia, and certified compostable according to EN 13432"
- *Green-net*, by APM / BioPro of Ravenna, a natural bioplastic based on PHA, already used for biodegradable food packaging and possessing a high breaking load.

The timetable of the pilot action has been as follows:

- 12-18 November 2018: Socking of the mussel seed. All socks deployed were "ROM Plastica "Bio-Net". Samples were taken and buried at a beach for the exposure tests described before.
- 9 February 2019: underwater monitoring
- 17 May 3019: underwater monitoring
- 3-7 June 2019: harvest and re-socking. Socks used were 50% Bio-Net and 50% Green-Net. Samples were taken and buried at a beach for the exposure tests described before.
- 22 July 2019: underwater monitoring
- 28 august 2019: underwater monitoring

The fifth underwater monitoring and final harvest phase weren't performed, because by August 28th all the experimental socks were lost at sea (see "results" for the details).

RESULTS

ON BOARD OBSERVATIONS – CRITICALITIES EMERGED

Bio-Net	Green-Net
Breaking load of biodegradable nets is less than the plastic version (the net can be torn by hands) → Doubts about the ability of the material to sustain an increasing load during a long exposure to the marine environment	Although the technical specs of the material report a breaking load of 1150 N (about 117 kg), the net can still be torn by hand. Same considerations of "Bio-net" apply.
Greater friction on the tubes used in the loading operations → increase in production times of at least 50%.	Green-net behave exactly like plastic nets in the loading operations – no difference in production times.
On harvest, the socks that weren't damaged during the growth phase, snapped under their own weight when pulled out of the water	Green-Net socks didn't make it to the harvest phase. They all broke during the storm events.

UNDERWATER OBSERVATIONS

9 February 2019

At this stage the experimental socks showed no signs of wear. They were actually in better conditions than the plastic ones.

17 May 2019

After 3 more months, the experimental site had been subjected to several storms, which delayed the harvest and re-socking phase a lot (normally, it would have been carried out by mid-April). This resulted in the mussels growing more than expected and applying an excessive weight on the socks. This in turn caused the major part (around 70%) of the experimental socks either to snap, or to lose the product. On the other hand, the polyethylene socks, while subjected to the same conditions, weren't damaged to the same extent.

22 July 2019

With warm climate mussels grow faster, and the load on the socks increase accordingly. After only 1 and ½ months from deployment, and some storm events Bio-net showed the same behaviour observed in the first period; Green-net socks resisted better but showed signs of premature degradation.

28 August 2019

By this time, all experimental socks were lost at sea.

EXPOSURE TESTS

The net samples buried in the sand were taken and examined after 2 months. The samples were examined at the stereomicroscope, looking for signs of degradation, as filaments separating from the main fibres. Globally, Green-net samples show signs of quicker degradation than Bio-net samples under test conditions.

FINAL CONSIDERATIONS

There is no doubt that the trial as a whole represented a failure, with respect to the objective of identifying a biodegradable material suitable for replacing polypropylene in socks for mussel farming.

Anyway, some lessons can be learned to fine tune future experimentation, since the need to find a substitute for plastics in mussel farming remains, and there are several materials available that may have favourable characteristics, but couldn't be tested in this pilot action for cost and time reasons:

1. *Focus on biodegradable materials*: Compostable bioplastics can be easily disposed of when collected properly, but like Bio-Net, they don't necessarily degrade quickly in the environment.
2. *Involve the raw material producers more*: Generally, biodegradable plastics are engineered to degrade quickly, for example to be employed in shoppers and food packaging. This can well be why all Green-net socks broke, despite their initial break load which is comparable to that of traditional

plastics. Therefore, producers must be involved more in the designing of the material to be tested, so to try engineer it to be more durable during the production phase and degrade only after, instead of just looking for what is already present in the market.

3. *Test more materials in smaller samples*: During the first phase of the pilot action, 1000 socks of the same material were deployed. In the second phase, they were 500 of Bio-net, and 500 of Green-net. Representative results could have been obtained with smaller numbers, allowing either to save funds, or to test more materials.
4. *Test different sock lengths*: In Dory, the experimental socks were made all the same length of the traditional plastics socks. By experimenting with shorter lengths, it could be possible to find that some material can resist through the production cycle, at the expense of a part of the product.

Finally, the cost of the new material must be taken into consideration. Both materials used in Dory were 4 times more expensive than plastics, for a given length. When selecting new materials to test, there must be an indication that the price of the nets, when produced on large-scale, will be affordable for mussel-farmers, or otherwise that incentives for their use can be put into force.