



Biobased gears as solutions for creation of an eco-friendly offshore aquaculture sector, in a multitrophic approach, and new biobased value chains

Deliverable 2.1

Survey to Stakeholders



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Summary

In this deliverable we present the survey that will be carried out in BIOGEARS. The objective of the survey is to gather data for a **market analysis** of biobased ropes or aquaculture biogears and to estimate the **minimization of plastic use in the European aquaculture sector**.

Two questionnaires have been designed to gather information from the identified stakeholders related to the rope producers and aquaculture sector, among other stakeholders. Note that the questionnaires described in the current report are alive, i.e., they are liable to be improved during the life of the survey which will be distributed tentatively from September to December 2020 .

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1. Objective

The overall objective of conducting a survey in BIOGEARS project will be to gather information from different stakeholders to give answers to the following objectives of the project:

- (1) Develop the **market analysis of biobased ropes or aquaculture biogears (ABG)**; by defining market scenarios for biobased ropes, by estimating their potential price and market share in the framework of the bioplastic market for aquaculture ropes (D2.3). This analysis will be linked to O2 (D 2.2).
- (2) Estimate the **minimization of plastic use in the European aquaculture sector**, by the incorporation of biobased ropes to mussels and seaweed production, addressed to O3 (Task 2.3).

The overall objectives of the surveys to stakeholders and the implications and inputs of data to other tasks and WPs along the lifespan of the project are shown in Figure 1. On the progress of the project, the first year of the project will be devoted to the market analysis, which will be used to assess the characteristics of the product developed and their potential introduction to the market, regarding the demand and the potential of use ABG by mussel and seaweed aquaculture in Europe. Along the first year, a survey will be developed and distributed to stakeholders, to gather information of the potential use of the ABG by aquaculture stakeholders, rope manufacturers and suppliers and the overall acceptance of mussels and seaweed by the commercialisation and distribution chain and also by the consumers and the general public. Therefore, a set of different surveys will be developed regarding the approach needed, or the information to be gathered from the different stakeholders. Thus, all the data gathered will be crucial for the understanding of the needs and expectations of each stakeholder which will be used to define the ABG value chain that can be created by the introduction of ABG in the European aquaculture. Thus, all these inputs, corresponding to the market analysis and the outputs of the surveys obtained in the first year of the project, will be used to build up a more precise approach of the new ABG value chain generated in the second year of the project. Along the second year of the project, the validation of the ABG will be performed by testing them at sea in different marine conditions and using different production technologies and systems (see Task 4.1 and Task 4.2) for mussel and seaweed production, such as; raft technology in sheltered marine conditions and longline technology in offshore conditions, including IMTA (Integrated multi-trophic aquaculture) approach. The results of the tests at sea will be used in the third year of the project in WP5 to assess environmental, economic and social feasibility of ABG, and to finally construct a circular business model, based on the value chain defined (WP6), under the EU policy framework and the strategies of the circular bioeconomy and circular biobased economy. In the third year of the project, in WP6, all these inputs from WP2 and WP5 will be used to define an exploitation roadmap of ABG in the European aquaculture sector (Figure 1).

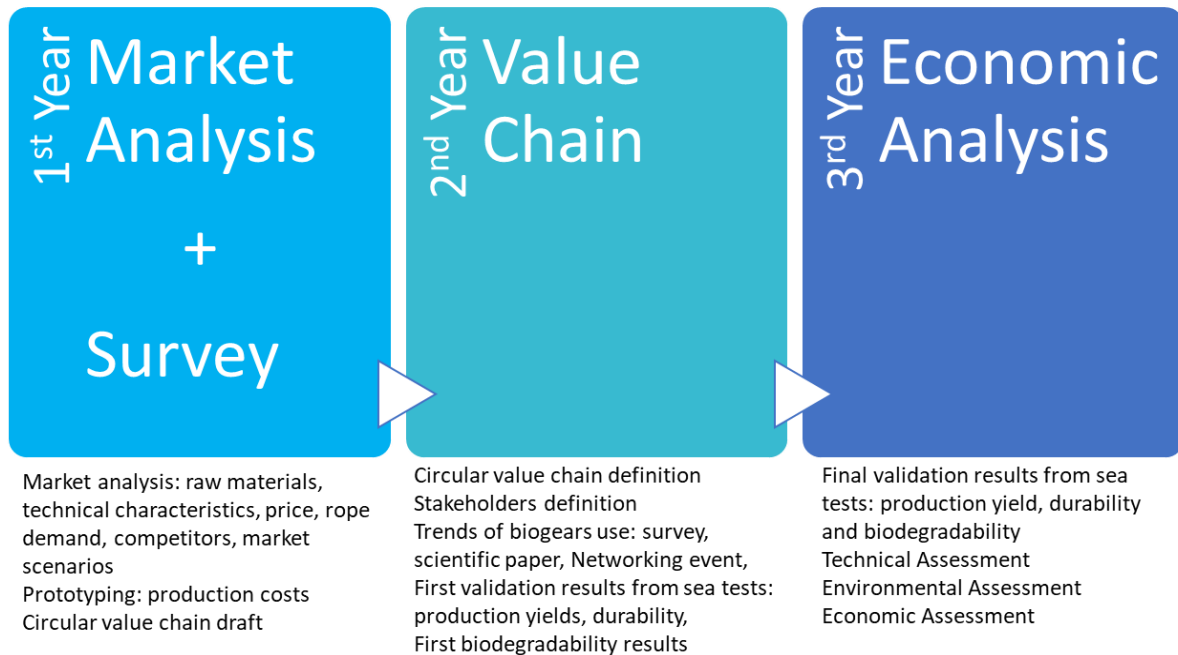


Figure 1. Assessment to be done using the survey in data gathering as inputs for market and value chain definition and economic analysis along the lifespan of the project.

2. Background

To reach the objectives of the survey on **market analysis of ABG**, the market analysis (Deliverable 2.3) can be used as background information on the definition of market scenarios for ABG, estimation of their potential price and on their market share in the framework of the bioplastic market. Thus, the executive summary of market analysis (D2.3) is used as background information:

The rope market for aquaculture is focussed mainly on mussel, seaweed and IMTA production. The aquaculture rope sales volume in Europe is estimated to be between 1,612,500 and 3,319,000 meters of rope. From this total amount, the percentage that can switch from conventional ropes to biobased ropes (ABG) depends on several factors such as regulation, potential price premium, and the price of biobased ropes compared to conventional ropes.

The **mussel's** production profitability depends on the production technology used and the production country:

- In the case of raft technology, the production in Europe seem to be stable without growth expectation. In Europe, productions are mainly family owned business, with a not high margin for new investment. Given the type of business, it must be explored if the investment on a new bio-base rope will be welcome or not.
- In the case of longline sector, in several countries it seems to be possibilities of increase its production due to creation of protected areas for mussels and national plans. But this sector profitability seems to be even lower than in the case of raft, even with a negative net profit margin in several countries.

- The overall conclusion is that the additional cost, if any, of the use of ABG ropes should be low to be stand by the mussel's business. Additionally, given the business form, they can be resistant to the change if the benefits of the change are not very clear.
- Repair and maintenance costs, that in principle the costs of new ropes are part of these costs, (5%-7% of the total costs), which indicates that does not represent a high percentage over the total costs.
- The mussel market offers considerable potential for further development with good reasons for anticipating a sustained future. However, at all levels within the industry, including production and processing, profitability levels are low, and have declined in recent years (PricewaterhouseCoopers, 2006). The economic performance of mussels on the European market may be challenged by some threats detected at the production level as well as on the marketing side. Though access to recent information on the profitability of the mussel production industry has not been available, it has been observed that some countries seem to have withdrawn somewhat from previous ambitions (Norway, Croatia, Ukraine), with declining production over the past five years.

The seaweed market shows an increasing trend worldwide and in Europe, as algae are perceived by consumers as "superfood", being nutritive and healthy, and can be the source for applications in the ingredients, bio-compounds and biotechnology products market and other novel applications in sectors such as: biorefinery, construction, automotive, biocomposites, packaging, etc.

- Number of seaweed (macroalgae) producing companies is low in Europe (around 20) and producing technology is on development, especially for offshore marine production areas.
- A trend on the increase of productions and number of companies is overviewed, although the expansion of seaweed industry is highly dependent on technology development, especially for offshore marine production areas where seaweed production implementation and expansion is being targeted (i.e. Norway).
- Seaweed production cycle is relatively short, around 8 months in kelp species, and ropes are changed every production cycle, which means that; durability of ropes (meaning technical and mechanical properties required for aquaculture performance at sea) are not as restrictive as those for mussel ropes, intended to be used along in longer production cycles up to 12-14 months in offshore facilities in the south-eastern Bay of Biscay (Azpeitia et al 2017) and raft mussels culture in Galicia (Pérez-Camacho et al. 2013) for around 10 years. Thus, on average, the lifetime of seaweed ropes is 1-year vs 10-years for mussel ropes.
- Seaweed production yield (i.e. 8 kg/m rope for kelp species in industrial farms) can be lower than mussel production yield (10-20 kg/m rope in offshore production and in rafts, with or without thinning-out) per metre of rope, however a higher market price of seaweeds (i.e. from £4/kg wholesale fresh wet seaweed, kelps) than mussels can provide a wider profitability margin for the implementation of ABG in seaweed sector.
- ABG permit seaweed harvesting using machinery in longlines, with the advantage of disposing ABG together with seaweed residues for organic composting without differentiation of residues, unlikely to when using conventional plastic gears.

An IMTA approach

- The number of IMTA companies, involving bivalve and seaweed production are still scarce.
- Technology and other aspects, such as product added value through certification and profitability assessment regarding circular economy and policy are still on first steps of development.
- Provides the opportunity to expand seaweed industry in already established mussel industry (stable), as seaweed ropes can be deployed in mussel longlines or rafts using the same infrastructures with a lower initial investment, and thus avoids the need for marine spatial planning to find new areas for seaweed culture saving time in licensing.
- Provides the opportunity to producers to implement ABG balancing farm profitability, as one species (seaweed) can compensate the over costs of the other (mussel), thus allowing a quicker penetration of ABG in rope segment market and implementation success in European aquaculture.
- Implementation of IMTA of mussels and seaweed cultured with ABG can give the opportunity for the creation of new biobased value chains, providing a wider range of new added value products (ABG, mussels and seaweed and biomass generation after rope composting), the engagement of new stakeholders and the creation of businesses and local circular economy.

Other applications and market segments for ABG:

- Bouchot mussel sector can be a promising market segment for ABG, with a potential market of (6,864,726 m/year), taking into account that the targeted durability of ABG (1 year) is coincident with that of ropes (coconut fibre) used for the production cycle of mussel cultured in bouchots (10-12 months), which are yearly replaced by new ones. Besides, ABG could be harvested with mussels (using amphibious boats) without breaking down into fibres. Currently, mussel ropes (coconut fibre) are destroyed at harvesting by the action of scrapping, thus coconut fibres can be deployed, change sea bottom conditions, and generate negative impacts on benthic ecosystems. ABG could be recovered after harvest (not destroyed) and disposed in land organic composting circuits. Thus, ABG could also provide an eco-friendly solution for bouchot industry.
- Oyster sector that use ropes deployed from rafts and tables (adult) or as collectors (spat).
- Net applications of ABG should be explored in: (1) bouchot mussel sector for nets used to protect mussels growing on ropes from marine action (tides, currents, storms), wind and predators, (2) seaweed emerging sectors dealing with offshore or marine areas with high energy conditions where rigid structures and nets rather than ropes are being successful (i.e. Norway), (3) oyster net bags for intertidal rack culture.

Additionally, the SWOT analysis of the shellfish sector in Spain (Table 1), as the most important mussel producing country in Europe, can give the insights to identify the sector drivers for the implementation of ABG in the production of mussel in the European aquaculture sector.

Table 1. SWOT analysis of shellfish aquaculture sector in Spain (OESA, 2017)¹

STRENGTHS
<p>Existence of research centres specialized in mollusc hatchery</p> <p>Accredited innovation capacity</p> <p>Optimal natural environmental conditions and (resources)</p> <p>Market opening aided by fisheries and transformation sectors</p> <p>Species complementarity with fisheries and shellfishing</p> <p>Institutional support at regional level</p> <p>High capacity for product diversification through R&D& i</p> <p>Activity with high social and cultural rooting</p> <p>Existence of highly experienced training and capacitation entities</p> <p>Traceability and control systems of proven effectiveness</p>
WEAKENESS
<p>Scarce dynamism of production</p> <p>Legal unsafety</p> <p>Long administrative times for licensing</p> <p>Sectorial planning of aquaculture activity with low coordination or territorial dimension</p> <p>Sector atomization, also of its organization structures</p> <p>Low coordination of policy and specific R&D lines for the sector</p> <p>Low transference of R&D results to producers</p>
OPPORTUNITIES
<p>Increasing global and national seafood consumption and demand</p> <p>Existence of «Mexillón de Galicia» POD (Protected Origin Denomination)</p> <p>Increasing interest on integrated multitrophic aquaculture (IMTA)</p> <p>International projection of processes and products</p> <p>High production potential and of economy of scale</p>
THREATS
<p>Increasing International competence and inequality of opportunities</p> <p>Attraction of EU for seafood produced in Third Countries</p> <p>Increasing conflicts for land and water use</p> <p>High number of economic activities impacting on aquaculture sites</p> <p>Highly increasing global production with respect to a stagnated national production</p> <p>Sanitary impact of other activities or uses on the littoral</p> <p>Underused production capacity</p>

The background on IMTA development in European aquaculture sector is based on deliverables of INTEGRATE project and final considerations (final deliverables in progress).

Regarding the background on the estimation of the **minimization of plastic use in the European aquaculture sector**, by the incorporation of biobased ropes to the market, addressed to O3 (Task 2.3), BLUNET's survey results and the SWOT analysis have been considered as feedback on this issue.

¹ https://www.observatorio-acuicultura.es/sites/default/files/images/adjuntos/libros/cuaderno_mejillon.pdf

3. Design of the questionnaire

For the design of the survey background information has been taken into account not to add unnecessary questions or to gather the targeted information that can be used to fill the gap on the trends of the aquaculture sector and of other sectors involved on biobased circular value chains generated by ABG manufacturing and implementation in the European market. For the design, the definition of context and objectives, the selection of target stakeholders and the definition of the structure of the questionnaires have been conducted.

3.1. Definition of context and objective

According to the potential value chain of the ABG, the survey is defined focusing on the development, manufacturing, and implementation of ABG in the European Aquaculture sector (Figure 2).

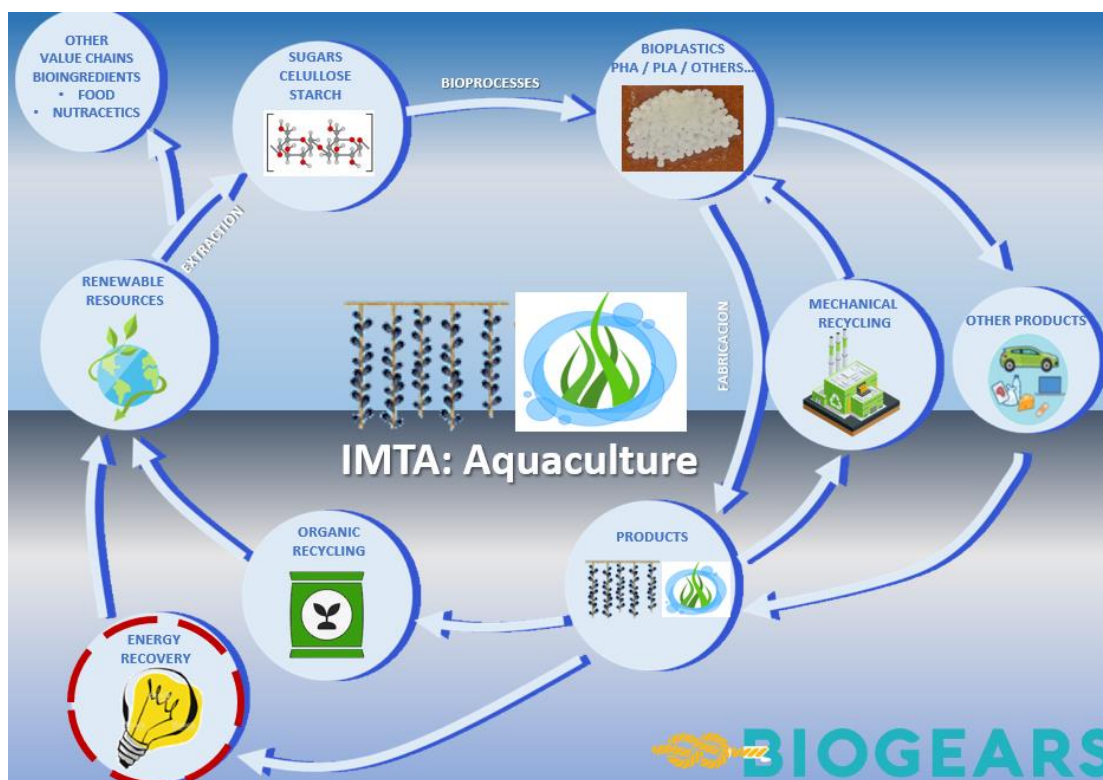


Figure 2. ABG value chain based on the aquaculture production of mussels and seaweed using biobased aquaculture ropes.

Main drivers that can promote a change towards the use of ABG or replacement of oil-based ropes by ABG have been identified in D2.3 Market Analysis, as influencing the change of aquaculture sector towards eco-friendly aquaculture practices:

1. FOOD SUPPLY & FOOD SECURITY
2. INCREASING POPULATION & SEFOOD DEMAND
3. FOOD QUALITY & HEALTH
4. ENVIRONMENTAL AWARENESS
5. ANIMAL WELFARE
6. FOOD SYSTEM:
7. NEGATIVE IMAGE & MEDIA ATENTION TO AQUACULTURE
8. POLICY
9. TECHNOLOGY INNOVATION
10. MARKET POTENTIAL
11. PRICE PREMIUM POTENTIAL

The above main drivers have been grouped in 4 general categories or general drivers and the objectives of survey have been set, in terms of responds needed on each driver under a category (Table 2).

Table 2. Relationship of main drivers, grouped in 4 categories (market/economic; sustainability; social/policy; technology), and objectives of the survey (information to be gathered).

DRIVERS	Information to be gathered
TECHNOLOGY	Activity sector, dedication
	Type of technology used
	Replacement of plastic ropes by ABG
	IMTA systems knowledge
	IMTA systems disposition (likeliness to install)
SUSTAINABILITY	Environmental impact (minimization of plastics)
	Biodegradability
	Recycling/compostability
SOCIAL/POLICY	Local value chains
	Biobased value chains (circular economy)
	Awareness of policies on plastic use
	Responsability of plastic producers
MARKET/ECONOMY	Intention to buy
	Price they will pay
	Product added value (certifications, labels, premium price, etc)
	Product safety (health)

3.2. Identification of target stakeholders

The 4 main driver categories group the type of responds that we need to get from the survey (Table 2) from different stakeholders in the value chain (Figure 2). In this way the results of the survey will allow us to distinguish the trends or the grade of predisposition of each stakeholder towards using ABG in Europe and promote a more eco-friendly aquaculture sector and the acceptance of the products, mussel and seaweed, produced with ABG.

The stakeholders identified as target stakeholders for the conduction of the survey presented in this deliverable are:

- **Aquaculture producers and activity goods and service suppliers**
- **Rope manufacturers**

Therefore, two different surveys are designed in this deliverable (D 2.1).

On a second approach other 2 surveys are expected to be conducted to estimate the use of ABG in the acceptance of the **aquaculture products**:

- Retail and consumers (subcontracting)
- General public (AZTI media distribution)

On a third approach, a networking event will be organized by ABG consortium during the 2nd International Conference on Circular Economy on Textiles and Plastics (15-16 December 2020, in Bruges, Belgium), where another survey will be elaborated and conducted to have the feedback of the stakeholders related with the value chain previous to the rope manufacturing, which will involve the following target stakeholders:

- Raw materials plastic
- Raw materials from natural resources (biomaterials, biopolymers)
- Compounders
- Yarn manufacturer
- Textile manufacturers

The results of all surveys will be used to achieve the main objectives of the survey (Task 2.2) and to give inputs to other WPs, as detailed in the section 1 of this deliverable. All these results will be analysed and discussed in a scientific paper (Deliverable 2.2), aiming to cover the trends and drivers of change of all main stakeholders involved in the whole value chain generated by the production of ABG and the implementation of their use in the European mussel and seaweed aquaculture sectors.

3.3. Questionnaire to AQUACULTURE stakeholders

In this section, the questionnaire for aquaculture stakeholders, aquaculture producers and activity goods and service suppliers (ancillary industry) is designed. A list of aquaculture stakeholders has been elaborated, specially focused on mussel and seaweed, including IMTA producers (irrespective of the species produced), although is to be confidential, as this deliverable is of public access.

The structure of the questionnaire has been designed considering the specific aim of Task 2.2 but keeping the global vision of the project and including sections that could support and complement the development of other tasks to give input to other WPs, as explained in section 1 of this deliverable, regarding the general objective of the survey within the project.

The questionnaire contains open-ended questions, close-ended questions, Likert-scores, multiple and single choice answer options, as well as spaces for additional comments. The different types of questions have been organized by content and structured into three main sections:

- Section 1: General questions
- Section 2: Activity specific questions
- Section 3: Additional information

In section I: general questions will be asked to build the profile of respondents, such as the activity geographical area and dedication or type of business activity in the aquaculture value chain.

In section II: questions related to information to be gathered on specific drivers identified for the shift towards the use of ABG and minimization of plastic gears and plastic use in offshore mussel and seaweed aquaculture, such as technology, sustainability, social/policy and market/policy (Table 3) will be asked:

In **Technology questions**, when a respondent is an aquaculture producer (already answered in Section I), the initial questions will be directed towards knowing the species they produce and the technology they use for it. Fish producers will be also included as their answers in questions of substitution/replacement of plastic gears by ABG can give an idea of acceptability of ABG by other aquaculture sectors, helping to minimize plastic use and the generation of marine litter by marine aquaculture. Additionally, questions regarding the general awareness and knowledge of IMTA production systems and sustainability will be asked to all aquaculture stakeholders, producers and good and services suppliers. In case of aquaculture producers, their intention or willingness to install an IMTA system will be also asked.

In **Sustainability questions**, respondents will be asked about the awareness of plastic use in aquaculture, as being mussel and seaweed ropes 100% of oil-source plastics, and their impact on marine environment. Also, about other options of gears, based on biobased materials, which are being implemented in other activity sectors they may be aware of, intending to be biodegradable and thus generating a lower environmental impact. Questions to address stakeholder's intentionality towards the substitution of conventional gears (100% oil-based plastic) by ABG will be asked, assessing the weight of drivers such as biodegradability, composability, price, or convenience on this decision.

In **Social/policy questions**, respondents will be asked about their awareness on new policies related to the plastic use in marine environments, which can be also in line with their awareness on the negative impact of plastics in the sea, and the new policy in development that can be applied to plastic producers (rope manufacturers) on their responsibility on the correct use of the plastics beyond their

end of life. Related also to policy and social wellbeing, respondents will be asked about their perception of the generation of circular economy and short local value chains that can promote jobs locally.

In **Market/Economy questions**, respondents will be asked about their willingness to buy and the price that they will pay for ABG. Regarding the willingness to buy, they will be asked about the drivers involved in their decision, such as; sustainability (minimization of plastic use in the oceans or promote a more sustainable and eco-friendly aquaculture), policy (awareness of new policy on plastic use in the oceans and after use responsibility), product quality and added value (premium price products, certifications, product safety-microplastics and relation with consumer's health issues). They will give a value to each driver (1 to 5) so that a ponderation of the drivers or weight on their decision-making can be assessed. Finally, as the last question, and expecting that they have all the benefits of ABG in mind, they will be asked to give an average price for the ABG (ranges of price will be presented as answers).

In section III: 1 general question for general perception on advantages and disadvantages of the use and implementation of ABG in European aquaculture will be asked.

The questionnaire has been structured in 20 total questions, being 17 of specific nature and importance for aquaculture producers and stakeholders to have a survey that can take around 10 minutes to answer, intending nor to be too long.

3.3.1. Questionnaire to AQUACULTURE producers and suppliers

BIOGEARS: SURVEY TO AQUACULTURE PRODUCERS AND SUPPLIERS

Presentation of the questionnaire:

Hello, this questionnaire is being distributed from EU_BIOGEARS project to the aquaculture sector, where you may work. BIOGEARS aims to fill the gap on aquaculture biobased gears (ABG) for mussel and seaweed aquaculture, by providing the European aquaculture sector with biobased, biodegradable ropes that are durable, marketable and fit-for-purpose, and hence have a highly reduced carbon footprint along the whole value chain. Thus, produced ABG aim to substitute the currently used 100% petrol based (non-recyclable) plastics gears, which can potentially contribute to marine litter generation and impact on the marine environment when not disposed of correctly. Therefore, aims to generate biodegradable ABG that can be introduced in land composting circuits and generate biomass and promote circular biobased economy. Finally, ABG aims to produce healthy and low-trophic aquaculture products, mussels and seaweed, boosting eco-friendly aquaculture by using IMTA (Integrated Multitrophic Aquaculture) and biobased value chains in Europe.

Section I: General questions

Q1: Which is your business activity segment in the aquaculture value chain?

(Select answer from Q1 list in Annex 1)

Q2: Which EU Country (EU-28) do you work in? (Select answer from Q2 list in Annex 1)

Section II: Activity specific questions

Technology questions: Only for aquaculture producers

Q3: Which species do you produce? (Select answer from Q3 list in Annex 1)

Q4: Which System/technology do you use for production? (Select answer from Q4 list in Annex 1)

Q5: Which type of culture do you practice? (Select answer from Q5 list in Annex 1)

Q6: Which type of gears do you use? (Select answer from Q6 list in Annex 1)

Q7: Which is the annual quantity of bags (units), nets (m) or ropes (m) (excluding main lines and mooring lines) used for production? (Select answer from Q7 list in Annex 1)

Section II: Activity specific questions

About: IMTA:

“**IMTA**”, Integrated Multitrophic Aquaculture, is a production system that integrates the production of vertebrate and invertebrate species and macroalgae. Cultivated organisms are fed aquatic species, like fish or shrimp, and species extracting the organic and inorganic matter from the water. Species extracting the organic matter (uneaten food and faeces) may be mussels, oysters, clams, sea urchins or polychaetes. Species extracting the inorganic matter, such as macroalgae, capture and use the inorganic nutrient wastes. In BIOGEARS project approach, IMTA allows the creation of more sustainable production systems because wastes of mussel production are valued as a resource for macroalgae rather than considered a burden or pollution. This contributes to environmental sustainability and a more efficient use of resources, while favouring economic diversification (product diversification, bringing company stability through risk reduction), and social acceptability (best management practices).

Q8: The implementation of IMTA systems can contribute to the sustainable development of Aquaculture? Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don’t agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Q9: The implementation of IMTA systems/productions, using environmentally responsible practices, can contribute to increasing the good perception and acceptability of the aquaculture products. Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don’t agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Q10: I will implement an IMTA system in your production site

Likert scale response

(1 – Don’t agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Sustainability questions

About Plastics: Numerous studies on the abundance of plastics debris, especially in the oceans, have established that plastic pollution is pervasive with even the remotest locations affected. While concentrations vary locally, plastic debris has been found in the Arctic, the Antarctic, uninhabited islands, and the deep sea. Plastics represent the majority of marine litter on the ocean surface, on beaches and on the sea bottom. According to AWI's Litterbase database, 73 % of all items collected in 523 studies from 3 565 locations are plastics. In relation to the marine litter generated by aquaculture, the amount of studies conducted is scarce and give insight on the contribution of fishing and aquaculture sectors, although not clearly dividing each contribution. Some studies have reported that the exposure of marine fish and invertebrates to non-biodegradable plastic resulted in oxidative stress, and the subsequent induction of lipid peroxidation. The transference of nanoplastics to fish through the food chain establishes a possible route of exposure to nanoplastics for humans.

Q11: Regarding the use of plastic in the marine environment and the negative impacts they cause to the marine ecosystems, Aquaculture, as a food producing sector, should be one of the first marine sectors to avoid the use of plastics. Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don't agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Q12: I think that the current aquaculture gears (100% made of plastic from fossil resources) should be substituted by gears (ropes, nets, lines) made of more eco-friendly materials? Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don't agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Q13: I will you use these eco-friendly gears (ropes, nets, lines) instead of the conventional (100% plastic)? (Select answer from Q13 list in Annex 1)

Social/Policy questions:

Q14: Have you heard of or are you aware of the policy in development related to the generation of a more sustainable and eco-friendlier aquaculture sector in Europe and the use of plastics in the sea? (Select answer from Q14 list in Annex 1)

Q15: I'm aware of the policy in development that is going to be implemented to producers of plastic items related to the extended producer responsibility about the correct use (disposal and management as plastic residue) of their products beyond their end of life. Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don't agree at all; 2 –Somehow agree; 3 – Agree; 4 – Agree a lot; 5 –Totally agree; NA – Missing answer)

Q16: The implementation of ABG or biobased ropes in mussel and seaweed European aquaculture can be a change factor or a driver for the generation of new biobased value chains and circular

economy in Europe (Figure 2 of this deliverable is added to illustrate the question). Please valuate in a score from 1 to 5.

Likert scale response

(1 – Don't agree at all; 2 – Somehow agree; 3 – Agree; 4 – Agree a lot; 5 – Totally agree; NA – Missing answer)

Q17: The use of ABG in European aquaculture can generate 'short' value chains (local or regional), tending to use biodegradable/compostable biomaterials for the manufacture of ropes (ABG) that can be disposed in land organic composting circuits and generate organic biomass for other local activities, thus generating also local jobs. For the generation of these local value chains please select the main drivers. (Select answer from Q17 list in Annex 1)

Market/Economy questions:

At the global level, since 2016, aquaculture has been the main source of fish available for human consumption, reaching a share of 52 percent in 2018 (FAO, 2020). In nominal terms, prices in the fishery and aquaculture sector are expected to rise in the long term up to 2030 due to a number of factors affecting demand (improved income, population growth and higher meat prices) and supply (stable capture fisheries production, slowing growth in aquaculture production, and cost increase for inputs of feed, energy and oil). In addition, the slowdown in China's fisheries and aquaculture production will stimulate higher prices in China, with repercussions on world prices. In turn, Europe is dependent on imports, from Asiatic countries and specially from China to reach the seafood demand. The higher prices at the production level, coupled with high demand of fish for human consumption, will globally stimulate an estimated 22 percent increase in the average price of internationally traded fish by 2030 relative to 2018 (FAO, 2020). High feed prices could also have an impact on the species composition in aquaculture, with a shift towards species requiring less feed, cheaper feed, or no feed (FAO, 2020).

Q18: Shellfish and algae production could increase to reach Europe's seafood demand, as being species requiring no feed (no fishmeal and fish oil requirement) and less energy and oil (less fossil fuel dependence) than other marine species, although in a sustainable way. For the development and expansion of mussel and algae aquaculture in Europe please select the main drivers. (Select answer from Q18 list in Annex 1)

Q19: To boost consumer's good health and wellbeing and support responsible production and consumption in the food system, sustainable (environmental, social, and economic) and resource efficient food production systems and industry are identified among the Sustainable Development Goals. In this context, ABG could be used as new tools to track the change towards a sustainable aquaculture development and therefore of the food system. (Select answer from Q19 list in Annex 1)

Section III: Additional information**Many thanks for all your contributions!**

Q20: This question is an open answer question to know the general opinion of respondents on the advantages or disadvantages of the implementation of ABG in European aquaculture and market.

3.4. Questionnaire to ROPE MANUFACTURERS

A questionnaire for rope manufacturers, already identified in Deliverable 2.3, has been elaborated to be conducted on personal interviews by phone calls or using online teleconference tools. The design of the questionnaire has been done to explain, in brief, the general objectives of the project and of the survey, also explaining confidentiality terms, the number of questions and the proximate duration of the survey. Additional information will be also appreciated and introduced in the comments section, at the end of each driver category where the questions are grouped, such as: market/economic, sustainability, social/policy and technology (Table 2).

3.4.1. Questionnaire to ROPE manufacturers

ABG: SURVEY TO ROPE PRODUCERS

BIOGEARS: is a new innovative project funded by the European Union under the European Maritime and Fisheries Fund that is set to develop aquaculture biobased gear solutions (ABG) for the creation of an eco-friendly offshore aquaculture sector using a multitrophic approach and new biobased value chains. BIOGEARS will foster an eco-friendly aquaculture industry with the results of the project creating a biobased value chain under the EU Bioeconomy Strategy framework.

OBJECTIVE: The objective of this survey is to find out, from the point of view of rope manufacturers, the potential of implementing more sustainable production systems, such as **ropes made from organic materials**, aiming to be biodegradable/compostable.

Confidentiality: The response of the survey will be presented jointly assuring the confidentiality of the respondents. Results of this survey will be used only in BIOGEARS project. I agree that the conversation is recorded.

Questionnaire: The questionnaire is made up of 40 questions related to the policy and regulation, sustainability, economy and market. The estimated duration of the interview is 20 min.

COMPANY GENERAL DATA	ANSWER
Name of the company:	
Number of workers:	
Main activity:	
Other activities:	
Location:	
Main clients (specify the country of the companies):	
Others	
Comments	

MARKET/ECONOMY	ANSWERS
Q1: For the mussel's production, how many tn/metres of ropes do you sell in Europe? <ul style="list-style-type: none"> - On-growing ropes - Collector ropes 	
Q2: For the seaweed production, how many tn/metres ropes do you sell in Europe?	
Q3: How many ropes (tn/metres) do you sell in third countries?	
Q4: Is the rope demand increasing, decreasing or stable? <ul style="list-style-type: none"> - Mussels - Seaweed - By country 	
Q5: There is any aquaculture producer that have already required 'bio' ropes (ABG) How many metres? Which country it is from? For which aquaculture production sector?	
Q6: Do you produce any kind of 'bio' or 'compostable' rope? <ul style="list-style-type: none"> - How many (tn/m)? - Countries? - What bio – material can be used? - Aquaculture sector: species (mussel, seaweed, others) and technology (longline, raft, others) 	
Q7: What is the price of the conventional rope for mussel production? (EUR/tn or EUR/metre)	
Q8: What is the price of the conventional rope for seaweed production? (EUR/tn or EUR/metre)	
Q9: What is/may be the price of an ABG for mussel production? (EUR/tn or EUR/metre) <ul style="list-style-type: none"> - On-growing ropes – Specify bio - material - Collector ropes – Specify bio - material 	
Q10: What is may be the price of an ABG for seaweed production? (EUR/tn or EUR/metre) – Specify bio - material'	
Q11: What is the approximate cost of producing a conventional rope? (EUR/tn or EUR/metre) for mussel and seaweed	
Q12: What is the approximate cost of producing an ABG? Increase of cost over the traditional rope bases? [in % or in a range] <ul style="list-style-type: none"> -By type of rope or raw material. 	
Q13: What is/may be the Increase of production cost of an ABG over the conventional rope basis? [increase in % or in a range] <ul style="list-style-type: none"> - By type of rope or raw material 	
Q14: What maximum price could a mussel producer pay for an ABG? <ul style="list-style-type: none"> Longline/Country <ul style="list-style-type: none"> - On-growing ropes - Collector ropes Raft/Country <ul style="list-style-type: none"> - On-growing ropes - Collector ropes Bottom/Country <ul style="list-style-type: none"> - Collector ropes 	
Q15: What maximum price could a seaweed producer pay for an ABG? <ul style="list-style-type: none"> -Specify by type of rope and country: 	
Q16: What is de durability of the ropes (months) for mussel production? <ul style="list-style-type: none"> Longline/Country <ul style="list-style-type: none"> - On-growing ropes - Collector ropes Raft/Country <ul style="list-style-type: none"> - On-growing ropes - Collector ropes Bottom/Country 	

- Collector ropes	
Q17: What is the durability of the ropes (months) for seaweed production? Longline/Country - Specify type Raft/Country - Specify type Others/Country - Specify type	
Q18: What are the advantages of an ABG? (open answer)	
Q19: What are the disadvantages of an ABG? (open answer)	
Q20: If the certification/labelling of aquaculture products will consider the materials of the rope, do you think that it will affect to the demand of ABG for the aquaculture sector?	
Comments	

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

ENVIRONMENTAL SUSTAINABILITY:	1	2	3	4	5	NA
Q21: Ropes for the mussel's production in aquaculture are sustainable.						
Q22: Ropes for the seaweed production are sustainable.						
Q23: Sustainability of mussel's production can be improved by using ABG.						
Q24: Sustainability of seaweed production can be improved by using ABG						
Q25: The demand of 'sustainable' ropes is increasing.						
Q26: The 'sustainability' of the ropes can be improved in (give a value to each): - Raw materials - Additives - Compounds - Production process - The use of the ropes and end of life use - Others (specify)						
Q27: Certifications of sustainability for aquaculture products (mussels and seaweed) should consider the materials of the ropes. (Example: ASC - https://www.asc-aqua.org/)						
Q28: In my opinion, at the end on the life of the rope the following concepts are important (give a value to each): - Recycling potential - Biodegradability - Composability						
Comments						

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

SOCIAL / POLICY / REGULATION: Several EU and national policies and initiatives upon aquaculture ² :						
<ul style="list-style-type: none"> ▪ Common Fisheries Policy ▪ European Green Deal ▪ Farm to Fork Strategy ▪ Marine Litter Strategy ▪ European Strategy for Plastics in a Circular Economy <p>The circular economy is increasingly being promoted:</p> <ul style="list-style-type: none"> ▪ 2015: EU Action Plan on Circular Economy ▪ 2018: Circular Economy Package ▪ 'Basque Strategy on Circular Economy 2030'. ▪ Extended producer responsibility³ 						
	2	3	4	5	NA	
Q29: I am aware of all the regulations that affect ropes for aquaculture.						
Q30: I know what happens with the ropes when they arrive to the end-of-life.						
Q31: I am aware of the future application of the extended producer responsibility.						
Q32: I know how to face to extended producer responsibility.						
Q33: I know what it is the Circular Economy.						
Q34: Currently I apply Circular Economy to rope production.						
Q35: Circular Economy will impact on the type of ropes used in the aquaculture, driving a change in rope production						
Comments						

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

TECHNOLOGY	1	2	3	4	5	NA
Q36: The mussel sector's readiness to change towards using ABG. Longline <ul style="list-style-type: none"> - Country 1 - Country 2 - Country 3 - ... Raft <ul style="list-style-type: none"> - Country 1 - Country 2 - Country 3 - ... Bottom <ul style="list-style-type: none"> - Country 1 - Country 2 - Country 3 - ... 						
Q37: The seaweed sector's readiness to change towards using ABG. <ul style="list-style-type: none"> - Country 1 - Country 2 - Country 3 - ... 						

² https://ec.europa.eu/fisheries/cfp/aquaculture/policy-areas_es

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019L0904&from=EN>

Q38: I know what the IMTA system production is.						
Q39: IMTA producers' readiness to change towards using ABG						
Q40: The main characteristics of the ropes in the future should be: <ul style="list-style-type: none"> - Recycling potential - Biodegradability - Composability - Others 						
Comments						

3.5. Survey distribution

The questionnaire to aquaculture stakeholders will be designed using Survey Monkey (<https://www.surveymonkey.com/>), a specific software dedicated to the design, distribution, and collection of information through online questionnaire surveys. Therefore, the distribution of this questionnaire will be done using a specific link to monkey survey, which respondents will directly access to provide their feedback. The questionnaire will be open for completion in ABG project website, social media and by sending emails to personal networks. The questionnaire will be conducted to European aquaculture stakeholders already classified by species produced, production systems and environments in Task 2.1, and to ancillary industry by distributing an online survey in aquaculture producer associations (general scope), mussel producer associations, technology platforms such as EATiP (European Aquaculture Technology and innovation Platform) and its national mirror platforms gathering aquaculture industry and research associations, research bodies, certifications agencies and administrations at local-regional, national and European level.

The questionnaire to rope manufacturers will be conducted by personal interviews using telco tools. Those stakeholders were already identified in the D2.3 Market Analysis.

3.6. Analysis and interpretation

The use and implementation of ABG will be analysed by stakeholder, aquaculture stakeholders and rope manufacturers in this deliverable, and by driver category (Table 2), pondering the impact of each driver category on the answers. By this analysis, the stakeholders in the value chain more and less prone to drift the change towards the use of ABG will be identified, together with the drivers of change. The results of the analysis will help to identify strategies to unlock the potential of use of ABG by aquaculture stakeholders (including rope stakeholders) to finally boost the development of an eco-friendly aquaculture and also to impact on developing policies by giving recommendations if required.

3.7. Dissemination of results

The results of the surveys will be disseminated in BIOGEARS project media communication and dissemination tools, such as: website, twitter and LinkedIn accounts, newsletter, and press releases and in aquaculture related conferences. The results of the surveys included in this deliverable and of the surveys to be conducted to Retail and consumers, public and to textile sector stakeholders will be put together and discussed in a scientific paper (Deliverable 2.2). The scientific paper will be published in an open access journal to ensure the transferability of results to stakeholders.

4. Expected results

The expected results of the survey is to: (1) Complement and develop the market analysis of ABG; by defining market scenarios for biobased ropes, by estimating their potential price and market share in the framework of the bioplastic market evolution, and the intention of producers to buy ABG and shift towards eco-friendly aquaculture (D2.3). This analysis will be linked to O2 (D 2.2), (2) Estimate the minimization of plastic use in the European aquaculture sector, by the incorporation of biobased ropes to the market, addressed to O3 (Task 2.3), (3) Give key information to other WPs regarded that the intention of producers and aquaculture stakeholders to buy ABG instead of oil-based ropes will give valuable inputs for the improvement of the design and manufacturing of new prototypes (WP3) and the definition of strategies to scale up their production and implementation for the development towards an eco-friendly European aquaculture sector (WP6), (4) Actor's engagement to the project: by interaction and contact with aquaculture stakeholders to conduct the survey, and to keep in contact with them for other activities or events organised with stakeholders, such as a workshop and a networking event, (5) Definition of new value chains based on the use of biobased gears in aquaculture: by identifying the actor's and stakeholders on the aquaculture sector and gathering information from them will give inputs to WP6 and WP7 (linked to Task 6.1, Task 6.2, Task 7.1 and Task 7.2), (6) The transference of the results to stakeholders: the results of the survey will be published in a peer reviewed scientific journal specialised in aquaculture as the future trends of the sector towards a biobased and eco-friendly aquaculture, linked to O2 (Task 2.2). This will be an open access publication to assure the transference of the results to the Aquaculture stakeholders and to other stakeholders and actors involved in marine bioeconomy sectors, such as fisheries and maritime gear manufacturers (D2.2), and (7) support the implementation of results and replicability the interaction with stakeholders will be useful for the dissemination and transference of results beyond the lifetime of the project (linked to Task 7.1 and Task 7.2), thus for the implementation of the results obtained in other European regions by replicating a Blue Lab scenario for tracking eco-friendly aquaculture, with new biobased value chains under the Bioeconomy Strategy framework.

5. Annexes

5.1. ANNEXE I: Questionnaire to aquaculture stakeholders

Questionnaire options for the different questions. Only those questions for which a set of options are reported, are included in this annex.

Q1: Business activity sector

Aquaculture Producer	Technology supplier
Academic/Research	Goods supplier
Association/Non profit	Regulatory and policy makers
NGO (Non-governmental Organization)	Storage
Certification agency	Transportation
Consultant	Distributor
Finance	Wholesaler
Insurance	Packaging/repackaging
Legal	Processing
Government	Retailer
Regulatory and policy makers	HORECA (Hotels, Restaurants and Catering)
Media and press	Consumer
	Others

Q2: EU Country (EU-28)

Belgium	Bulgaria	Ireland	Poland
Bosnia-Herzegovina	Croacia	Italy	Portugal
Bulgaria	Cyprus	Kazakhstan	Romania
Croacia	Denmark	Kosovo	Russia
Cyprus	Estonia	Latvia	Slovakia
Denmark	Finland	Lithuania	Slovenia
Estonia	France	Malta	Spain
Albania	Georgia	Monaco	Sweden
Azerbaijan	Germany	Montenegro	Turkey
Belgium	Greece	Netherlands	Ukraine
Bosnia-Herzegovina	Iceland	Norway	United Kingdom

Q3: Species produced

Multiple choice answer:

Fish	Mollusc	Algae
Salmon (<i>Salmo salar</i>)	Mediterranean mussel (<i>Mytilus galloprovincialis</i>)	<i>Ascophyllum nodosum</i> ,
Trout (<i>Salmo trutta</i>)	Blue mussel (<i>Mytilus edulis</i>)	<i>Chondrus crispus</i> ,
Rainbow trout (<i>Oncorhynchus mykiss</i>)	Other mussels (<i>Mytilus</i> sp.)	<i>Fucus</i> sp.
European Sea bass (<i>Dicentrarchus labrax</i>)	Flat oyster or European flat oyster (<i>Ostrea edulis</i>)	<i>Himanthalia elongata</i> ,
Sea bream (<i>Sparus aurata</i>)	Japanese oyster or Pacific cupped oyster (<i>Crassostrea gigas</i>)	<i>Laminaria hyperborea</i> ,
Bluefin tuna (<i>Thunnus thynnus</i>)	Japanese carpet Shell (<i>Ruditapes philippinarum</i>)	<i>Laminaria digitata</i> ,
Meagre (<i>Argyrosomus regius</i>)	Scallops (<i>Pectinidae</i>)	<i>Palmaria palmata</i> ,
Red porgy (<i>Pagrus pagrus</i>)	Other shellfish	<i>Porphyra umbilicalis</i> ,
Turbot (<i>Scophthalmus maximus</i> or <i>Psetta maxima</i>)		<i>Sachcharina latissima</i>
Other marine fish		<i>Ulva</i> sp.
		Other seaweed

Q4: System/technology used for production

Multiple choice answer:

Cages
Suspended longline
Suspended rafts, tables
On-bottom racks
Bouchots
Bottom

Q5: Type of culture

Single choice answer

Monoculture
Polyculture
IMTA

Q6: Type of gears
(This question is NOT available for those with choice CAGES)

Multiple choice answer:

Ropes
Nets
Bags

Q7: Which is the quantity of ropes (m) used for production, excluding main lines and mooring lines?

(This question is NOT available for those with choice CAGES, nor NETS or BAGS)

Single choice answer

1,000-5,000
5,000-15,000
15,000-25,000
25,000-35,000
35,000-45,000
45,000-55,000
55,000-65,000
65,000-75,000
75,000-85,000
> 85,0000

Q13: I will you use these eco-friendly gears (ropes, nets, lines) instead of the conventional (100% plastic). Please evaluate the main drivers for the use of ABG:

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

Drivers/score	1	2	3	4	5	NA
I will use them because they do not impact as negatively on the marine ecosystem as the conventional ones (100% plastic) if they are lost or fall on the seabed.						
I will use them because they are made of biomaterials and biopolymers that come from natural resources						
I will use them because they are biodegradable/compostable at their end-of-use and promote circular economy						
I will use them because they promote more eco-friendly aquaculture regardless their price						
I will use them because they promote more eco-friendly aquaculture although at a convenient price						

Q14: Have you heard of or are you aware of the policy in development related to the generation of a more sustainable and eco-friendlier aquaculture sector in Europe and the use of plastics in the sea?

Multiple choice answer:

Common Fisheries Policy
European Green Deal
Farm to Fork Strategy
Circular Economy Strategy
Marine Litter Strategy
European Strategy for Plastics in a Circular Economy

Q17: The use of ABG in European aquaculture can generate 'short' value chains (local or regional), tending to use biodegradable/compostable biomaterials for the manufacture of ropes (ABG) that can be disposed in land organic composting circuits and generate organic biomass for other local activities, thus generating also local jobs in other activities than aquaculture. Please evaluate the main drivers for the generation of local/regional value chains:

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

Drivers/score	1	2	3	4	5	NA
Local industry and administration cooperation are necessary for the generation of local/regional aquaculture value chains and jobs						
Local/regional availability and/or development of biobased materials for the manufacturing of ABG for aquaculture						
Local/regional administrations can support circular bioeconomy generation by giving incentives to industry						
Local/regional policy supporting Farm to Fork Strategy can shorten the value chain related to the generation of local aquaculture products for food safety						
Local/regional policy supporting plastic minimization and circular biobased strategy can boost circular bioeconomy by the development of ABG						
Local/regional consumer's demand on sustainable and healthy seafood (nutritive and using biobased ropes which are biodegradable and compostable that can avoid health issues related to toxic effects of microplastics) can boost eco-friendly aquaculture						

Q18: Shellfish and algae production could increase to reach Europe’s seafood demand, as being species requiring no feed (no fishmeal and fish oil requirement) and less energy and oil (less fossil fuel dependence) than other marine species, although in a sustainable way. For the development and expansion of mussel and algae aquaculture in Europe please select the main drivers.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neither agree nor disagree; 4 – Agree; 5 – Strongly Agree; NA – Missing answer)

Drivers/score	1	2	3	4	5	NA
Shellfish and algae production could increase to reach Europe’s seafood demand by using eco-friendly production systems, including IMTA (Integrated Multitrophic Aquaculture).						
Shellfish and algae production could increase to reach Europe’s seafood demand by using gears (ropes) that minimize the use of plastic in the sea.						
The use of biomaterials that are biodegradable/compostable to produce aquaculture gears (ABG) for mussel and algae production can be an alternative to minimize plastic use and marine litter generation from aquaculture and promote circular economy by inland management of ropes in organic composting.						
The use of biomaterials (biodegradable/compostable) to produce ABG (ropes) and their correct management after the end of life (inland organic composting) could be incorporated as a good practice in the minimization of plastic use in the production of mussels and algae in aquaculture labels, brands and certifications.						
The use of biomaterials (biodegradable/compostable) to produce ABG (ropes) and their use in aquaculture could give added value to aquaculture products, such as mussels and algae, including their production in IMTA systems, as being eco-friendly, nutritive and safe (produced without toxic plastics).						
The use of biomaterials (biodegradable/compostable) to produce ABG (ropes) and their use in aquaculture could give added value to aquaculture products, such as mussels and algae, as price premium products or reaching a higher market, as being eco-friendly, nutritive and safe (produced without toxic plastics).						

Q19: To boost consumer’s good health and wellbeing and support responsible production and consumption in the food system, sustainable (environmental, social and economic) and resource efficient food production systems and industry are identified among the Sustainable Development Goals. In this context, ABG could be used as new tools to track the change towards a sustainable aquaculture development and therefore of the food system. Please tell us what your willingness will be to buy ABG and the potential price you will pay for them. Select at least one statement from Willingness and one from Price:

Multiple choice answer:

WILLINGNESS	I will use them regardless their price because they promote eco-friendly aquaculture and healthy aquaculture products for society
	I will use them at a convenient price because they promote eco-friendly aquaculture and healthy aquaculture products for society
	I will use them only if they are subsidised because they promote eco-friendly aquaculture and healthy aquaculture products for society
PRICE	I will use them and pay 5-10% more for ABG than for conventional aquaculture ropes
	I will use them and pay 15-20% more for ABG than for conventional aquaculture ropes
	I will use them and pay > 20% more for ABG than for conventional aquaculture ropes

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Work Participants	ITSASKORDA, AZTI			

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