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Promoting the blue circular economy of the Aquaculture value chain in Tunisia

Mapping report of the aquaculture value chain actors
Analysis and potential areas of circular development

www.switchmed.eu

Dr. Mohamed S. Azaza (INSTM) / Prof. Dr. Harry Palm, Dr. Adrian Bischoff-Lang (Steinbeis)
Martin Schüring (ttz Bremerhaven)

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Disclaimer

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1. Reminder of the Objectives of the SwitchMed Programme

The SwitchMed initiative, funded by the European Union and implemented by UNIDO, aims to stimulate the creation of new business opportunities and job creation while reducing the environmental impacts of existing economic activities in the south of the Mediterranean. SwitchMed is part of the continuity of the results of the first phase to support and further intensify the transition to sustainable consumption and production practices (SCP: Sustainable and Cleaner Production) that contribute to a green and circular economy in the region.

The integration of the circular blue economy component within SwitchMed in 2020 aims in particular to contribute to the preservation of marine and coastal ecosystems in the southern Mediterranean. The application of SCP practices, including the UNIDO TEST methodology, to economic activities related to marine and coastal areas is crucial in efforts to develop the concept of a blue economy in the Mediterranean region.

The approach consists of stimulating the development of industrial projects oriented towards the blue economy to reduce the negative environmental impact on the marine ecosystem (depletion of natural resources and pollution), as well as to increase the efficiency and competitiveness of the sectors established and emerged from blue economy.

To reach this goal, the SwitchMed project will proceed in several phases through:

- Identifying projects / initiatives with high potential for sustainable development and in line with Tunisia's sectoral priorities,
- Implementing a number of pilot projects by demonstrating via the TEST methodology and / or promoting the circular economy via innovative technologies and finally by
- Disseminating results and best practices to expand at the national level.

As part of this first phase, scheduled for 2021, the project will focus on carrying out an in-depth study of the aquaculture value chain in Tunisia, in relation with the key players in the industry, to analyse the regulatory and market barriers, the potential for optimization to reduce the environmental impact of industrial sites as well as studying innovative technology transfer opportunities (SMART) in the implementation of circular solutions. Particular attention will be paid to national flows to propose an analysis of scenarios and alternative business models aimed at their valuation and the creation of added value at national and local level.

This study is part of the SwitchMed II program and includes a value chain analysis of the aquaculture sector in Tunisia. Marine fish production and processing can be considered having future potential in the food production industry. Switched is a key action carried out under the EU-funded regional cooperation with the Mediterranean region.

The integration of a blue economy component within the second phase of SwitchMed II shall contribute to preserving healthy marine and coastal ecosystems and ensure the continuous delivery of goods and services for present and future generations. These principles are to be established and advanced in the form of 4 – 5 pilot projects, which shall be a major outcome of this study.

Aquaculture is a very promising activity within the emerging blue economy sector, being currently the fastest growing food-production sector with an annual expansion rate of 8 % in the last three decades, now contributing to ~ 44 % of all seafood. However, aquaculture is still an underutilized technology in the countries of the Southern Mediterranean like Tunisia. The current project shall identify key areas for optimisation towards SCP.

The major outcome of this study will be the definition of 4 – 5 pilot projects as a result of the survey and the identification of the key areas. These pilot projects are intended to set an example for the entire sector on the way to more sustainable and SMART production methods.

Based on a compilation and evaluation of the current state-of-the-art of the Tunisian aquaculture sector, a representative survey among the key players within the sector will be carried out to identify the above-mentioned key areas.

2. Methodological Approach

2.1. Involvement of national stakeholders

The national stakeholders are involved by the following measures:

- Pre-opening event, opening event and Atelier Technique
- Bilateral consultations (see 2.c)
- A quantitative 2-step-survey approach (see 2.d)

The quantitative approach is carried out by representative sampling, considering the following criteria:

- Belonging to the identified priority sub-sectors
- Geographical representation
- Representativeness in terms of company size
- Potentially important data quality

Companies were selected by these criteria and directly addressed.

2.2. Selection of priority sub-sectors

The analysis of the different sub-sectors of the aquaculture sector according to the above-mentioned criteria highlights four priority sub-sectors:

- Finfish aquaculture in net cages for Seabream, Seabass and Meagre (12 companies)
- Aquafeed (3 companies)
- Finfish Hatcheries (2 Hatcheries)
- Shellfish (6 companies)

These sub-sectors are not isolated. There are various interactions as shown in figure 1.

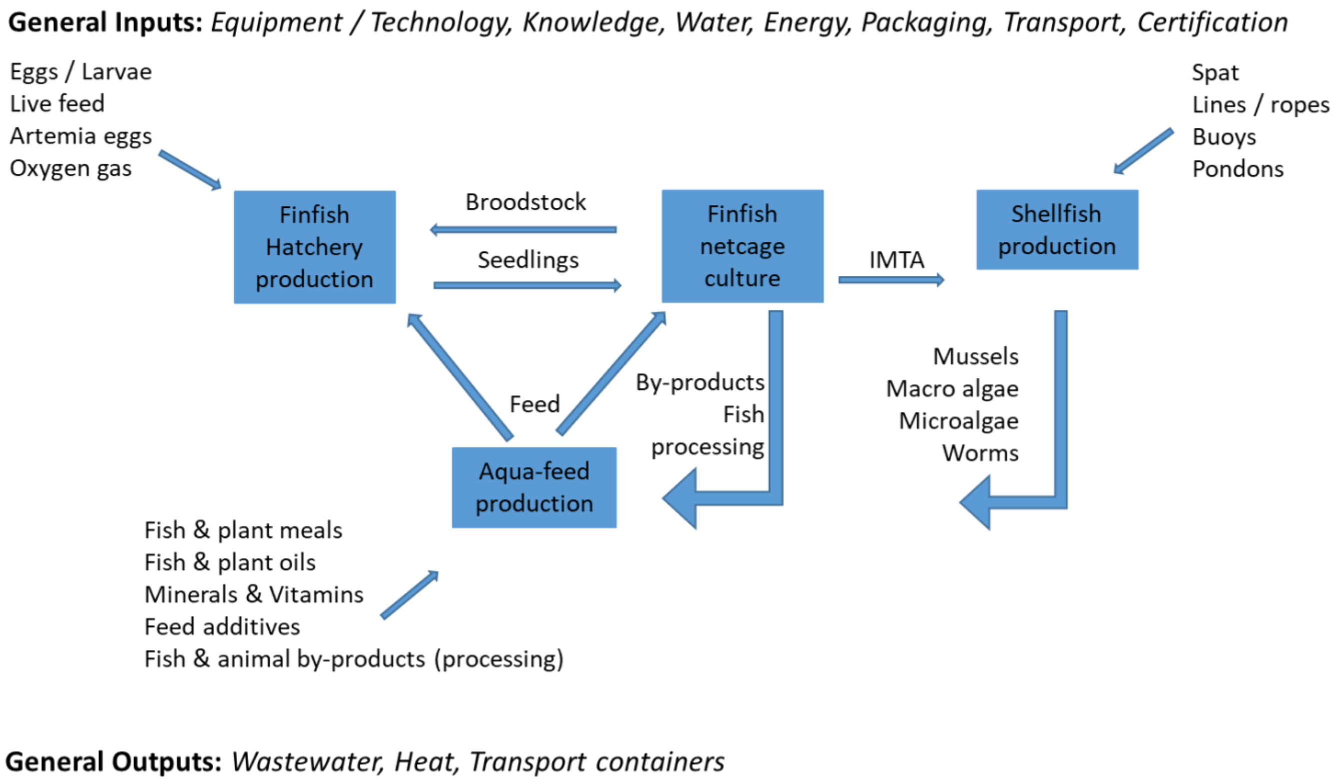


Figure 1: Schematic of the interactions between the different subsectors of the aquaculture sector

The survey focused particularly on the following issues:

- Potential production increase
- Improving feed conversion efficiency and feed management (reduce FCR)
- Diversification of species
- Reduction of the impact on the environment
- Reduction of feed costs
- Hatchery development
- Energy use
- Potential application of new technologies

2.3. Bilateral consultations

Besides the 3 official meetings (Pre-Opening event, Atelier Technique, opening event) a bilateral consultation with the general directorate of fisheries and aquaculture (DGPA) enabled access to the aquaculture data base to check some data collected from aquafarms through the questionnaire (Phase II). In fact, this consultation allowed us to adjust some data that appeared skewed in a way that is regarded as inaccurate.

The official meetings constitute an excellent opportunity to discuss with all stakeholders of all subsectors and all implicated partners such as administration, research, professional institution, extension services, technical institution, and NGOs. This allows us to tailor the questionnaire based on the relevant interaction with participants. The most relevant points were considered in the elaboration of the questionnaire. Following are the most relevant key take-aways from the meetings in terms of thematic priorities:

- Increasing stakeholder conflicts in the coastal regions, negatively affecting public awareness of the aquaculture sector
- Price dependency of the local products on the international markets
- Low prices on the local markets with less competitiveness to regular fisheries products and therefore high production costs and low income for the farms
- Increasing problems with fish diseases and parasites
- Increasing environmental issues
- The aquaculture sector was not able to develop sufficient hatchery capacities and local feed sources, both seen as the main cost driving factors that limit income and benefits inside the sector.
- SMART Technology use is at low level in the aquaculture sector

2.4. Surveys

2.4.1. Preliminary survey

The preliminary survey was addressed to all farms and companies of all subsectors. This allows the mapping of the aquaculture sector with the main shortcoming and gaps. Also, through this preliminary survey, we selected the most relevant aquafarms and companies for the deeper interview campaign.

The results of this survey were presented in an official meeting to have feedback of the stakeholders and we take into account all relevant points for the second survey.

2.4.2. Interview campaign

For the interview campaign, we proceeded by the selection approach:

- For the finfish subsector, we selected 12 aquafarms, 11 out of 12 interviewed farms participated (91.66%). For the selection two main criteria were taken into account: geographical position and production capacity.
- For the aquafeed companies, we selected 3 manufactures and finally, 2 participated in the survey.
- For the hatcheries, currently only one hatchery is in activity, which participated in this survey.
- For the shellfish subsector, 8 farms were selected for the 2nd phase, 5 shellfish farms (i.e., 62.5 %) participated

The average participation rate of the selected companies is 79 %, which gives a representative overview of the whole sector.

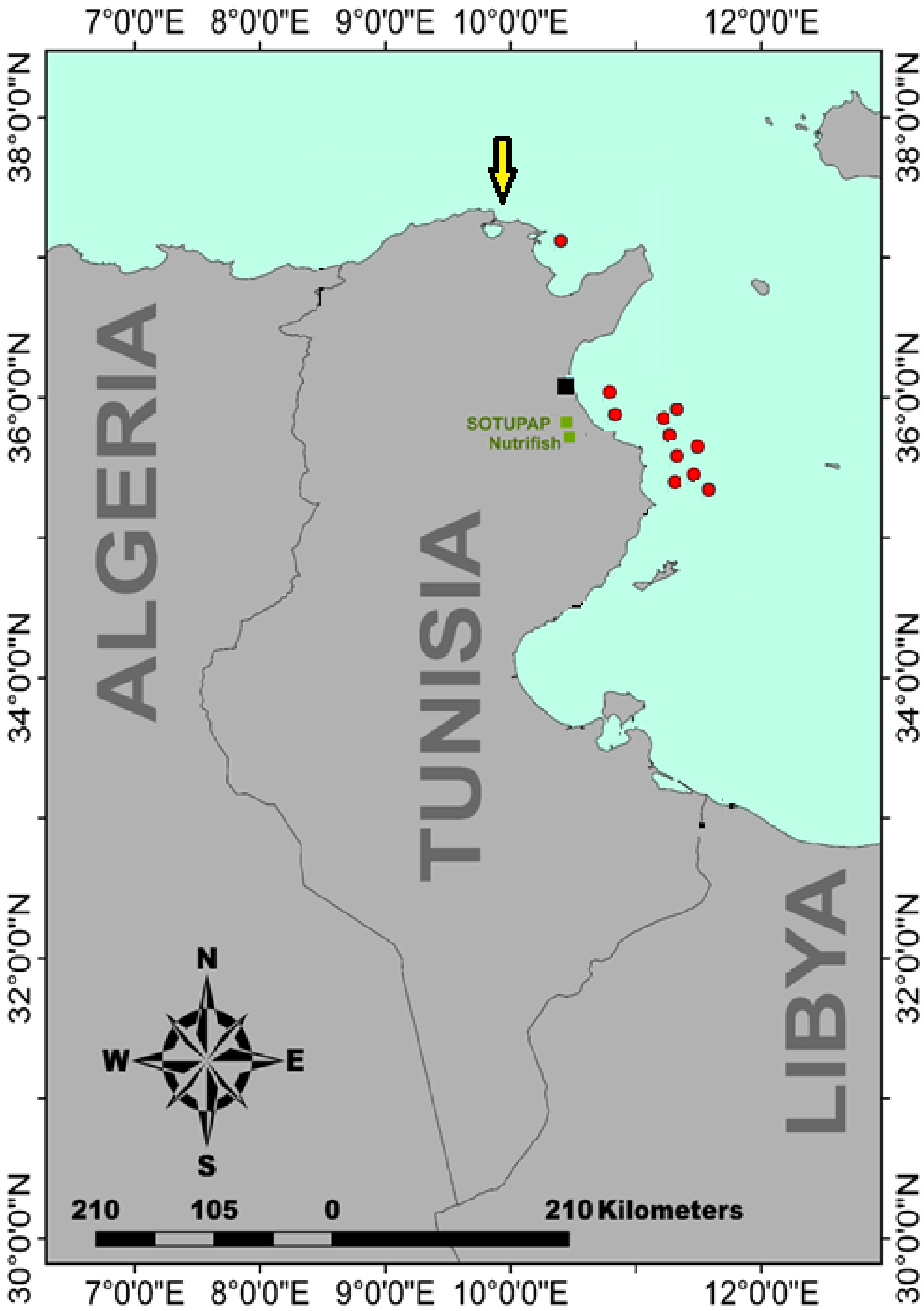


Figure 2 The map of geographical distribution of the surveyed companies

3. Survey Results by subsector

3.1. Fish Farming

Currently there are 25 productive marine fish farms in Tunisia. Following the preliminary questionnaire of the first phase, we selected 12 finfish farms for the 2nd Phase. The criteria for choosing these farms were:

- Their geographical position: we have chosen companies farms located in all production areas (North and East).

- Their production capacity: we have chosen aquaculture farms based on their production capacities (small, medium, and large production capacity) to cover all categories.

The selected finfish farms were contacted by e-mail and they received the questionnaire. After a month of data collection, only one farm, out of 12, did not participate in this assessment. Thus, the participation rate is 91.66% (11 from 12 interviewed farms). Since some of the responses from a few farms were not sufficiently clear or missing, they were contacted by telephone/e-mail and/or direct interview, to improve the accuracy of their responses.

The 12 selected finfish farms have a total production capacity of around 17850 tons. They are classified, in terms of production capacity, into three groups as follows: (i: from 400 to 800 tons, ii: from 1000 to 1600 tons and iii: from 2000 to 3500 tons). The production capacity of these farms represents 78 % of actual Tunisian Finfish production.

Table 1. Characteristics of the selected aquafarms.

Finfish Farm	Abbreviation	Production Capacity
Sea Food	AF1	400
Pirate Fish	AF2	750
STEP	AF3	800
Porto Farina	AF4	1000
TTF	AF5	1300
AquaSud	AF6	1500
Hanchia Fish	AF7	1600
Aquafish	AF8	2000
Ruspina	AF9	2500
Rafaha	AF10	2500
Prima Fish	AF11	3500

The analysis of average annual production data over the past 3 years for the interviewed finfish farms (Fig. 1) showed that only 3 out of 11 farms have reached their potential production capacities (AF1, AF2, AF5). However, the remaining other farms (8) their means annual productions vary between 25 to 87.5% of their potential production capacities.

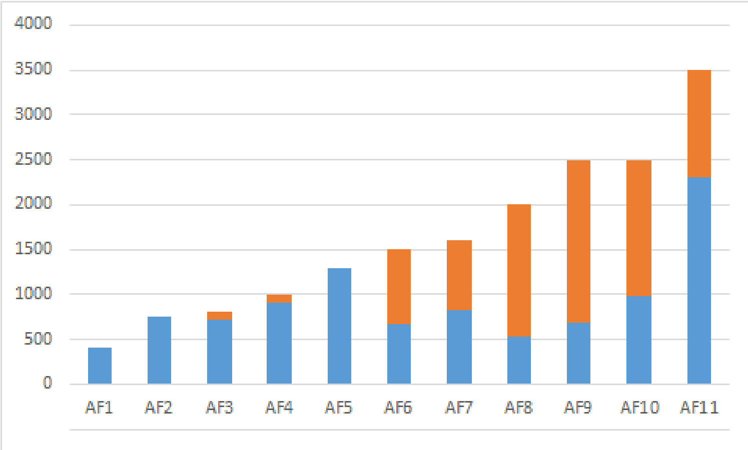


Figure 3. Annual average production Over the 3 last years (Blue bars) versus Production capacity of the interviewed finfish farms (Orange bars).

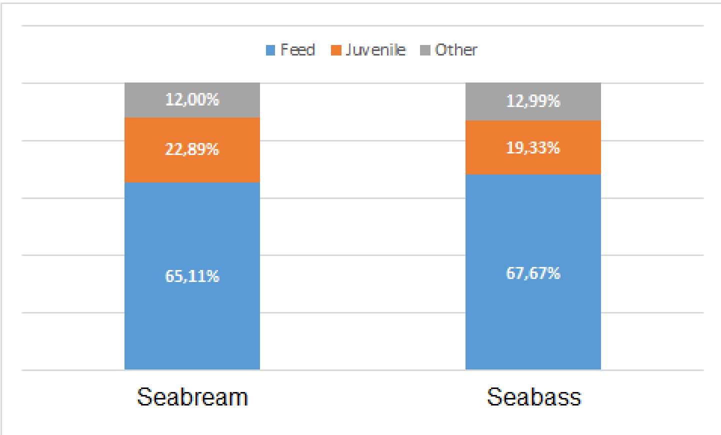


Figure 4: Variable costs of seabream and seabass production

As indicated by Figure 3, we noticed that the production over the last few years of the interviewed farms is below their potential production capacities.

Figure 4 demonstrates the repartition of the variable costs of seabream and seabass production. Gathered data demonstrate that feed represents significant part of the production cost and can reach 65 and 68 %, respectively. for seabream and seabass. The strategy of aquaculture farms in the short and medium term is of utmost importance. The results are shown in the following figure (Fig. 5).

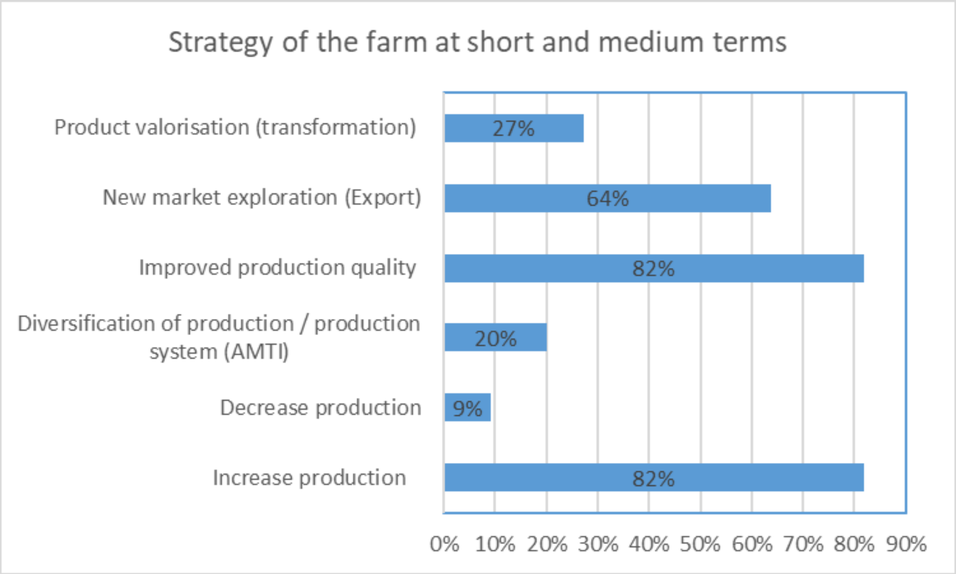


Figure 5: Strategy of the aquafarms at short and medium terms

As indicated in this figure, increased production and improved production quality are the top priorities of interviewed farms and thus constitute the main strategic tasks in short and medium terms, followed by new market exploration.

The interviewed farms elucidate that the main factors limiting the expansion of their business are:

- High investment cost (indicated by 63.63 % of the interviewed aquafarms)
- Limitation of local market capacity and competition in foreign markets
- High cost of inputs
- Production cost versus selling price

Finfish production is based on two main inputs: Aquafeed and Juvenile. Figure 4 indicates their origins (imported or local produced). Regarding Aquafeed (Fig 6 A), results indicate a decreasing tendency over the last years of the imported aquafeed although the imported quantity is still high (48.71 % on 2020).

For the juvenile, results (Fig. 6 B) demonstrate that over the last years (2016-2020) most of the needed juvenile is imported and reached 87.45 %. However Tunisian hatcheries contribute no more than 13 % (year 2020).

Since the most inputs are not produced locally and thus imported, producers encountered of some difficulties when procuring aquafeed and juvenile. These difficulties are summarized in Figure 7. The most interviewed farms (73%) indicate that the high price is considered the main encountered problem for their acquiring, followed by the fact that their quality is not always assured. In addition, the complicated administrative procedure (*e.g.,* authorization) is indicated by 45 % of the interviewed aquafarms.

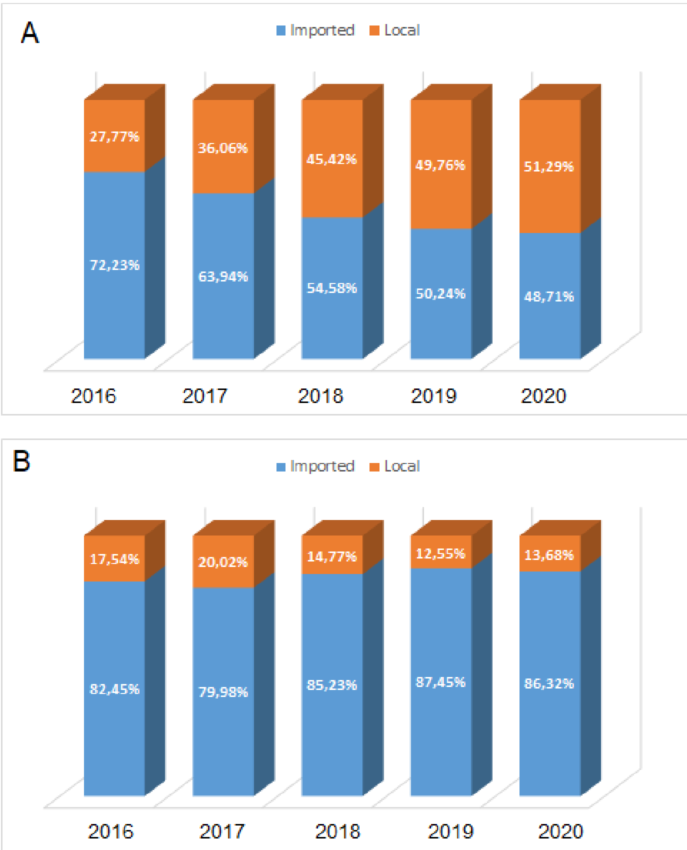


Figure 6: Origin of aquafeed (A) and Juvenile (B) used in finfish production over the last five years

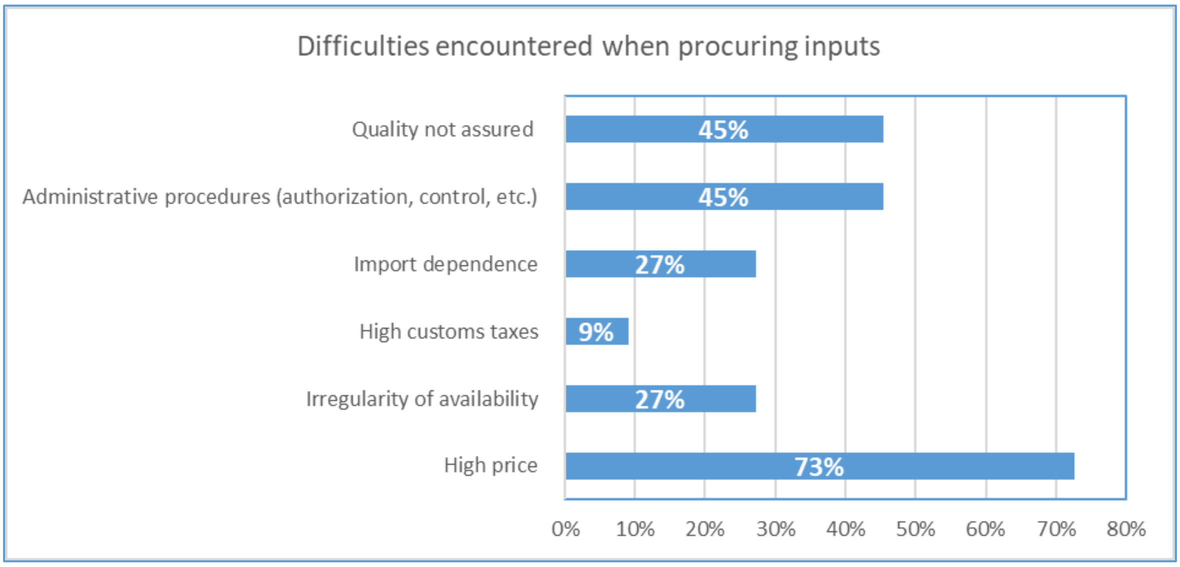


Figure 7: Difficulties encountered when procuring inputs.

From the previous questionnaire (preliminary questionnaire in the first phase) we noticed the lack of using technologies/innovation tools and thus the applied rearing systems can be considered more basic.

According to the producers, the main obstacles to innovation/use of technologies are indicated in the following figure (Fig. 8). High investment cost to implement technologies remain the main problem (90 % of the interviewed aquafarms). Also, the lack of government incentives is indicated by 45 % of the producers/aquaculturists.

The government and competent authority are aware of the use of new technologies to improve production efficiency through the decree N° 2017-389 of March 9, 2017 of financial incitation when introducing new/innovation technologies. The APIA (Agency for the Promotion of Agricultural Investment) is the institution that is involved in the financial mechanisms. The criteria of eligibility and application procedures are indicated at the end of this document as annexed document. However, as indicated by figure 7, 64 % of the interviewed farms are unaware of this incitation. So, an effort should be deployed to raise aquaculturists awareness of the issue.

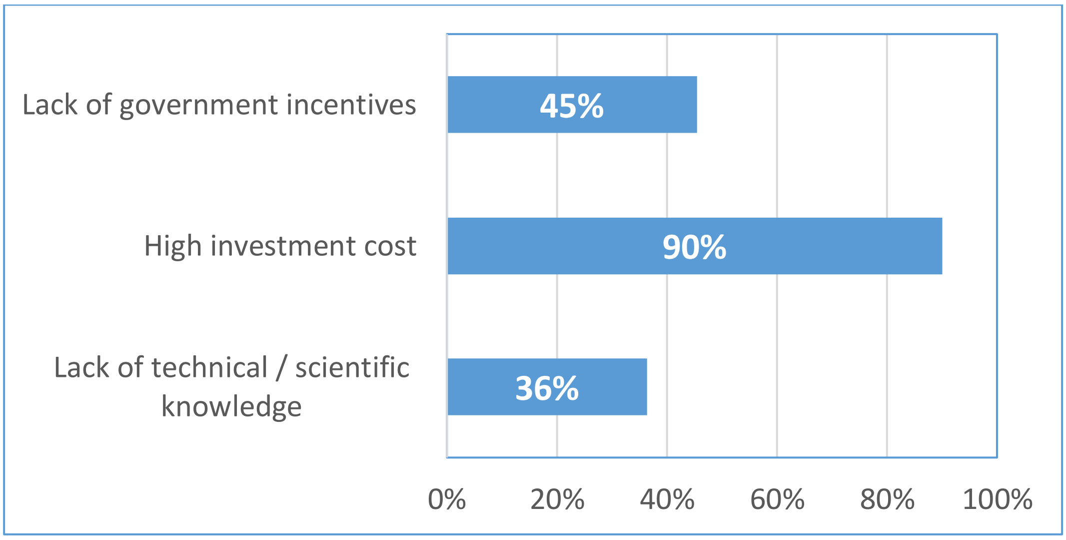


Figure 8: The main obstacles to innovation / use of technologies

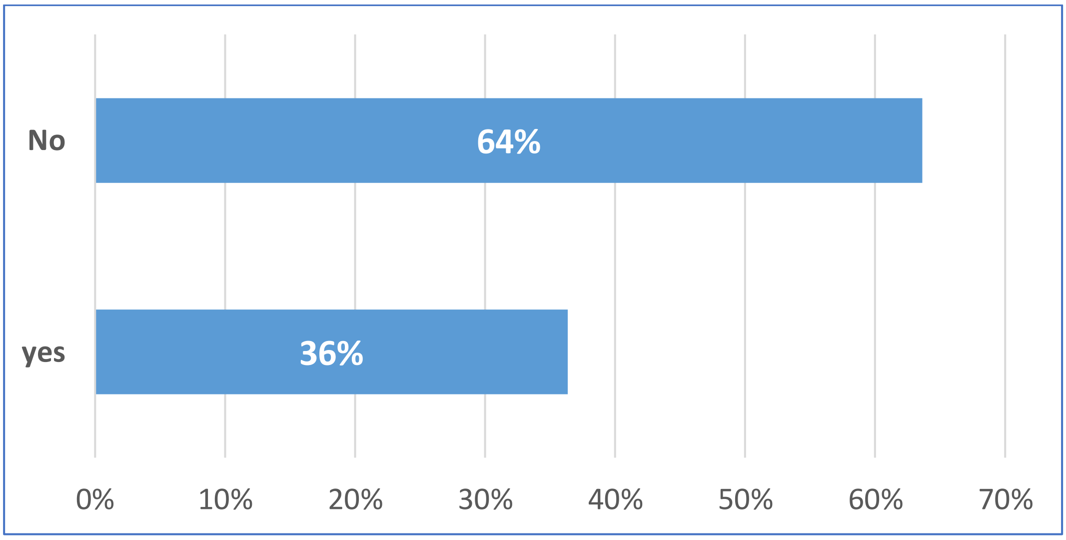


Figure 9: The awareness of the financial incentives for investing in mastering and introducing new technologies.

To identify the most relevant SMART Technologies which can improve and enhance finfish profitability and reduce environmental impacts, we suggested the following technology systems:

- T1: Environmental control system
- T2: Net cage health, cleaning net cages

- T3: Optical system for monitoring and adjusting the feed ration according to environmental conditions and fish behaviour.
- T4: Collection system of dead fish
- T5: Surface feed distribution system (homogeneous distribution)
- T5: Submarine feeding system: Improved feed conversion efficiency
- T6: Stunning and slaughtering systems

In terms of relevance, interviewed farms selected as priority the following SMART technologies systems:

T3 (Optical systems) was ranked as top 1 by 63 % of interviewed farms followed respectively by T5 (spread feed distribution) and T1 (Environmental control system). It is obvious that the two selected technologies as priorities concern the feed management. This parameter is of utmost importance in aquaculture, particularly in intensive system. In fact, this importance is confirmed through the collected data in this questionnaire as indicated in Figure 4 that indicates the significant part of the aquafeed in the production cost which can reach 65 % and 68 %, respectively for seabream and seabass. On the other hand, according to interviewed farms the feed conversion ratios (FCR) of the finfish production system of the interviewed farms can reach 2.3. According to FAO, intensive systems for sea bream have a much better FCR of 1.3. Consequently, the high FCR in Tunisian finfish mariculture can be improved through the optimization of feed management which will enhance not only the financial profitability of the aquafarm, but also reduce the environmental impact of the aquaculture activities.

Besides to the above-mentioned issue of feed management and the possibility of improvement efficiencies, 78 % of interviewed farmers confirm that the pre-fattening stage (first stage after seeding cages) is the most critical stage (Fig. 10).

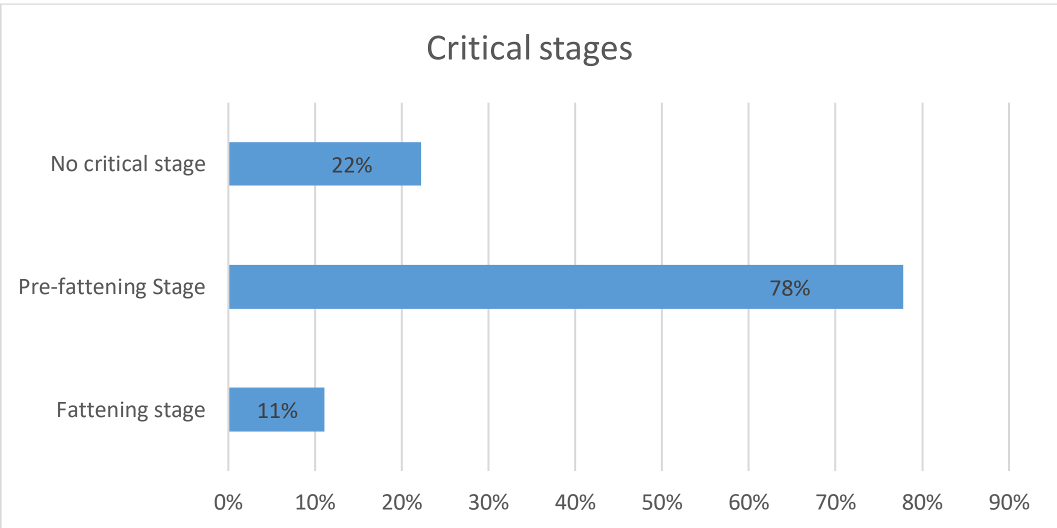


Figure 10: critical stages of finfish production

In terms of the most problematic season, 73 % of interviewed farms indicate autumn season in which fish diseases and fish mortality occurred (Fig. 11).

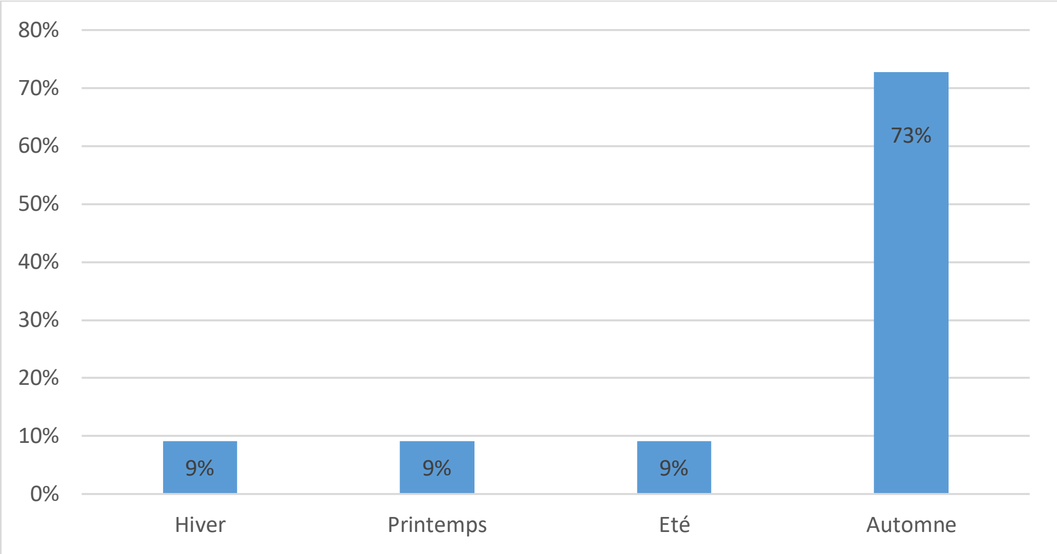


Figure 11: most critical season of finfish production

In intensive finfish net cage production, two main aspects can affect mortality and fish stress (welfare fish): fish diseases and fouling phenomena.

Regarding fish diseases, all farms are in accordance that the most encountered disease are:

- Virus: Nodavirus, Lymphocystis
- Bacteria: Pasteurellosis, Vibriosis
- Parasites : Enteromyxum (Myxozoa), Sparicotyle (Monogenea)

For fouling phenomena, aquaculturists proceed regularly by changing nets. As indicated in the following figure (Fig. 12), 91% of farms change nets more than 4 times, and 55 % of farms change nets more than 6 times during a production cycle, causing high handling costs.

Associated mortality events to this practice are relatively low, as demonstrated in the figure 13. In fact, only 27% of interviewed farms indicate fish mortality associated to the net change. According to all interviewed aquafarms, the cumulative mortality associated with the process of changing nets during a production cycle do not exceed 5% in all farms.

During the production cycle, when producers are faced to some technical/environmental problems, 82 % of aquafarms contact research institutes to deal with these problems (Fig. 14 a). As indicated by figure 14 b, the most contacted institutes are: INSTM (contacted by 73% of aquafarms), followed by ISBM (contacted by 27 % of aquafarms). The geographical position of these two institutions (Both in Monastir region) and their proximity to the potential aquaculture production areas in Tunisia facilitate and justify these cooperative contacts with marine aquaculture farms.

It is worth to note that besides research institutes, aquafarms contact the CTA (Technical center for Aquaculture) to deal with some technical problems.

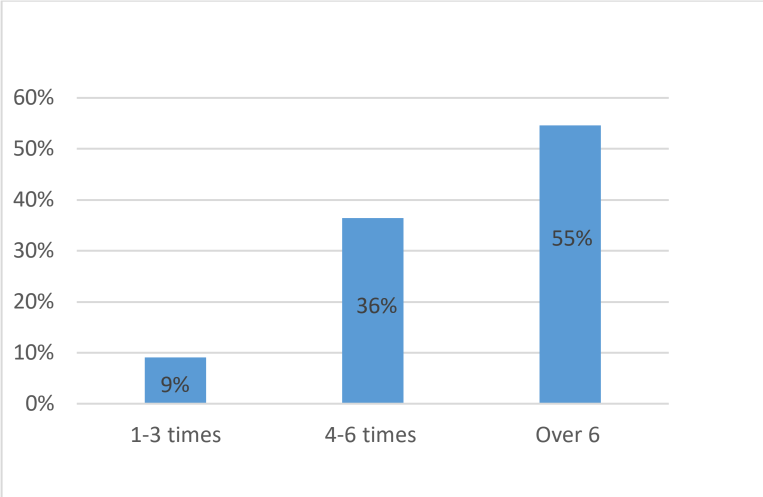
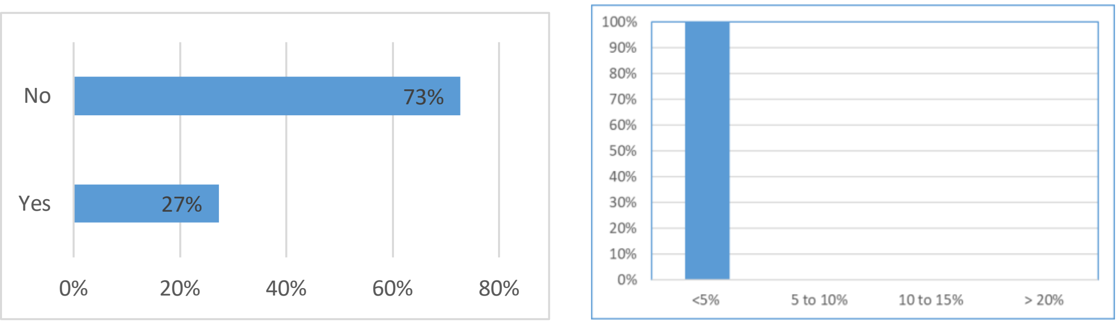
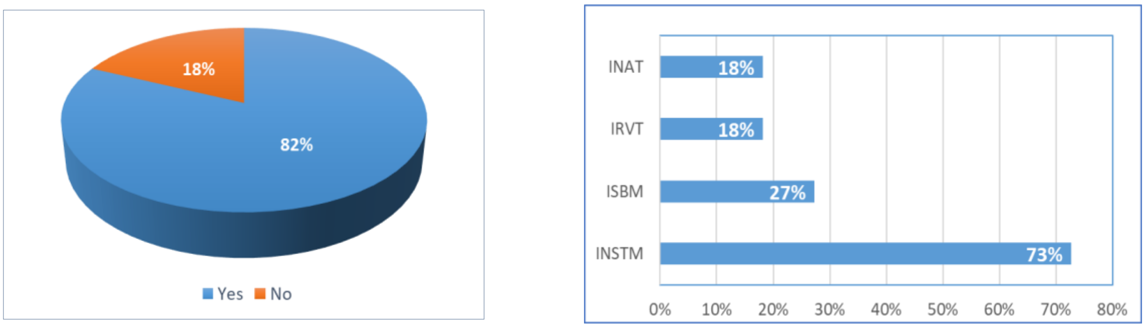


Figure 12: Mean Frequency of changing nets during a production cycle to deal with the fouling phenomenon.



(a) (b)

Figure 13: Encountered mortality in aquafarms (a) and mortality rate (b)



(a) (b)

Figure 13: Relationships between aquafarms and research institutes: Fig a: Yes/No: existing /not existing technical cooperation relationship. (b): most contacted institutes to deal with encountered problems.

Regarding the quantity and costs of used energy by aquafarms, results are indicated in the following table (Table 2). Generally, there is no clear trend in the quantity of used energy and production capacity of aquafarms. As indicated in the below table 33% of the interviewed aquafarms are aware of the high energy use and suggest using photovoltaic installation as an initiative to reduce the costs of energy.

For freshwater use (Table 3) there is no clear trend regarding the production capacity or current production with the used quantity or costs. It is worth to note that, except one aquafarm (farm 10), the used water is treated following standards processes by the National Sanitation Utility (ONAS) before releasing them into the natural ecosystems. Also, the grow out takes place in seawater, so the water saving potential is limited.

Table 2: Estimation of quantity of used energy and initiative to reduce their costs

Aquafarm	**Quantity (KW/month)**	**Cost (Dt)**	**Initiative to reduce the cost**
Farm 1		92 000	No initiative
Farm 2	30 955	149 533	No initiative
Farm 3			
Farm 4	11616	44 367	photovoltaic installation
Farm 5		141 404	solar panels
Farm 6	6000	80 000	No initiative
Farm 7			
Farm 8	27948	71 500	photovoltaic installation
Farm 9	32052	82 000	No initiative
Farm 10	19200	60 000	No initiative
Farm 11	240 Tons de fuel	250 000	No initiative

Table 3: Estimation of freshwater use

Farm	Quantity	Source	Annual Cost (DT)	Destination	Initiative to reduce consumption
Farm 1		SONEDE	17 000	ONAS	Currently: No/ treatment will be implemented
Farm 2*					
Farm 3	337	SONEDE	18 358	ONAS	treatment processes will be implemented soon
Farm 4		SONEDE	2 645,4	ONAS	Using water well
Farm 5	1550	SONEDE	2 690,0	ONAS	No Initiative
Farm 6	100	SONEDE	3 600,0	ONAS	No Initiative
Farm 7*					
Farm 8	4059	SONEDE	10 000	ONAS	No Initiative
Farm 9	8441	SONEDE	20 800	ONAS	No Initiative
Farm 10	2940	SONEDE	2 646,0	Earth septic system	treatment and reuse
Farm 11*					

- *Aquafarms don't have reliable information in this matter.

According to the interviewed aquafarms the generated waste quantity ranged between 3 to 10 tons per aquafarm. The main generated waste is plastic bags used for aqua feed. Generally, no cost charge was attributed by aqua farms to collect and process the generated waste, since specific companies were interested by collecting plastic aquafeed bags for further re-use in other industrial sectors. This means that in the case of plastic, the loop is practically closed.

Table 4: Waste generated by production systems.

Aquafarm	**Quantity (Tons per year)**	**Treatment cost/collection cost (DT)**	**Initiative to reduce quantity**
Farm 1	10	Not estimated	
Farm 2	*No response*		
Farm 3	10		Specific companies (waste collector)
Farm 4	*No response*		
Farm 5	4	0	Agreement with companies of plastic recycling
Farm 6	3		Selling waste to recycling companies
Farm 7	*No response*		
Farm 8	5		Recycling plastic
Farm 9	5		Recycling plastic
Farm 10		2000	Selling waste to recy-cling companies
Farm 11	20		

The last Investments made by the interviewed aquafarms are indicated in the following table (Table 5). The main investments made are:

- Extension of production capacity by adding new cages
- Acquisition of net cleaner
- Acquisition of feed spreader

According to interviewed aqua farms, the reasons for these investments are indicated in figure 15. Results demonstrate that for 80% of the aquafarms, the main reason is to enhance financial profitability and only 20% with regard to environmental perspectives (feed spreader to reduce uneaten feed that constitutes a potential pollution source).

Table 5: The last investments made by aqua farms.

Aquafarm	Type	Cost (Thousand Dinars)
Farm 1	No response	
Farm 2	Extension production (adding cages)	1200
Farm 3	Buying nets and freezer unit	400
Farm 4	Buying boot and feed spread	300
Farm 5	No response	
Farm 6		
Farm 7		
Farm 8	Feed spread and net cleaner	
Farm 9	Net cleaner	
Farm 10	Extension production (adding cages)	1000
Farm 11	Extension production (adding cages)	1100

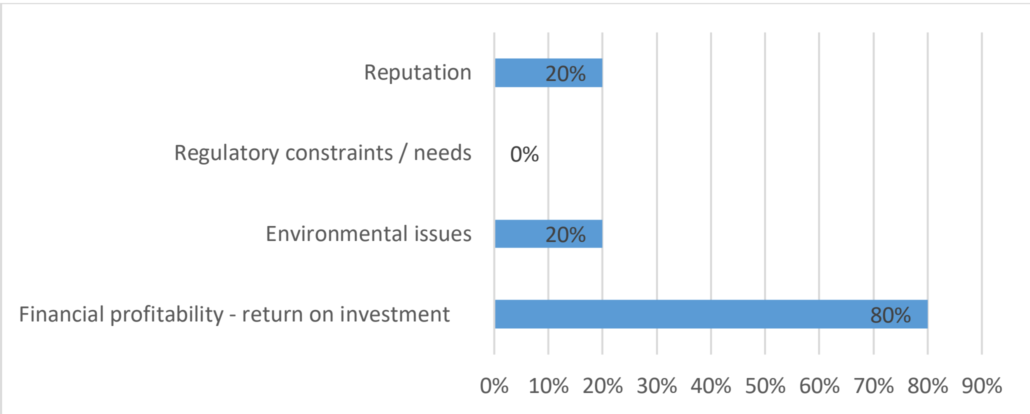


Figure 14: The reason of the last investments made by aqua farms

Scenario for sustainability improvement

Figure 16 synthetize the different streams of inputs and outputs within the subsector, and the interrelations with upstream/downstream subsectors.

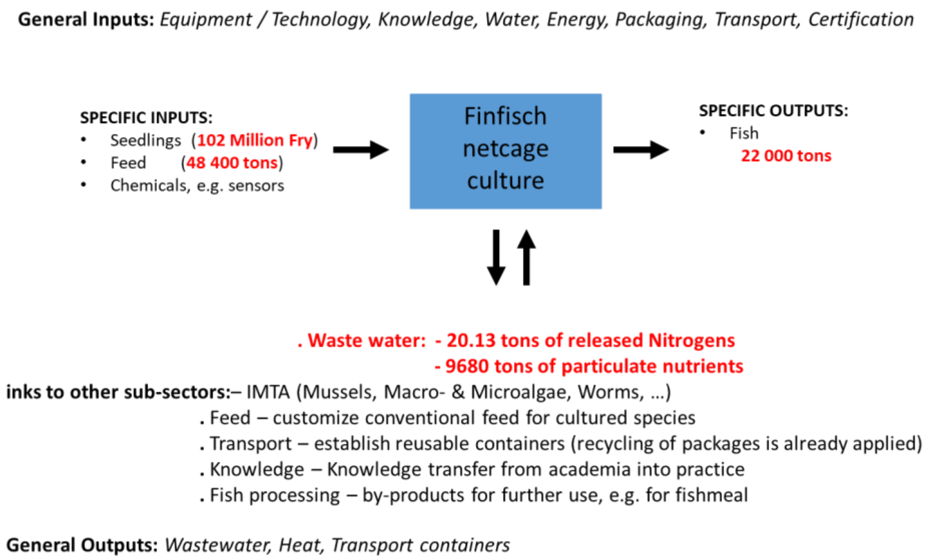


Figure 15: Interaction of Subsector of finfish net cage culture with other subsectors

The main quantitative results of this subsector are summarized as following: Average FCR of Tunisian aquaculture farms are ranged between 2.1 and 2.4 *versus* 1.5-1.8 (benchmarking).

This leads to:

- Significant economic loss (Feed is the main cost factor!)
- Significant environmental impact (The unconverted feed is waste!)

The FCR is influenced and can be optimized by the following technologies / approaches:

- Environmental monitoring (Catalogue T1/T2)
- Optical surveillance systems (T5)
- Feeding systems (T6)
- Feed composition, Feed additives (T7)

Each of these measures provides a potential of ~ 5 – 10 % FCR optimization. The implementation of these measures enables bigger production quantities of up to 78 % with the same feed input and the same environmental impact without exploring new areas for aquafarms, which also avoids potential stakeholder conflicts. Or the other way round: In the ideal case, the same production could be achieved with only ~ 56 % of the currently used feed

In addition, an optimized FCR would provide more independence from imports and reduce directly the highest cost factor.

Progressive FCR-Optimisation within 10 years: Same quantity, reduced feed use, augmented production, same feed use

To improve FCR, the recommendation is the optimization of feed management, this by:

- Adjustment of the food ration according to the new biomass
- Adjustment according to environmental parameters

This is ensured through using of the following SMART technologies:

- Optical system for monitoring and adjusting the feed ration according to environmental conditions and fish behaviour.
- Environmental control system

Scenario for sustainability improvement: Using SMART technologies to optimize feed management and thus to improve feed conversion efficiency (FCR)

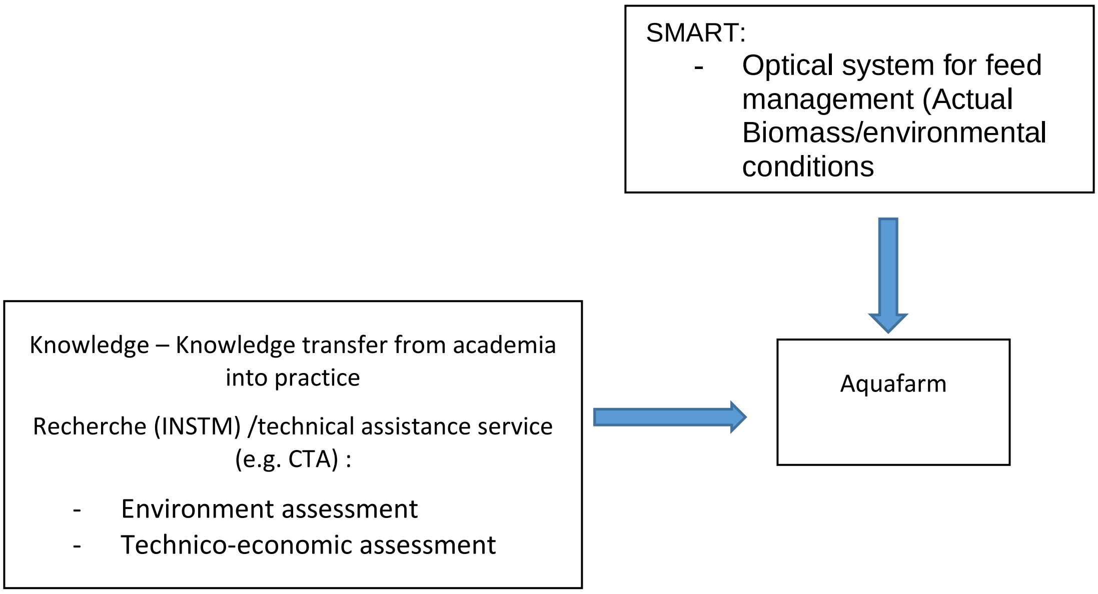


Figure 16: Scenario of using SMART to optimize feed management

The Tunisian aquaculture is expected to grow based on the intensification and increase of mariculture net cage systems for the two most relevant finfish species, Sea bream (Sparus aurata) and Sea bass (Dicentrachus labrax). However, already today stakeholder conflicts and increasing environmental awareness of the public require involvement of all potential users of the coastal zones. Strict environmental monitoring under application of the best possible practice can help to reduce stakeholder conflicts and increase sustainable mariculture production in Tunisian coastal waters.

3.2. Aquaculture Feed

Currently there are 3 aquafeed manufacturers in Tunisia (see Desk review). Their total production capacity is around 90,000 tons. Following the questionnaire of the previous phase, we selected the 3 existing factories for this questionnaire. Finally, only 2 companies participated in this questionnaire: The SOTUPAP company and the NutriFish company (Table 6).

Table 6: The selected aquafeed companies

Aquafeed company	Production capacity (Tons/year)	Actual Production (Tons/year)	% of Actual production
Nutrifish	30 000	11175	37,2%
Sotupap	30 000	10530*	35,1%

- Means of the five last years.

As indicated in the above table, both companies produce far below their production capacity (37 and 35 %, respectively for Nutrifish and SOTUPAP companies). These values corroborate with Figure 4A, in which 49 % of the needed aquafeed is imported. This situation reduces the efficiency of the two companies. In this context the future strategy of both companies at the short and medium terms is summarized in the following figure (Fig. 18).

Both companies have the same goals:

- Increase feed production.
- Identify local ingredients as alternative of conventional sources
- Improved product quality
- Explore new foreign markets (export)

The three goals potentially contribute to a rise in the sustainability of these companies. In fact, increasing feed production can enhance the financial profitability of these companies and thus valorise the high investment. Regarding the two remaining goals, it is obvious that improving production quality is a perquisite to explore new foreign markets for export.

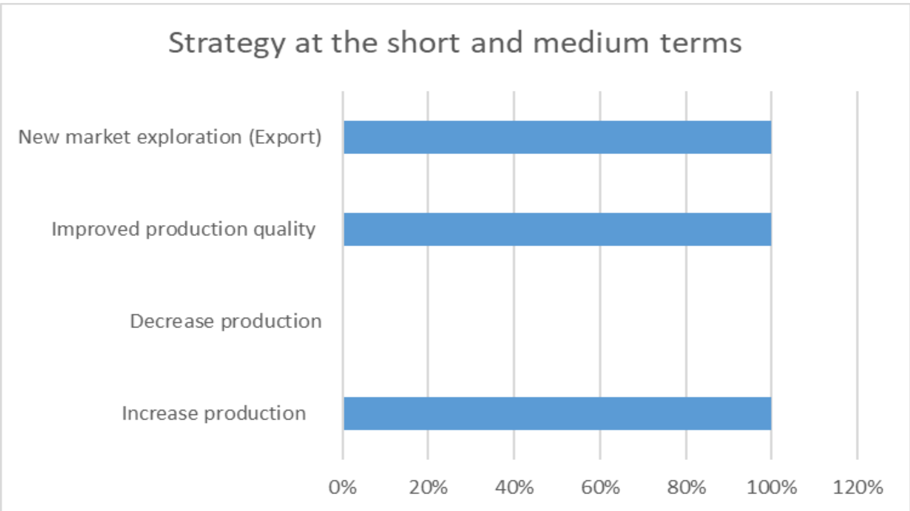


Figure 17: Strategy of company at short and medium terms

To reach these goals, the aquafeed companies must overcome the encountered problems to extend their activities by increasing the current production and thus increase the rate of their contributions to the feed needs of Tunisian aquafarms.

According to interviewed aquafeed companies, the main problems hindering the expansion of their activities are:

- High customs duty and VAT for some raw materials
- Limitation of local raw materials (by-product; animal and vegetal sources) authorized by regulation
- Increased costs of raw materials
- Increased production costs
- Competition from feed imports

Besides the above-mentioned factors, aquafeed producers encountered some other difficulties when procuring input feeds (ingredients such as: fish meal, fish oil, soybean meal etc.). Some of these ingredients are imported, which can further complicate their acquisition. These difficulties are summarized in the following figure (Fig 19).

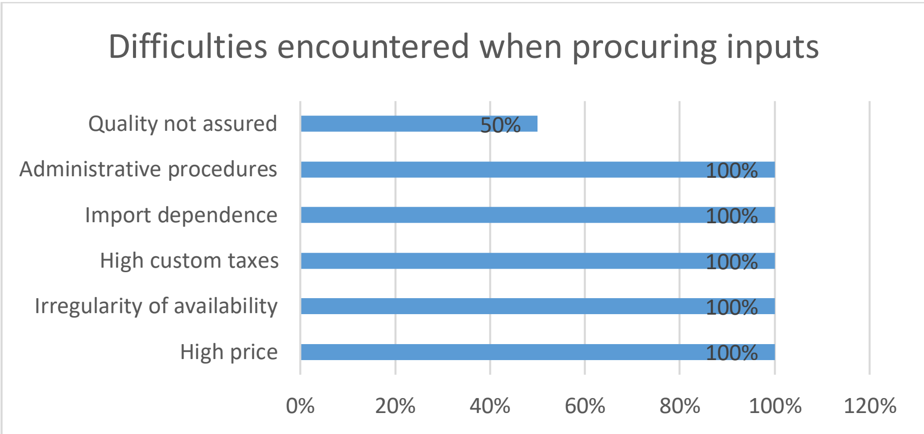


Figure 18 : Difficulties encountered when procuring inputs for aqua feed.

According to the aquafeed producers, the main obstacles to innovation/use of technologies are indicated in the following figure (Fig. 20). High investment costs to implement technologies remain the main problem (selected by the two interviewed aquafeed companies). In this context, both interviewed companies are unaware of the incitement decree (N° 2017-389 of March 9, 2017) dedicated to introducing new/innovation technologies (Fig. 21). The potential areas for aquafeed companies in applying innovation related to the environmental issues is to reduce air pollution released in the atmosphere.

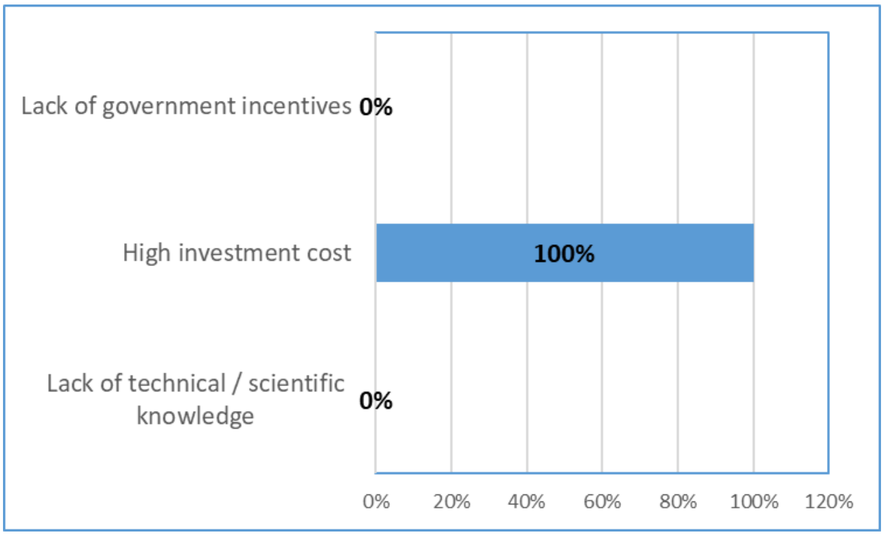


Figure 19: The main obstacles to innovation / use of technologies

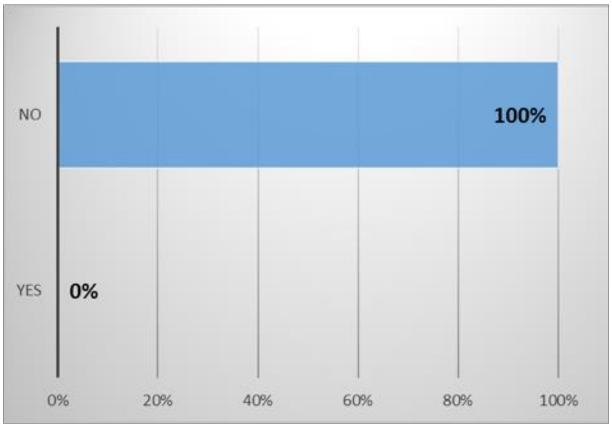


Figure 20: The awareness of the financial incentives for investing in mastering and introducing new technologies.

When aquafeed producers are faced to some technical/scientific aspects, both interviewed companies already established a scientific relationship with INSTM and ISBM (Fig. 22). It is worth to note that the two companies and the two research institutes are all in the region of Monastir. As explained above, the geographical location plays an important role of building the cooperation between companies and the two research institutes.

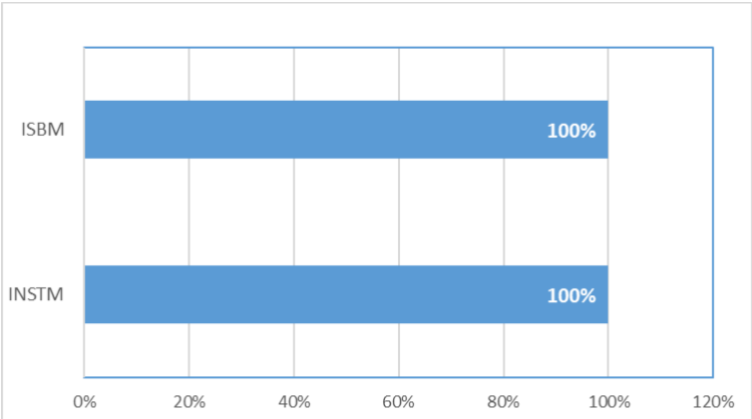


Figure 21 : Relationships between feed companies and contacted institutes to deal with encountered problems.

Regarding the quantity and costs of energy use by aquafeed companies, results are indicated in the following table (Table 7). Generally, both companies are aware of the significant financial amount allocated for the used energy, and thus some initiatives to reduce costs of energy are in course. The estimated quantity and costs of freshwater are indicated in table 8. It is worth to note that there is no release of used water into the environment since they evaporate in the processes of aquafeed fabrication. The evaporation process is accompanied by an unpleasant odour.

Table 7: Estimation of the quantity of energy used and initiatives to reduce the costs.

Companies	Quantity of Energy	Costs (DT)	Initiative to reduce costs
Company 1	Electricity: 3360000 kwh / an Gaz: 264000 m^3/ an	145000	- Installation of an energy consumption control system by machine group. - Add speed variators to machines with a power greater than 15 KW. - Improvement of the power factor (COS phi) towards 1: add a capacitor bank.
Company 2		90 218	Yes

Table 8: Estimation of freshwater use

	quantity m^3 / an	Source	Cost (Dt)	Destination	Initiative
Company 1	15 000	Water from Sonede	12 000	Evaporation	No
Company 2	16 000	Water from Sonede	17 823	Evaporation	No

In both aquafeed companies, the generated waste quantity ranged between 6 to 8 tons per year and exclusively concerns the plastic bags (Table 9). According to the feed producers, no cost charge was attributed to the treatment of the generated waste since specific companies are interested to collect plastic aquafeed bags for further re-use in other industrial sectors.

Table 9: Waste generated by production systems.

	Quantity/an	Treatment cost	Initiative
Company 1	6-8 tons of plastic bags	0	No
Company 2	7 tonnes of plastic bags	0	No

The last investments made by the two aquafeed companies are indicated in the following table (table 10). The main investments made are:

- Installation of storage silos
- Odor treatment unit

According to the interviewed aquafarms, the reasons for these investments are indicated in figure 23. Results demonstrate that in both aquafeed companies, the reasons for these investments are:

- Reputation
- Regulatory constraints
- Environmental issues

Both companies confirm that they are already seeing the expected benefits of these investments.

Table 10: The last Investments made by the two aquafeed companies.

	Investment	Cost
Company 1	- Installation of storage silos - odour treatment unit	1,320 million de Dt
Company 2	- odour treatment unit	265 000 Dt

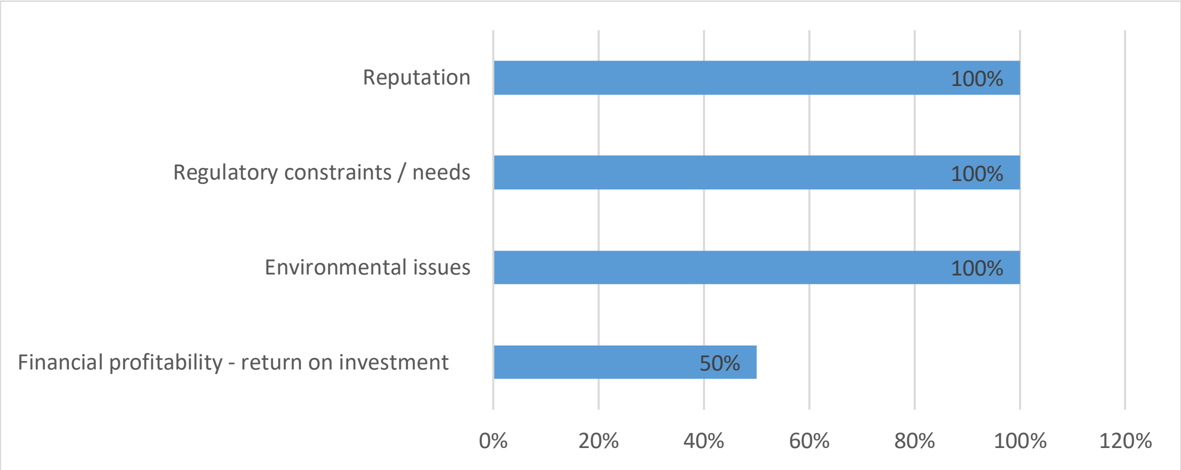


Figure 22: The reason of the last investments made by aqua farms.

Scenario for sustainability improvement: Improving locally produced ingredient to reduce dependence to imports and create sustainable fish feed supply chain in Tunisia

Figure 24 synthetize the different streams of inputs and outputs within the subsector, and the interrelations with upstream/downstream subsector.

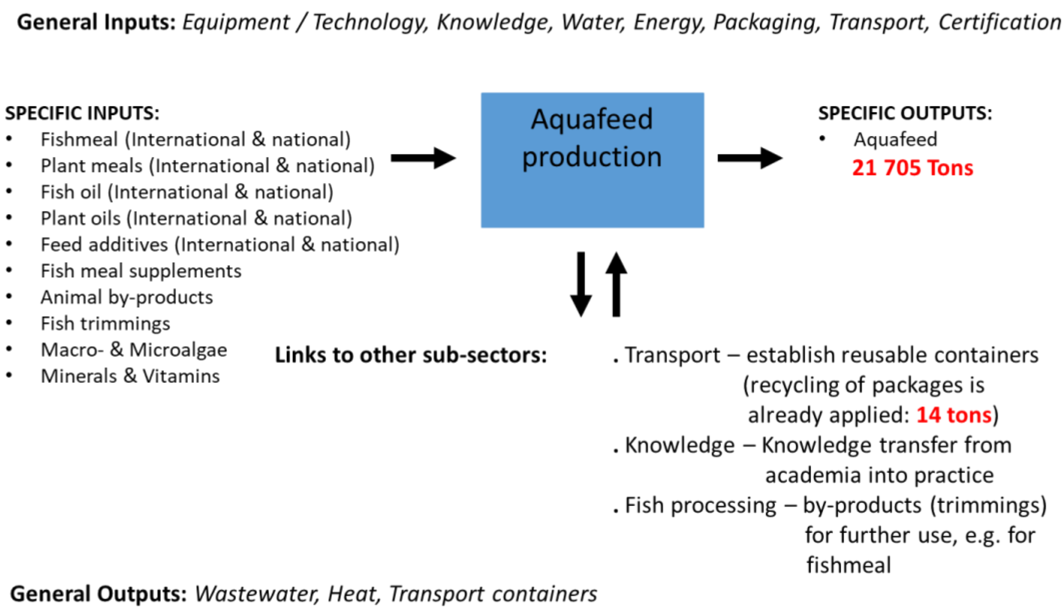


Figure 23 : Interaction of Subsector of Aquafeed production with other subsectors

- Food represents a significant part of the production cost (60%)
- 50% of aquafeed requirements are imported
- The 50% of locally produced foods are based on imported ingredients (not locally produced).
-

This leads to the:

- Increase of production cost
- Low competitiveness of the aquaculture sector

To overcome these issues:

- Substitute (total, if possible or partial) expensive and imported ingredients with local raw materials and / or by-products rich in proteins (e.g., Tuna by-product meal / Insect meal)
- Use of food additives (antioxidants, immunostimulants etc.)

This allows to:

- Valorisation of waste from seafood processing units (Tuna, Shrimp, etc.)
- Valorisation of waste through their conversion (recycling) to produce insects
- Reduce the impact of this waste on the environment
- extension of the value chain to produce animal proteins of high nutritional value
- Valorisation of seafood processing by-products for integration into aquaculture feed
- Reduce the cost of aquaculture feed

Alternative scenario: Substitution of conventional ingredients by alternative source of nutrients, such as insects-based proteins.

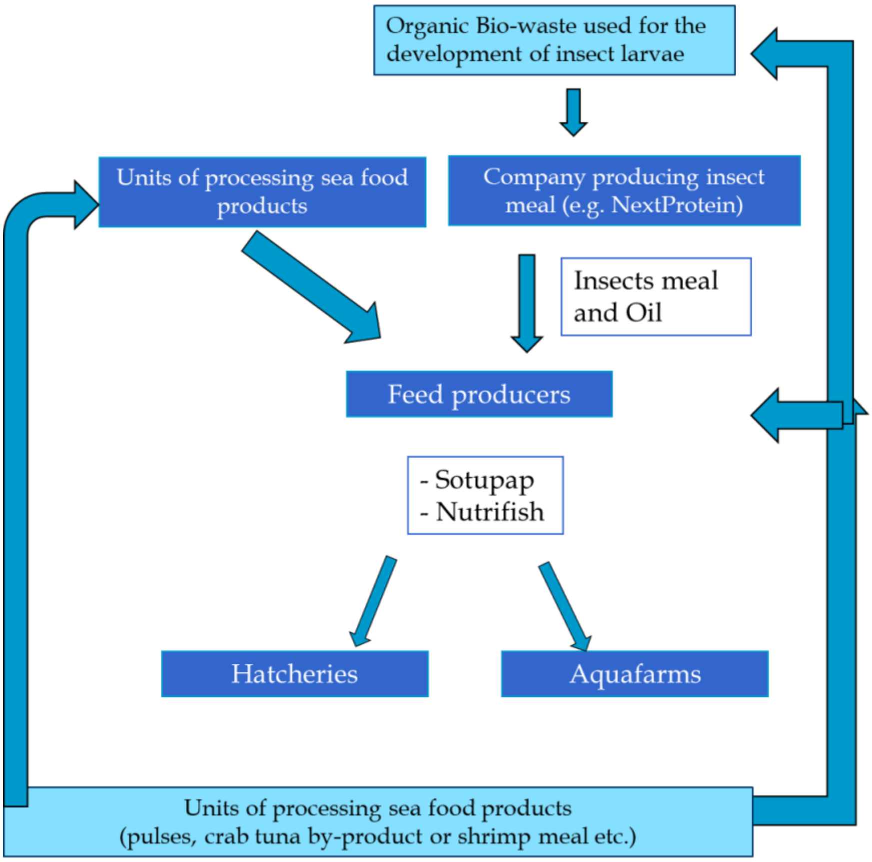


Figure 24: Scenario of identification of alternative ingredients in aquafeed.

The actual annual production capacity of the Tunisian feed industry could reach 90,000 tons according to the listed companies' profiles. Nevertheless, to date the aquaculture producers import around 30,000 tons aquafeed, and the input of feed in combination with imports of the seedlings represent 80 to 85% of the total production costs. It is obviously contradictory that aquaculture feed is imported despite significantly higher national production capacities.

Besides availability of the raw materials, feed quality might be an important factor that still forces the fish producers to rely on international feed companies. Consequently, it is of importance to enable the Tunisian fish feed industry to develop and apply locally produced high quality fish feed products according to the needs of the producers.

3.3. Hatcheries

In Tunisia, currently only one hatchery is in activity, which responded to our questionnaire.

The interviewed hatchery is the "Aquaculture Tunisienne" and has a production capacity of 25 million fingerlings.

According to this hatchery, their strategies at the short and medium terms are:

- Increase production
- Diversification of production
- Improved production quality
- New market exploration (Export)
-

As indicated in the above response, the top priority of the hatchery is to increase production. This needs to extend their business. However, according to this hatchery the difficulties that limit this extension are indicated below:

- Financial aspects
- Production capacity at Weaning and Nursery levels
- competitive fry price
-

The hatchery is aware of the financial incentives for investing in mastering and introducing new technologies and improving productivity. However, they consider that High investment cost and Lack of technical / scientific knowledge are the main obstacles to beneficiate of theses valuable tools.

According to the responsible staff of the hatchery, the first larval and the weaning stage are the most problematic in the production. This early part of the life cycle is accompanied by high mortalities and morpho-anatomical malformations. In fact, at the end of this stage the survival rates are as following:

- 35% for Sea bream
- 25% for Sea bass

The encountered morpho-anatomical malformations are indicated below:

- Skeletal deformities (fusion of vertebrae, lordosis and scoliosis): rate = 5 to 10%
- Absence of the swim bladder: rate = 5 to 10%
- Short opercula: Rate = 12 to 15%

If the hatchery is faced some technical/environmental problems, there is a permanent cooperation and contact of the hatchery with research institutes through agreements and MoU. According to the hatchery responsible staff both INSTM and IRVT institutes are the most contacted institutes.

Regarding energy use, although we don't have a comparison tool, owing we have only one interviewed hatchery, we consider that the consumed energy level ($5\ 10^6$ KWh/an) is relatively high since the costs reached 1,5 million dinars. The responsible staff of the hatchery is aware of this high energy consumption and therefore planned some initiatives as urgent measure to reduce the energy use as much as possible. According to the interviewed hatchery, these measures are:

- internal awareness-raising policy to rationalize energy consumption
- External energy audit by a study office
- implementation of photovoltaic projects to reduce the energy consumption to 50%

Scenario for sustainability improvement: Reducing the energy consumption via resource-efficiency programme and/or renewable source of energy

Tunisia has only 2 productive hatcheries which supply only no more than 15 million fries. Aquafarmers therefore import 87 million fry to reach current annual production. Fry is the 2 nd major cost drivers (after feed) and the Tunisian government intends to increase inland hatchery production. The two major species Sea bream (*Sparus aurata*) and Sea bass (*Dicentrachus labrax*) are widely produced around the Mediterranean and are the most promising candidates for a future mariculture finfish production increase. It's worth to note that high energy was consumed in the hatchery, which can significantly increase the production cost of fry. Therefore, the reduced energy consumption or identifying alternative more sustainable sources is a prerequisite.

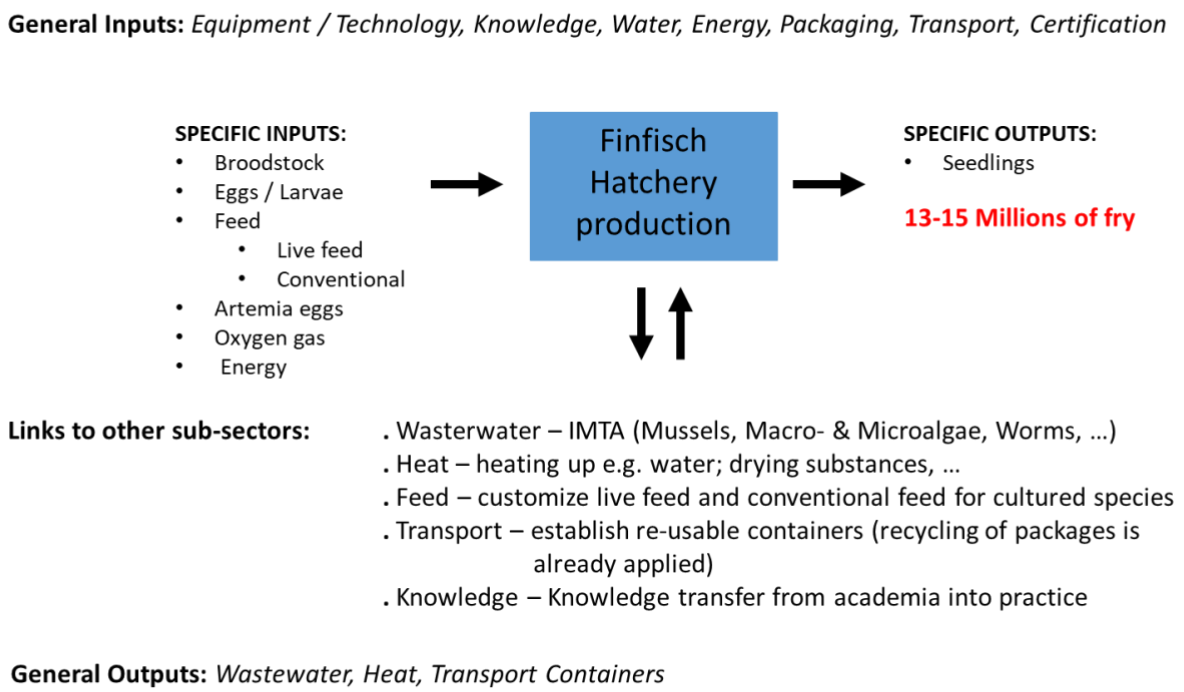


Figure 25 : Interaction of Subsector of finfish net cage culture with other subsectors

3.4. Shellfish Farming

Through the preliminary questionnaire of the first phase, we selected 8 shellfish farms for the 2nd phase. We received feedback from 5 shellfish farms (*i.e.,* 62.5 %) as indicated in the table below (Table 11).

Table 11: The shellfish farms participating in the questionnaire.

Aquafarms	Production capacity
Promer	180
Prodmer	180
Biomarine	350
Sté Cosirenne	200
Aquacompany	80

The strategies of these farms at short and medium terms are indicated in figure 27. As indicated in this figure, increased production and new market exploration are the top priorities of the interviewed farms, followed by improved production quality.

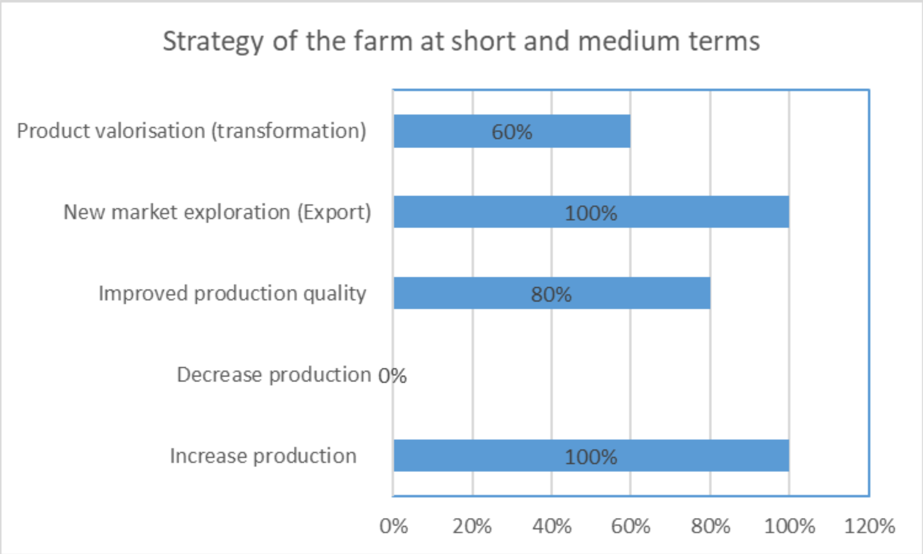


Figure 26 : Strategy of the aquafarms at short and medium terms

The interviewed farms elucidated that the main factors limiting the expansion of their business are indicated in the following figure (Fig. 28).

- High investment cost (indicated by all farms of the interviewed aquafarms)
- Limitation of local market capacity (also indicated by all farms)
- Lack of financial investment (indicated by 80 % of farms)

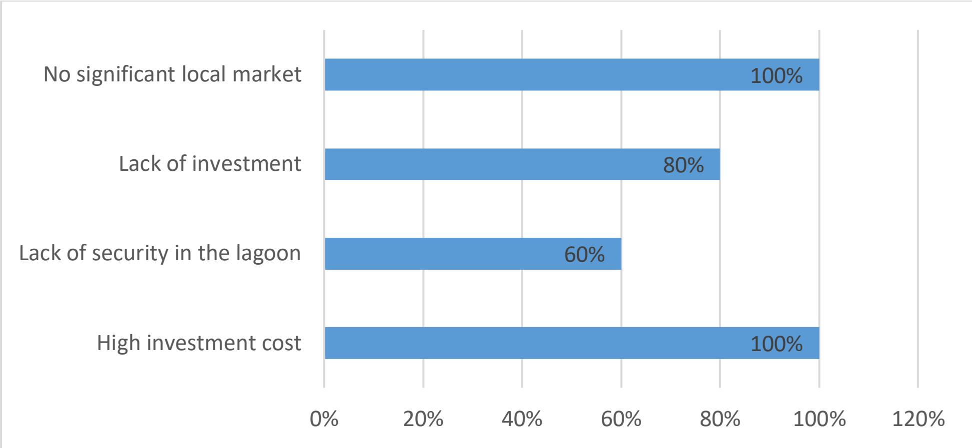


Figure 27 : The main factors limiting the expansion of the shellfish activities.

It is worth to note that through the first questionnaire we noticed the lack of using technologies/innovation tools by the shellfish farms. According to the recorded data of the present survey, the main obstacles to innovation/use of technologies are indicated in the following figure (Fig 29). According to all farmers, high investment cost to implement new technologies remain the main problem (100 % of the interviewed producers), particularly regarding harvest and sorting products techniques. Also, the lack of government incentives is indicated by 20 % of the shellfish producers.

The government is aware of the useful technologies to improve production efficiency. For this reason, a financial incitation (the decree N° 2017-389 of March 9, 2017 of financial incitation when introducing new/innovation technologies) was disposed to the farmers. However, as indicated by figure 23, 80 % of the interviewed shellfish farms were unaware of this incitation. So, an effort should be placed on raising aquaculturists awareness to benefit from this opportunity.

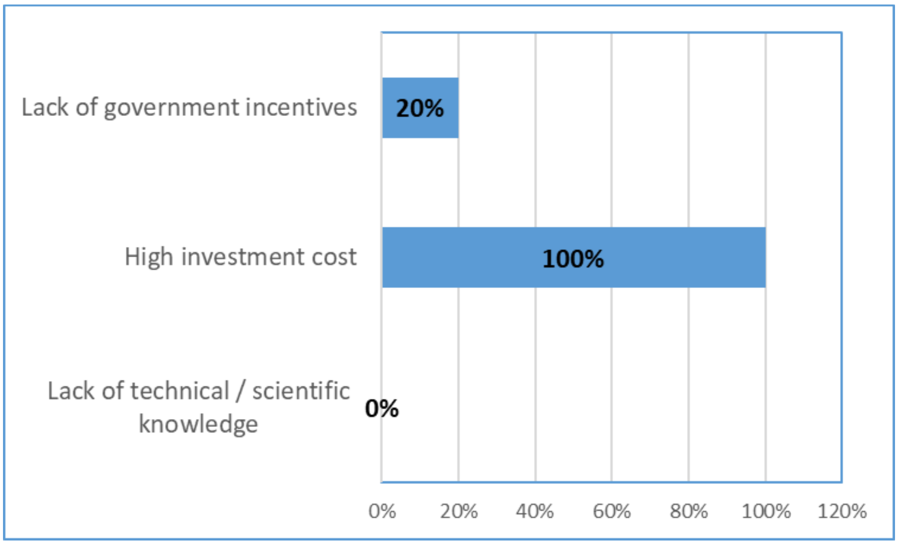


Figure 28: The main obstacles for innovation / use of technologies

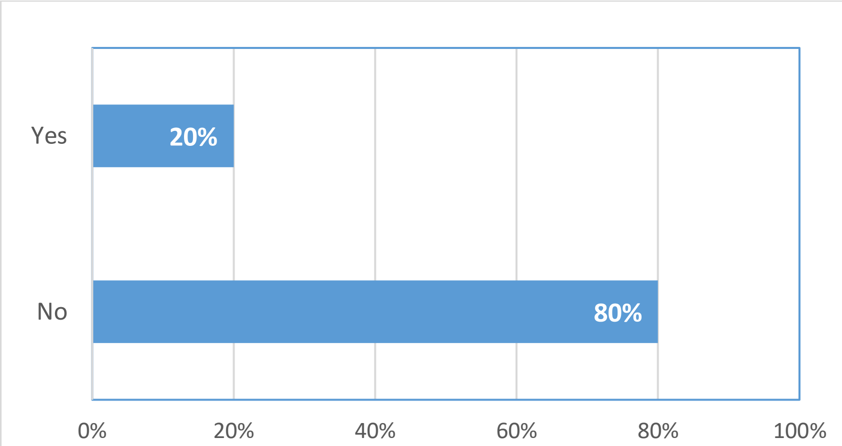


Figure 29 : The awareness of the financial incentives for investing in mastering and introducing new technologies.

Main part of mussel and oyster production occurs in Bizerte lagoon. This large lagoon is sheltered and has large shallow regions, higher temperatures, and significant nutrient inputs. This activity remains underdeveloped due to strong anthropogenic pressures on the lagoon and health constraints. In this specific context, 80 % of shellfish producers indicate that the environmental conditions of the production sites constitute a serious constraint for their farms (Fig. 31).

Regarding self-monitoring of the environment parameters by shellfish producers and availability of the environmental database of their production sites, only 20 % of the aquafarms already disposed a database. In this context, it is worth to increase awareness of the producers to build a specific environmental database for each farm for best management practices and optimisation of the planned activities that anticipate critical events encountered throughout the production cycle.

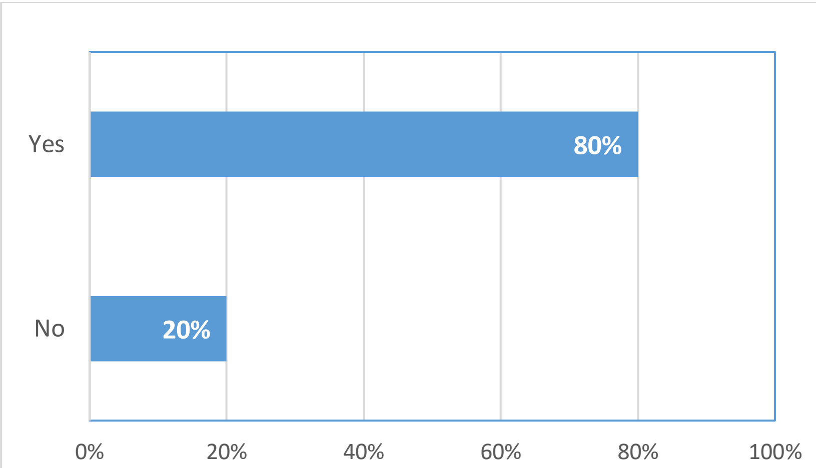


Figure 30: Presence (Yes) or absence (No) of environmental constraints for shellfish farms

According to the interviewed shellfish farm, the most problematic stages of the production cycle are:

- The natural spat collection/fixation
- Harvesting and marketing the harvested products
- The marketing of harvested products because of blockages by veterinarians when sanitary analysis is not compliant with the suitable level for human consumption.

According to the interviewed shellfish farms, 80 % of the producers considered the hot season as the most problematic season in which, associated with poor water quality, a high mortality level occurs (Figure 32).

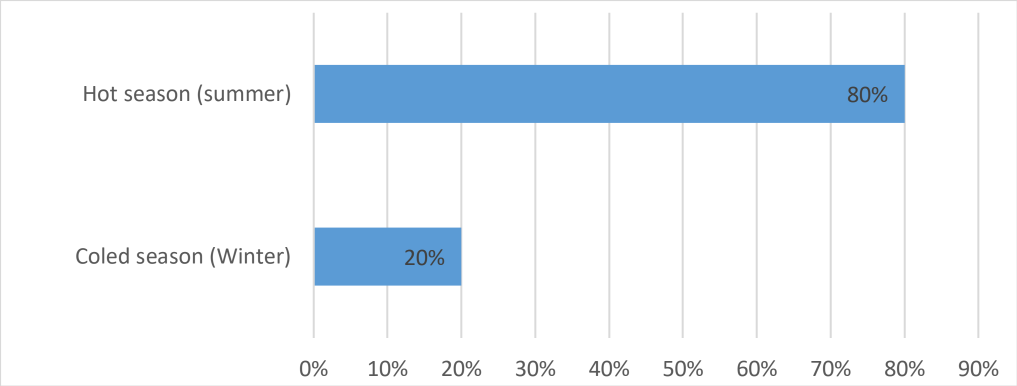


Figure 31: Most critical season of shellfish production

In shellfish production, only 20% of the producers encountered diseases (Fig. 33). Oyster's parasites are the main obstacle, which can affect the production efficiency.

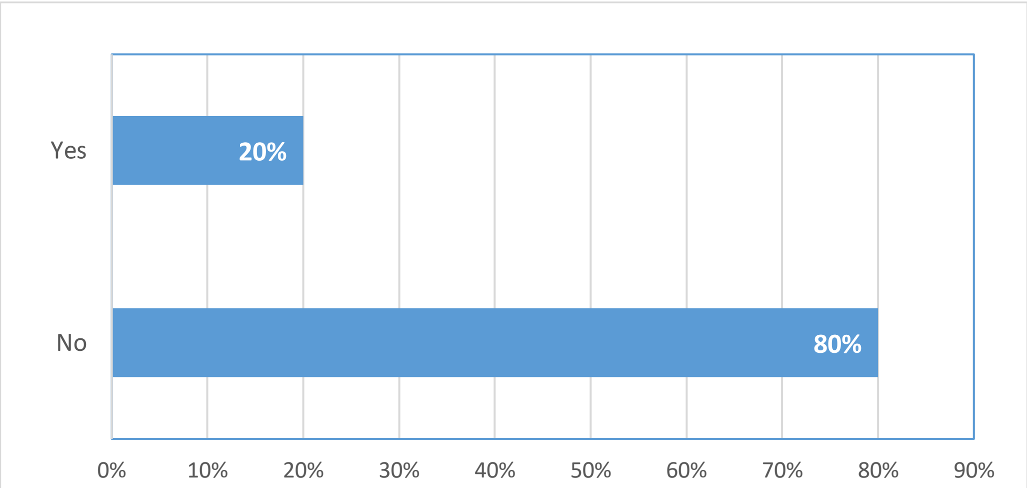
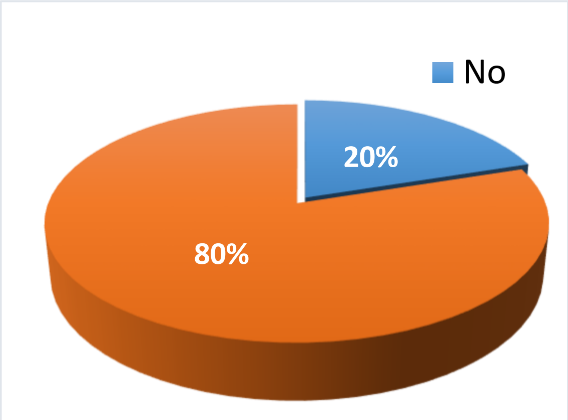
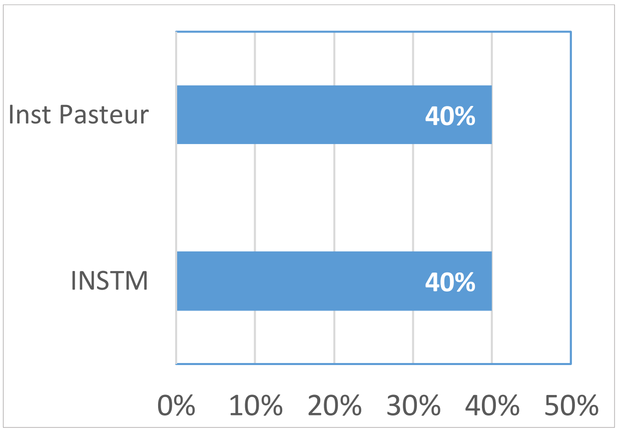


Figure 32: Frequency of the encountered disease in shellfish production

During the production cycle, when producers are faced with some technical/environmental problems, 80 % of the shellfish farms contact research institutes to deal with these problems (Fig. 34 a). As indicated by figure 34 b, the INSTM and Pasteur Institute (IP) are the main contacted research institutes.



(a)



(b)

Figure 33:. Relationships between aquafarms and research institutes: Fig a: Yes/No: existing /not existing technical cooperation relationship. (b): most contacted institutes to deal with encountered problems.

According to the interviewed shellfish farms, we tried to estimate the total generated waste quantity. This quantity is classified as follows:

- Nets: 3 tons / year
- Lanterns and bags for oyster farming: 300 Kg / year
- hawsers and ropes: 2 tons / year
- Floats: 2 tons /year

The above-mentioned waste quantity was gathered and treated by specific enterprises for recycling plastic matter.

Scenario for sustainability improvement: Fostering symbiosis with aquafarms via Integrated Multitrophic Aquaculture (IMTA)

Mussels and oyster production in Tunisia is currently carried out by 7 companies with a total capacity of 880 to per year (Desk review). While the actual production especially of *Mytilus galloprovincialis* has reduced during the last 10 years, especially oysters can contribute to an increase in total value of the Tunisian aquaculture sector. Mussels and oysters are extractive organisms that reduce eutrophication and can eliminate organic pollution based on intensive finfish mariculture. Especially oysters have a high commercial value and market demand. The combination of shellfish with the intensifying net cage mariculture activities for the production of the two major species Sea bream (*Sparus aurata*) and Sea bass (*Dicentrachus labrax*) allows more sustainable finfish aquaculture along the Tunisian coasts. Integrated Multi Trophic Aquaculture may help to reduce environmental impact, social acceptance and increase the carrying capacity in the finfish mariculture regions.

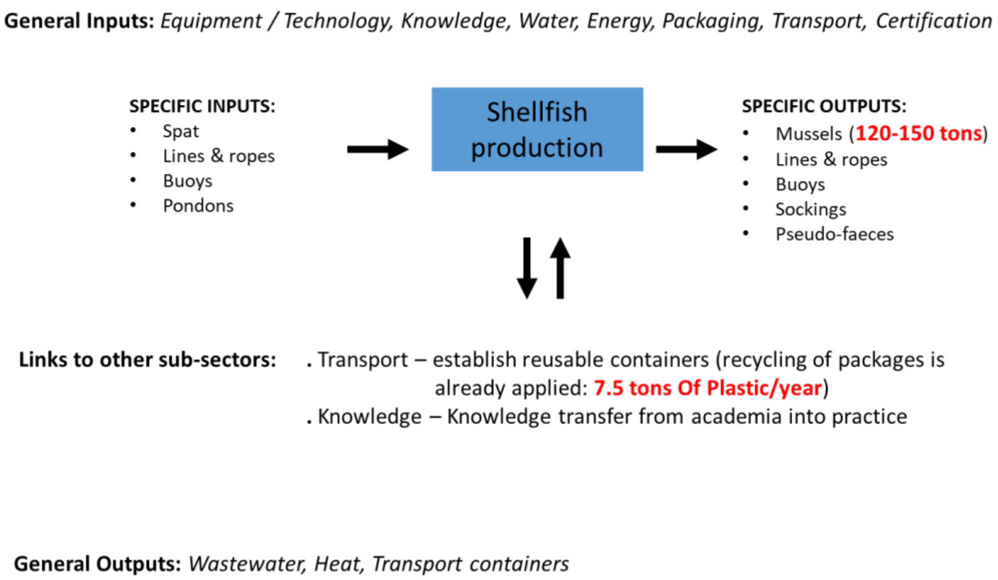


Figure 34 : Interaction of Subsector of finfish net cage culture with other subsectors

The key issues of this sub sector are: Tunisian Shellfish production is confronted with environmental problems in the Bizerte lagoon and relatively high mortality occurred in summer season because of eutrophication ecosystem and oxygen deficiency.

An alternative opportunity would be moving this activity to the open sea with good water quality and good oxygen level. However, low growth performance (oligotrophic ecosystem: less nutrients and organic matter) constitutes the main problem. To overcome this problem, the transfer to open sea should be associated to net cage finfish production to constitute an integrated multitrophic aquaculture system (IMTA) as a symbiotic production: Shellfish-Finfish.

4. Conclusions and Key Issues of the priority sub-sectors

The identified issues from the interview evaluations and the sector specific studies constitute the base for the identification of the priority sub-sectors and the strategic development tasks.

4.1. Fish Farming

In the last decade, the Tunisian aquaculture demonstrates a significant production increase based mainly on intensified finfish mariculture of especially sea bream (*Sparus aurata*) in offshore sea-cage systems. The potential area of production is in central-eastern Tunisia.

The assessment of the Tunisian aquaculture sector shows that the sector, despite the encountered constraints, is characterized by reasonable performance indicators (growth performance, survival rates. However, the FCR remains relatively high and should imperatively improve.

To reach this goal, we recommend the introduction of the respective and appropriate SMART technologies, which reduces uneaten distributed feed and environmental impact.

4.1.1. Waste treatment

The main solid output waste from net-cage rearing systems are the plastic bags of aquafeed and biological waste from dejection of fish, the uneaten feed and the faecal material released into the rearing environment.

Regarding plastic bags, the quantity is estimated from 4 to 10 tons per year and most aquafarms are selling these wastes to private companies for recycling plastics and thus their valorisation.

Regarding biological wastes from dejection fish, uneaten feed and faeces, treatment processes are more difficult since the rearing takes place in open sea and it is difficult to design a specific system to collect these wastes.

However, in the next section we will present some suggestions to cope with these difficulties and to reduce environmental impact of net cage finfish production occurring in the Tunisian coastal waters (offshore rearing systems).

4.1.2. Circularity of value chains and optimisation options

As indicated above, during its evolution the Tunisian aquaculture has encountered many constraints, due to economic, environmental and social aspects, which can affect its sustainability.

To meet these challenges and to ensure sustainable development, the aquaculture sector must find, through technological and ecological innovation, a way to increase and diversify production to meet growing demand while taking into account and limiting potentially negative impacts on the environment and to increase the circularity of the production processes.

In this context, Integrated Multitrophic Aquaculture systems (IMTA) aim to improve the productivity and environmental sustainability of open water marine fish farming through the implementation of innovative systems. The principle of this Innovative System is the design of an artificial food chain which allows a species to find a source of food in the waste of another species and thus improving the circularity of the production system.

Compared to conventional monospecific aquaculture, the IMTA can reduce as much as possible the environmental impact and the diversification of species produced in the same production site (*e.g.,* shellfish, algae and fish). By calculation based on the entire elimination of the phosphorus intake through extractive organisms such as mussels and marine algae, finfish aquaculture can become extractive in terms of nutrient input and reuse through other aquatic organisms.

The design of an IMTA is based on the trophic chain, where the fish are at the top, the waste from the floating cages, including that of uneaten food, can be extracted by mussels and other detrivorous such as worms or sea cucumbers, and the macro-algae absorb dissolved inorganic waste generated by the aquaculture operation. The mussels, detrivorous and algae can be used as aquafeeds or to enrich feed and soil in regular agriculture, supporting the blue economy.

This "recycling" of aquaculture nutrients would not only minimize wastes in the marine environment, but also produce species of high economic value which ultimately improve the economic profitability of aquaculture farms.

4.2. Aquaculture Feed

The Tunisian aquafeed production is based on 3 companies with a production capacity of *circa* 90 000 tons. The actual needs of feed of the Tunisian aquafarms are no more than 50 000 tons. Although this sufficient production capacity, Tunisian aquafarms import 50 % of their needs (Year 2020). At the short term it is worth to note that the existing aquafeed companies could ensure a full supply of feeds for the Tunisian aquaculture market and thus reduce the dependency on imports. As demonstrated above, the feed costs represent more than 60 % of the total production costs.

As demonstrated through our questionnaire, most used ingredients for the feed production are imported. Both interviewed feed companies have some difficulties when procuring raw material from foreign countries particularly because of the high costs of the required ingredients, high customs etc.

Further development of the feed sector towards locally produced raw materials for fish feed should be initiated, *e.g.,* a supply of fishmeal by a Tunisian fishmeal producer, or other supplier of raw materials for feed. This feed must match international feed quality standards and enable best growth rates for sea bream and seabass, enabling exploration of new markets.

Both issues could result in a reduction of production costs and thus improve the competitiveness of the Tunisian aquaculture, fish farming and aquaculture feed, since feed contributes more than 60 % to the total finfish production.

Companies such as Nextprotein, based in Tunisia[1] or NextGenProteins[2] as well as international institutes such as AWI[3] or Steinbeis[4] could help to gain more independence from imported feed.

4.2.1. Waste treatment

The main waste of the processing feed production is plastic bags of raw materials used for feed fabrication. The estimation of this quantity is 6 to 8 tons per year for each company. Both companies don't spend any treatment cost since a private company of gathering and recycling plastics valorises these solid wastes.

4.2.2. Energy saving

The process of feed manufacturing is an energy-intensive industry which can enhance feed costs and thus production costs. Both interviewed companies are aware of the high of energy costs and consider that the reduction of energy costs is of utmost priority. The TEST methodology in the context of resource efficiency could be introduced here.

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1 http://nextprotein.co/
2 https://nextgenproteins.eu/
3 https://www.awi.de/en/science/special-groups/aquaculture.html
4 https://www.steinbeis.de/en/network/searching-for-steinbeis-experts/detail.html?tx_z7suprofiles_detail%5Bprofile%5D=2868&cHash=a919695bc8db125f7d0c6fd17cab142d

4.2.3. Circularity of value chains and optimisation options

Proteins are the most expensive components of formulated feed and are the limiting components in diets, both in terms of costs and supply and thus, considered as the most critical input in aquafeed.

The use of other alternative sources that reduce feed costs is a prerequisite to produce fish cost effectively. Fish meal has traditionally been used as a major ingredient in commercial aquatic feeds as the most important source of highly digestible protein especially in marine finfish; however, the reduced availability as well as the escalating costs of fishmeal necessitates the need to identify suitable cost-effective alternatives as mentioned in chapter 3.b.

The waste or by-products of the fish processing industry (*e.g.,* tuna, sardines, shrimp heads, waste meal) can be used as a valuable source of protein. The total volumes of by-products from the seafood industry are significant and could become valuable ingredients in feed for fish. For example, Tuna by-product meal, generated in huge quantities, contains 35-45% crude protein and 4-7% crude lipid, which represents a potential to be used as a predominant protein resource in local fish diet formulations.

On the other hand, because vast quantities of fish by-products are generated in commercial sea food transformation that are discarded indiscriminately into the environment, utilizing fish by-product meal as a feed protein source may contribute towards valorisation of this source and the protection of the natural environment. The diversification of sources of nutrients, such as insect-based proteins should be considered as a sustainable alternative to fish-feed nutrients mix, which might open the doors for expanding circular business models beyond the conventional value chain.

4.3. Hatcheries

Currently, only a single hatchery is in activity and its capacity is limited. This capacity doesn't exceed 20 % of the required quantities. However, the adequate sites for the implementation of the hatcheries are available. Besides, the development of the hatchery implementation is well justified since the demand of fingerlings at the local and sub-regional levels is considered high. It's also worth to note that the costs and resulting price of fingerlings produced in a Tunisian hatchery could be highly competitive. This allows to develop a local economy with positive impact on social aspects via job creation, capacity building etc.

Another important aspect that should be considered is the upgrade of the production facilities by using new technologies, since the potential of innovation and technology in this area evolves rapidly.

4.3.1. Energy saving

Regarding energy use, a huge amount of energy was used by the active hatchery. This can be explained by technical aspects, mainly related to pumping the water from the sea to recirculate water inside the rearing facilities. This consumption level significantly increases the juvenile production costs. The responsible staff is aware of the high energy consumption in the facility and has already initiates to reduce/rationalize the used energy. The development of more closed, recirculating aquaculture systems (RAS), requiring less water and pumping energy but a higher level of technology, can be seen as one option for the future.

The analysis of the fingerlings production shows that the subsector has many strengths fostering its development and that several opportunities are available to improve its performance, through using advanced technology of water treatment and vaccination, as described in chapter 3.c.

However, regulatory, organizational, and administrative measures should be considered in order to strengthen the competitiveness of the hatcheries and thus overcome with one of the most important barriers for the development of the marine finfish production.

4.4. Shellfish Farming

Generally, Shellfish farming does not require significant financial resources compared to finfish. In Tunisia Shellfish farms are relatively small (investments does not exceed 250 thousand dinars and employment of generally less than 5 persons).

Over the last decades the production of shellfish in the Bizerte lagoon fluctuated around 140 tons. However, the production capacity of the lagoon is estimated to be 3000 tons. This is caused mainly by environmental conditions and the permanent contamination of farmed products, by biotoxin, rending product unsuitable for marketing on local as well as international markets. However, with the production of oysters, shellfish farming can produce a highly valuable product and can be considered as underexploited. Also, mussels and oysters are essential components in Integrated Multitrophic Aquaculture systems, that could also foster a sustainable finfish mariculture development off the Tunisian coasts.

4.4.1. Waste treatment

Shellfish farming is an extractive aquaculture activity since mussels and oysters are filter-feeding organisms and therefore do not need exogenous artificial food. Shellfish reduces environmental pollution and eutrophication and it’s breeding therefore contributes to water purification. However, because of the production of pseudofaeces below and in the vicinity of the shellfish culture systems, they can alter the direct surroundings.

For the solid waste categories, as indicated above the estimated quantity of used plastics (rope, nets, floats etc.) is relatively low and doesn’t exceed 7.5 tons per year.

4.4.2. Circularity of value chains and optimization options

Shellfish producers suffer from the low profitability of their companies since the efficiency of their companies largely depends on environmental conditions of the lagoon, especially, the endemic situation of toxic phytoplankton (biotoxins) in the shellfish. To cope with this problem, shellfish producers move their facilities to the open sea to look for more suitable environmental conditions. However, in the open sea because of less nutrients availability, the growth performance and thus the profitability is significantly affected. Besides, when moving to the open sea, producers need more sophisticated and robust facilities to support current and swells. New technologies, such as the development of hatcheries and juvenile shellfish production inside the lagoon and grow out in IMTAs based on nutrients from finfish production can help to push this aquaculture activity forward.

Shellfish production should become an integral part of the integrated multitrophic aquaculture production to be developed, as this can minimise the environmental impact and at the same time diversify the aquaculture products. In this context, shellfish beneficiate from organic matter released by finfish cage as food source to have a reasonably growth performance compared with the limited grow-out potential inside the lagoon.

5. Annex

Annex 1: Financial incitation

The decree N° 2017-389 of March 9, 2017 of financial incitation when introducing new/innovation technologies: The criteria of eligibility and application procedures.

Nature of financial incitation	% of the cost	Limit of financial incitation
Material investments to control modern technology and improve productivity	50%	500 000 DT
Sustainable development: Reduce pollution and protect environment	50%	300 000 DT
Research and innovation/ Promotion	50%	300 000 DT

Annex 2: Questionnaires Phase 1

The first questionnaire for the preliminary study was published online:
https://docs.google.com/forms/d/1rtOr_KG4gZ55tuR5sUhbJ_EUcZNn6-aCcUP7KVv8oFs/edit

The in the second and deeper survey the following questionnaires were sent out directly to the companies:

Questionnaire 1 : Pisciculture Marine

1) Nom de la Ferme aquacole

…………………………………………………………………………..

2) Capacité de production (Tonnes)

………………………………………………

3) Historique de la production (tonnes/an)

	2016	2017	2018	2019	2020
Daurade					
Loup					
Maigre					

4) Commercialisation : Merci de remplir les tableaux suivants.

	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
2020	Daurade			
	Loup			
	Maigre			

	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
2019	Loup			
	Daurade			
	Maigre			

	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
2018	Loup			
	Daurade			
	Maigre			

2017	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
	Loup			
	Daurade			
	Maigre			

5) Origines des intrants

	2020		**2019**		**2018**	
	Origine	**Quantité**	**Origine**	**Quantité**	**Origine**	**Quantité**
Alevins loup						
Alevins daurade						
Aliments	Local : Etranger :					
Médicaments						

6) Difficultés rencontrées lors des acquisitions des intrants

- ☐ Prix élevé
- ☐ Irrégularité de la disponibilité
- ☐ Taxes douanières élevées
- ☐ Dépendance de l'import
- ☐ Procédures administratives (autorisation, contrôle, etc.)
- ☐ Qualité non assurée

7) Performances technico-économiques : Merci de remplir les tableaux suivants.

Année 2020

Aliment local	Quantité consommée : ……………%	Prix (DT)	
		Taux de conversion alimentaire	
Aliment importé	Quantité Consommée ……………%	Prix (DT)	
		Taux de conversion alimentaire	

Année 2019

Aliment local	Quantité consommée : ……………%	Prix (DT)	
		Taux de conversion alimentaire	
Aliment importé	Quantité Consommée ……………%	Prix (DT)	
		Taux de conversion alimentaire	

Année 2018

Aliment local	Quantité consommée : ……………%	Prix (DT)	
		Taux de conversion alimentaire	
Aliment importé	Quantité Consommée ……………%	Prix (DT)	
		Taux de conversion alimentaire	

8) Stratégie de la ferme à court et à moyen termes :

- ☐ Augmenter la production
- ☐ Diminuer la production
- ☐ Diversification de la production/système de production (AMTI)
- ☐ Amélioration de la qualité de production
- ☐ Exploration de nouveau marché (Export)
- ☐ Valorisation du produit (transformation)

9) Qu'est-ce qui limite actuellement l'expansion de votre entreprise ? Veuillez en nommer 3 par ordre de priorité.

1. ……………………………………………………………………………………
2. ……………………………………………………………………………………
3. ……………………………………………………………………………………

10) Quels sont les principaux obstacles à l'innovation / utilisation des technologies

- ☐ Manque de connaissances techniques / scientifiques
- ☐ Coût d'investissement élevé
- ☐ Absence d'incitations gouvernementales

11) Etes-vous au courant des incitations financières pour l'investissement dans la maîtrise et l'introduction de nouvelles technologies et l'amélioration de la productivité (Décret N° 2017-389 du 9 Mars 2017).

- ☐ Oui
- ☐ Non

12) De quels acteurs importants d'autres sous-secteurs attendez-vous le plus d'impact positif pour votre ferme aquacole ? classer par ordre d'importance (1, 2, 3)

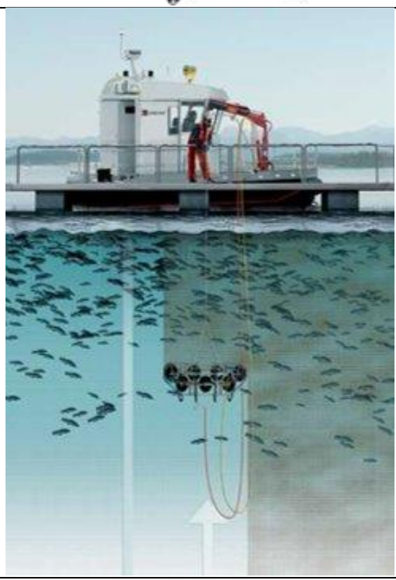
- ☐ Producteurs d'alevins (Ecloserie)
- ☐ Producteurs d'Aliments
- ☐ De la recherche scientifique

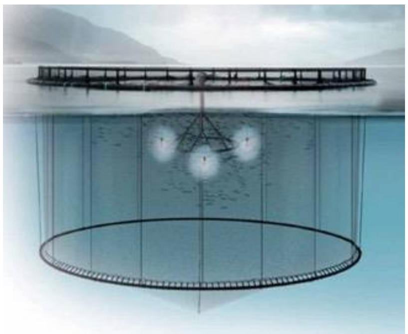
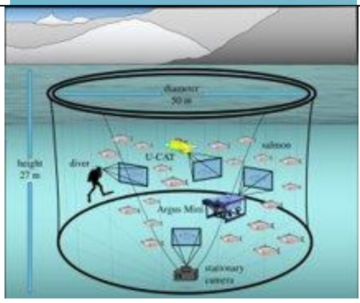
13) Ya t-ils des contraintes environnementales pour votre entreprise ?

- ☐ Oui
- ☐ Non

Si oui lesquelles :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………………………………………………………………………………

14) Veuillez classer (1, 2, 3, …) les technologies suivantes en termes de pertinence pour votre ferme aquacole.

Ordre	Désignation	Illustration/photo
………… .	Système de contrôle environnemental	
…………	Système de nettoyage des filets	

…………..	Système de collectes des poissons morts	
…………	Système d’alimentation sous-marin : Amélioration de l’efficacité de la conversion de l’aliment	
………..	Système de distribution d’aliment à surface (répartition homogène)	
………….	Système optique de surveillance et ajustement de la ration alimentaire en fonction des conditions environnementales et du comportement des poissons	

		
………… .	Système d’abatage sans stress pour le poisson (conservation de son bien être)	

15) Quelle étape du cycle de production est la plus problématique ?
………
………
……………………………………………………………………

16) Quelle est la saison la plus problématique ?
………
………
……………………………………………………………………

17) Avez-vous déjà vu des maladies / parasites dans votre ferme et pouvez-vous les citer ?
………
………
……………………………………………………………………

18) Pour faire face au phénomène de fouling, combien de fois (en moyenne) changez-vous les filets au cours d'un cycle de production

- ☐ 1-3 fois
- ☐ 4-6 fois
- ☐ Plus de 6

19) Dans les jours qui suivent le changement des filets, avez-vous observé des événements de mortalité d'organismes d'élevage ?

- ☐ Oui
- ☐ Non

20) Si «oui», merci d’estimer la mortalité cumulée liée au processus de changement des filets au cours d’un cycle de production ?

- ☐ < 5%
- ☐ 5 à 10%

- 10 à 15%
- > 20%

21) Avez-vous des contacts avec des instituts de recherche ? À qui adressez-vous lors des problèmes spécifiques ?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
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22) Où et comment recrutez-vous votre personnel ?
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………….

23) Employez-vous des Techniciens et/ou des Ingénieurs ? Et si non, le feriez-vous ?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…

24) Une estimation de la quantité d'énergie utilisée :

Kwh : …………………………………………………………………………………………………
…….
Coût/an : …………………………………………………………………………………………………
……
Y a-t-il une initiative pour réduire le coût/la quantité d'énergie utilisée :
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………

25) Une estimation de la quantité d'eau douce utilisée

Quantité : ……………………………………………………….
Source : …………………………………………………………..
Coût annuel : ……………………………………………………..
Le devenir de l'eau utilisée : …………………………………………………
Y a-t-il une initiative pour réduire la consommation d'eau (e.g. traitement/re-utilisation) :
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

……………………………………………………………………………………………………
………………………………………

26) Déchets générés par le système de production

Quantité : ………………………………………………………………..
Coût de traitement/de collecte : …………………………………………………
Y a-t-il une initiative pour réduire la quantité des déchets générés/créer de la valeur ajoutée :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………………………………

27) Investissement réalisé par la société : Quels sont les derniers investissements réalisés :

Type : …………………………………………………….
Coût : ……………………………………………………
Parmi les motivations de cet investissement :

- ☐ Rentabilité financière - retour sur investissement
- ☐ Enjeux environnementaux
- ☐ Contraintes/nécessités réglementaires
- ☐ Réputation
- ☐ Autre : ………………………………………………………………………………………
……

28) Percevez-vous déjà les bénéfices attendus de cet investissement :

- ☐ Oui
- ☐ Non

29) Seriez-vous intéressé par un projet pilote en relation avec vos activités et un entretien personnel pour clarification

……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………………………………………

30) Comment votre entreprise est-elle perçue par le public (réputation) ?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………

31) Seriez-vous disponible pour être contacté pour plus d'informations ?

- ☐ Oui, (e-mail / numéro de téléphone du contact): ………………………………………………………
- ☐ Non

Questionnaire 2 : Les producteurs d'aliments aquacoles

1) Nom de l'usine d'aliment

……………………………………

2) Capacité de production (Tonnes)
………………………………………………

3) Historique de la production (tonnes/an)

	2016	2017	2018	2019	2020
Aliment Daurade					
Aliment Loup					

4) Origines des intrants
Merci de compléter les informations du tableau suivant (* 1 : disponible ; 2 : moyennement disponible ; 3 : peu disponible)

Matière premières conventionnelles utilisées	Quantité (Tonnes/an)	Origine	Prix moyen d'achat (DT/tons)	Acquisition/disponibilité*		
				1	2	3
Farines de poisson						
T. de Soja						
Gluten de Maïs						
Farine de Blé						
Huile Végétale						
Huiles de poissons						
……………………………						
……………………………						

Matière premières non conventionnelles utilisées	Quantité (Tons/an)	Origine	Prix moyen d'achat (DT/tons)	Acquisition/disponibilité*		
				1	2	3

Matière premières non conventionnelles que vous pensez utiliser dans vos perspectives	Quantité (Tons/an)	Origine	Prix moyen d'achat (DT/tons)	Acquisition/disponibilité*		
				1	2	3

* 1 : disponible ; 2 : moyennement disponible ; 3 : peu disponible

5) 3° Répartition du Cout de production de l'aliment

	Valeurs (DT)
Matières premières	
Main d'œuvre	
Energie	
Autre ……………	
Autre …………………………	
Total	

6) Utilisez-vous des additifs alimentaires (immunostimulants, amélioration de la santé et du bien-être, amélioration de la digestibilité etc.)

- ☐ Non
- ☐ Oui, Merci de les citer :
  1- ……………………………………………………………

2- ………………………………………………………………
3- ……………………………………………………………..

7) Difficultés rencontrées lors des acquisitions des intrants

- Prix élevé
- Irrégularité de la disponibilité
- Taxes douanières élevées
- Dépendance de l'import
- Procédures administratives (autorisation, contrôle, etc.)
- Qualité non assurée

8) Stratégie de la société à court et à moyen termes :

- Augmenter la production++
- Diminuer la production
- Amélioration de la qualité de production++
- Exploration de nouveaux marchés (Export)++

9) Qu'est-ce qui limite actuellement l'expansion de votre entreprise ? Veuillez en nommer 3 par ordre de priorité.

4. ……………………………………………………………………………………
5. ……………………………………………………………………………………
6. ……………………………………………………………………………………

10) Quelles sont les améliorations techniques et/ou Logistiques que vous projetez à le faire pour une meilleure efficience ou pour une gestion optimisée des processus ?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………

11) Quels sont les principaux obstacles à l'innovation / utilisation des technologies (par exemple : pour réduire l'utilisation d'Energie, réduire l'impact sur l'environnement etc.)

- Manque de connaissances techniques / scientifiques
- Coût d'investissement élevé
- Absence d'incitations gouvernementales

12) Etes-vous au courant des incitations financières pour l'investissement dans la maîtrise et l'introduction de nouvelles technologies et l'amélioration de la productivité (Décret N° 2017-389 du 9 Mars 2017).

- Oui
- Non

13) De quels acteurs importants d'autres sous-secteurs attendez-vous le plus d'impact positif pour votre société ? classer par ordre d'importance (1, 2, 3).

- Aquaculteurs
- Fournisseurs de matières premières
- De la recherche scientifique

14) Avez-vous une unité de recherche-développement dans votre entreprise pour l'optimisation et l'amélioration de votre production ?

- Oui
- Non

15) Avez-vous des contacts avec des instituts de recherche ?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………………………………………

16) Où et comment recrutez-vous votre personnel ?
……………………………………………………………………………………………………
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……………………………………………………………………………………………………
……………………………………………

17) Employez-vous des Techniciens et/ou des Ingénieurs ? Et si non, le feriez-vous ?
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…

18) Une estimation de la quantité d'énergie utilisée :

Kwh :
……………………………………………………………………………………………………
…….
Coût/an :
……………………………………………………………………………………………………
……
Y a-t-il une initiative pour réduire le coût/la quantité d'énergie utilisée :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…

19) Une estimation de la quantité d'eau douce utilisée

Quantité : ……………………………………………………………
Source : ……………………………………………………………..

Coût annuel : …………………………………………………..
Le devenir de l'eau utilisée : …………………………………………………
Y a-t-il une initiative pour réduire la consommation d'eau (e.g. traitement/re-utilisation) :
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

20) Déchets générés par le système de production

Quantité : ………………………………………………………………..
Coût de traitement/de collecte : ……………………………………………………
Y a-t-il une initiative pour réduire la quantité des déchets générés/créer de la valeur ajoutée :
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

21) Investissements réalisés par la société : Quels sont les derniers investissements réalisés:

Type : ……………………………………………………….
Coût : …………………………………………………………
Parmi les motivations de cet investissement :
- ☐ Rentabilité financière - retour sur investissement
- ☐ Enjeux environnementaux
- ☐ Contraintes/nécessités réglementaires
- ☐ Réputation
- ☐ Autre : ……………………………………

22) Percevez-vous déjà les bénéfices attendus de cet investissement :

- ☐ Oui
- ☐ Non

23) Seriez-vous intéressé par un projet pilote et un entretien personnel pour clarification
…………………………………………………………………………………………………
…………………………………………………………………………………………………..

24) Comment votre entreprise est-elle perçue par le public (réputation) ?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

25) Seriez-vous disponible pour être contacté pour plus d'informations ?

- ☐ Oui, (e-mail / numéro de téléphone du contact) :
  ____
- ☐ Non

Questionnaire 3 : Ecloserie

1) Nom de la Ferme aquacole

…………………………………………………………………………...
2) Capacité de production (Tonnes)
……………………………………………………………………………

3) Historique de la production (tonnes/an)

	2016	2017	2018	2019	2020
Daurade					
Loup					

4) Stratégie de l'écloserie à court et à moyen termes :

- ☐ Augmenter la production
- ☐ Diminuer la production
- ☐ Diversification de la production
- ☐ Amélioration de la qualité de production
- ☐ Exploration de nouveau marché (Export)

5) Qu'est-ce qui limite actuellement l'expansion de votre entreprise ? Veuillez en nommer 3 par ordre de priorité.

7. ………………………………………………………………………………………
8. ………………………………………………………………………………………
9. ………………………………………………………………………………………

6) Quels sont les principaux obstacles à l'innovation / utilisation des technologies

- ☐ Manque de connaissances techniques / scientifiques
- ☐ Coût d'investissement élevé
- ☐ Absence d'incitations gouvernementales

7) Etes-vous au courant des incitations financières pour l'investissement dans la maîtrise et l'introduction de nouvelles technologies et l'amélioration de la productivité (Décret N° 2017-389 du 9 Mars 2017).

- ☐ Oui
- ☐ Non

8) De quels acteurs importants d'autres sous-secteurs attendez-vous le plus d'impact positif pour votre écloserie ? classer par ordre d'importance (1, 2, 3)

- ☐ Producteurs (fermes aquacoles de grossissement)
- ☐ Producteurs d'Aliments

- ☐ De la recherche scientifique

9) Ya t-ils des contraintes environnementales pour votre écloseries ?

- ☐ Oui
- ☐ Non

Si oui lesquelles :
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………

10) Quelle phase du cycle de production est la plus problématique ? (de Jour x à Jour y post éclosion)
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………

11) Quelle est le taux de survie à la fin du sevrage ?
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………

12) Quels sont les taux des principales malformations morpho-anatomiques rencontrées

- ☐ Squelettiques (fusion, lordose et scoliose) : taux = ……………
- ☐ Absences de vessies natatoires : taux = ………………………..
- ☐ Opercules courts : Taux = ………………………………..
- ☐ Maxillaires anormaux : Taux = …………………………

13) Pratiquez-vous la vaccination dans votre société ?

- ☐ Oui
- ☐ Non

14) Avez-vous des contacts avec des instituts de recherche ? À qui adressez-vous lors des problèmes spécifiques ?

……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………

15) Comment recrutez-vous votre personnel ?
……………………………………………………………………………………………
……………………………………………………………………………………………
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……………………………………………………………………………………………………
……………………………………….

16) Employez-vous des Techniciens et/ou des Ingénieurs ? Et si non, le feriez-vous ?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

17) Une estimation de la quantité d'énergie utilisée :

Kwh :
……………………………………………………………………………………………………
Coût/an :
……………………………………………………………………………………………………
Y a-t-il une initiative pour réduire le coût/la quantité d'énergie utilisée :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

18) Une estimation de la quantité d'eau douce utilisée

Quantité : ………………………………………………………….
Source : ……………………………………………………………..
Coût annuel : …………………………………………………..
Le devenir de l'eau utilisée : …………………………………………………
Y a-t-il une initiative pour réduire la consommation d'eau (e.g. traitement/re-utilisation)
:……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

19) Déchets générés par le système de production

Quantité : …………………………………………………………………..
Coût de traitement/de collecte : ……………………………………………………
Y a-t-il une initiative pour réduire la quantité des déchets générés/créer de la valeur ajoutée :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

20) Investissement réalisé par la société : Quels sont les derniers investissements réalisés :

Type : …………………………………………………….
Coût : ……………………………………………………….
Parmi les motivations de cet investissement :

- ☐ Rentabilité financière - retour sur investissement
- ☐ Enjeux environnementaux
- ☐ Contraintes/nécessités réglementaires
- ☐ Réputation

- ☐ Autre : ……………………………………………………………………………………………………
……

21) Percevez-vous déjà les bénéfices attendus de cet investissement :

- ☐ Oui
- ☐ Non

22) Seriez-vous intéressé par un projet pilote en relation avec vos activités et un entretien personnel pour clarification

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23) Comment votre entreprise est-elle perçue par le public (réputation) ?

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24) Seriez-vous disponible pour être contacté pour plus d'informations ?

- ☐ Oui, (e-mail / numéro de téléphone du contact): …………………………………………………………
- ☐ Non

Questionnaire 4 : Conchyliculture

1) Nom de la Ferme aquacole

………………………………………………………………………………………..

2) Capacité de production (Tonnes)

………………………………………………………………………………………..

3) Historique de la production (tonnes/an)

	2016	2017	2018	2019	2020
Moule					
Huitre					

4) Commercialisation : Merci de remplir le tableau suivant

2020	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
	Moule			
	Huitre			

2019	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
	Moule			
	Huitre			

2018	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
	Moule			
	Huitre			

2017	Production Totale	Production Par espèce (Tonnes)	Marché national (Tonnes)	Export (Tonnes)
	Moule			
	Huitre			

5) Stratégie de la ferme à court et à moyen termes :

- ☐ Augmenter la production
- ☐ Diminuer la production
- ☐ Amélioration de la qualité de production
- ☐ Exploration de nouveau marché (Export)

- ☐ Valorisation du produit (transformation)

6) Qu'est-ce qui limite actuellement l'expansion de votre entreprise ? Veuillez en nommer 3 par ordre de priorité.

10. ……………………………………………………………………………………
11. ……………………………………………………………………………………
12. ……………………………………………………………………………………

7) Quels sont les principaux obstacles à l'innovation / utilisation des technologies

- ☐ Manque de connaissances techniques / scientifiques
- ☐ Coût d'investissement élevé
- ☐ Absence d'incitations gouvernementales

8) Etes-vous au courant des incitations financières pour l'investissement dans la maîtrise et l'introduction de nouvelles technologies et l'amélioration de la productivité (Décret N° 2017-389 du 9 Mars 2017).

- ☐ Oui
- ☐ Non

9) De quels acteurs importants d'autres sous-secteurs attendez-vous le plus d'impact positif pour votre ferme aquacole ? classer par ordre d'importance (1, 2, 3)

- ☐ Producteurs de naissains (Ecloserie)
- ☐ Fournisseurs d'équipements
- ☐ De la recherche scientifique

10) Ya t-ils des contraintes environnementales pour votre entreprise ?

- ☐ Oui
- ☐ Non

Si oui lesquelles :
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………

11) Avez-vous une base de données environnementales de votre site de production
    - ☐ Non
    - ☐ Oui, Si oui quels sont les principaux paramètres environnementaux enregistrés/contrôlés
      1- ………………………………………………………………
      2- ………………………………………………………………
      3- ………………………………………………………………

12) Quelle étape du cycle de production est la plus problématique ?

……
……
…………………………………………………………………

13) Quelle est la saison la plus problématique ?

……
……
…………………………………………………………………

14) Avez-vous déjà vu des maladies / parasites/virus dans votre ferme et pouvez-vous les citer ?

……
……
…………………………………………………………………….

15) Avez-vous des contacts avec des instituts de recherche ? À qui adressez-vous lors des problèmes spécifiques ?

……
……
………………………………………………………………………………………………

16) Comment recrutez-vous votre personnel ?

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……
……
……
……………………………………………….

17) Employez-vous des Techniciens et/ou des Ingénieurs ? Et si non, le feriez-vous ?

……
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……
……

18) Une estimation de la quantité d'énergie utilisée :

Kwh :
……
Coût/an :
……
……

Y a-t-il une initiative pour réduire le coût/la quantité d'énergie utilisée :
……
……
……
……

19) Une estimation de la quantité d'eau douce utilisée

Quantité : ………………………………………………………………….
Source : ……………………………………………………………………..

Coût annuel : …………………………………………………..
Le devenir de l'eau utilisée : ………………………………………………….
Y a-t-il une initiative pour réduire la consommation d'eau (e.g. traitement/re-utilisation) :
………………………………………………………………………………………………

20) Déchets générés par le système de production

Quantité : ……………………………………………………………..
Coût de traitement/de collecte : ………………………………………………….
Y a-t-il une initiative pour réduire la quantité des déchets générés/créer de la valeur ajoutée :
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…

21) Investissement réalisé par la société : Quels sont les derniers investissements réalisés :

Type : …………………………………………………….
Coût : ……………………………………………………….
Parmi les motivations de cet investissement :

- ☐ Rentabilité financière - retour sur investissement
- ☐ Enjeux environnementaux
- ☐ Contraintes/nécessités réglementaires
- ☐ Réputation
- ☐ Autre :
  ………………………………………………………………………………………………
  ……

22) Percevez-vous déjà les bénéfices attendus de cet investissement :

- ☐ Oui
- ☐ Non

23) Seriez-vous intéressé par un projet pilote en relation avec vos activités et un entretien personnel pour clarification

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24) Comment votre entreprise est-elle perçue par le public (réputation) ?

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25) Seriez-vous disponible pour être contacté pour plus d'informations ?

- ☐ Oui, (e-mail / numéro de téléphone du contact) :
  ____
- ☐ Non

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