

Promoting the blue circular economy of the fish processing value chain in Morocco

*Survey report among stakeholders in the processing of fishery products
Analysis and potential for circular development*

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*"..., it is recommended to better exploit the full potential of the green economy and the blue economy, which create value in all territories. The Commission encourage adopting a strategy dedicated to the green economy and applied at the territorial level, **favouring the logic of a circular economy integrating local specificities and potentialities**. Particular attention should be paid to the development of green industrial sectors in the fields of solar energy, wind energy, liquid sanitation and waste management. In order to anticipate the future skills needs corresponding to the development of green sectors, the Commission invites the deployment of training programmes dedicated to green professions and the promotion, through appropriate incentives, of research-development-innovation initiatives led by academic, industrial and financial actors. ... "*

*Extract from the general report
the Special Commission on the Development Model,
May 2021*

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1 A reminder of the objectives of the SwitchMed programme

The processing and valorization industry of fishery products in Morocco occupies an important place in the national economy (creation of added value and employment, source of foreign exchange, food security, etc.). The industrial fabric of the marine fisheries sector is very diversified and accounted in 2019, 469 units of all activities combined, of which freezing is the dominant activity followed by the preservation of fish and the packaging of fresh fish.

The processing processes of fishery products generate, on the one hand finished products (canned, semi-preserved, frozen or fresh products, etc.), and on the other hand, unused residues commonly referred to as co-products. The latter refers to by-products, by-catches, discards, unsold goods, etc. These are generally fish or parts of fish (but also crustaceans, cephalopods) not consumed, such as skin, bones, heads, viscera, etc. They come from different treatment processes such as threading, evisceration, heading, peeling, washing, thawing or cooking.

"Co-products" can also consist of whole fish called "non-machinable." These are fish of low freshness whose handling and conservation have been deficient upstream of the value chain. Efforts have been made by the Department of Fisheries to improve the quality of landings through, in particular:

- The generalization of standardized containers in coastal fishing (seiners, trawlers, longliners),
- The elimination of bulk storage onboard vessels (seiners),
- The equipment of artisanal boats of insulated boxes (ice-box) aids in preserving the freshness of the catch and eventually increases the market value.

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 Southern Mediterranean. SwitchMed builds on the results of the first phase to further support and scale up the transition to Sustainable and Cleaner Production (SCP) practices 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 UNIDO's TEST methodology, to economic activities related to marine and coastal areas is crucial in developing the concept of the blue economy in the Mediterranean region.

This approach stimulates 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) and to increase the efficiency and competitiveness of established and resulting from the blue economy.

To achieve this goal, the SwitchMed project will go through the following phases:

- Identify projects/initiatives with high potential for sustainable development and in line with sector priorities;
- The implementation of a number of pilot projects by demonstrating the TEST methodology and promoting the circular economy via the demonstration of innovative technologies;
- Results and best practices disseminated to stakeholders on a national level.

As part of the first phase, scheduled for 2021, the project focuses on carrying out an in-depth study of the Fish Processing value chain in Morocco, concerning key industrial players, to analyze regulatory and market barriers, the potential for optimization to reduce the environmental impact of industrial sites, as well as the study of opportunities for the transfer of innovative technologies in the implementation of solutions. Particular attention will be given to national flows to propose an analysis of alternative scenarios and economic models aimed at their valorization and the creation of added value at a national and local level.

2 Methodological approach

The original methodological approach is described in the "Inception Report." The remaining project, data collection was complemented by bilateral talks and discussion cycles with representatives of the different subsectors.

2.1 Involvement of national stakeholders

National stakeholders are involved in the following measures:

- Launch Event and Technical Workshop.
- Bilateral meetings (see 2.c)
- A two-stage quantitative survey (see 2.d)
- Sectoral workshops

The quantitative approach is carried out by representative sampling, taking into account the following criteria:

- Belonging to the identified priority sub-sectors.
- Geographical representation
- Representativeness in terms of enterprise size
- Quality of potentially important data

From the outset of the programme, the Programme selected the Fédération Nationale des Industries de Transformation et de Valorisation des Produits de la Pêche (FENIP) as a true partner of the Programme. Also, all activities took place in consultation with FENIP. It has been associated even in the definition of the methodological approach.

In the same vein, the technical workshop presented the methodological approach to FENIP in January 2021. In March 2021, a kick-off workshop was organized with the support of FENIP and attended by representatives of companies, professional associations affiliated to FENIP and institutional leaders.

2.2 Selection of priority sub-sectors

According to the outlined criteria, the analysis of the different sub-sectors of the fish processing industry highlights three priority sub-sectors: canning, freezing and fish meal and oil, with a total population of 266 units.

Table 1 Established Sub-sectors

ESTABLISHED SUB-SECTORS	Volume exporté	CA Export	Total des emplois créés	Volume total des déchets	Score total
CONSERVE	*****	***	*****	*****	18
SEMI-CONSERVE	*	**	**	**	7
CONGELATION A TERRE (*)	*****	*****	***	*****	17
CONDITIONNEMENT	*	**	*	*	5
FARINE ET HUILE DE POISSON	*****	**	*	***	11

Beyond the historically well-established sectors presented in the table above, several avenues for the valorization of co-products could be identified:

- Oils enriched with omega 3
- Protein hydrolysates
- Use of by-products in animal feed (aquaculture)
- Manufacture of sardine pâté / terrine
- Valorization of shrimp shells

3 Results of consultations and investigations

The various meetings and surveys of professionals were conducted with the assistance of FENIP, who played a key role in raising awareness and mobilizing industrialists. The consultations and surveys were conducted according to the following framework:



Figure 1 Project framework

3.1 Kick-off meeting

The kick-off meeting was an opportunity for the United Nations Industrial Development Organization (UNIDO) to announce the launch of the SwitchMed Programme and to promote the circularity of the fishery processing value chain in the Kingdom of Morocco. This first meeting was held on March 22, 2021.

This project is part of the deployment of the Blue Economy component in the SwitchMed Programme led by UNIDO. The event was organized via videoconference in partnership with FENIP.

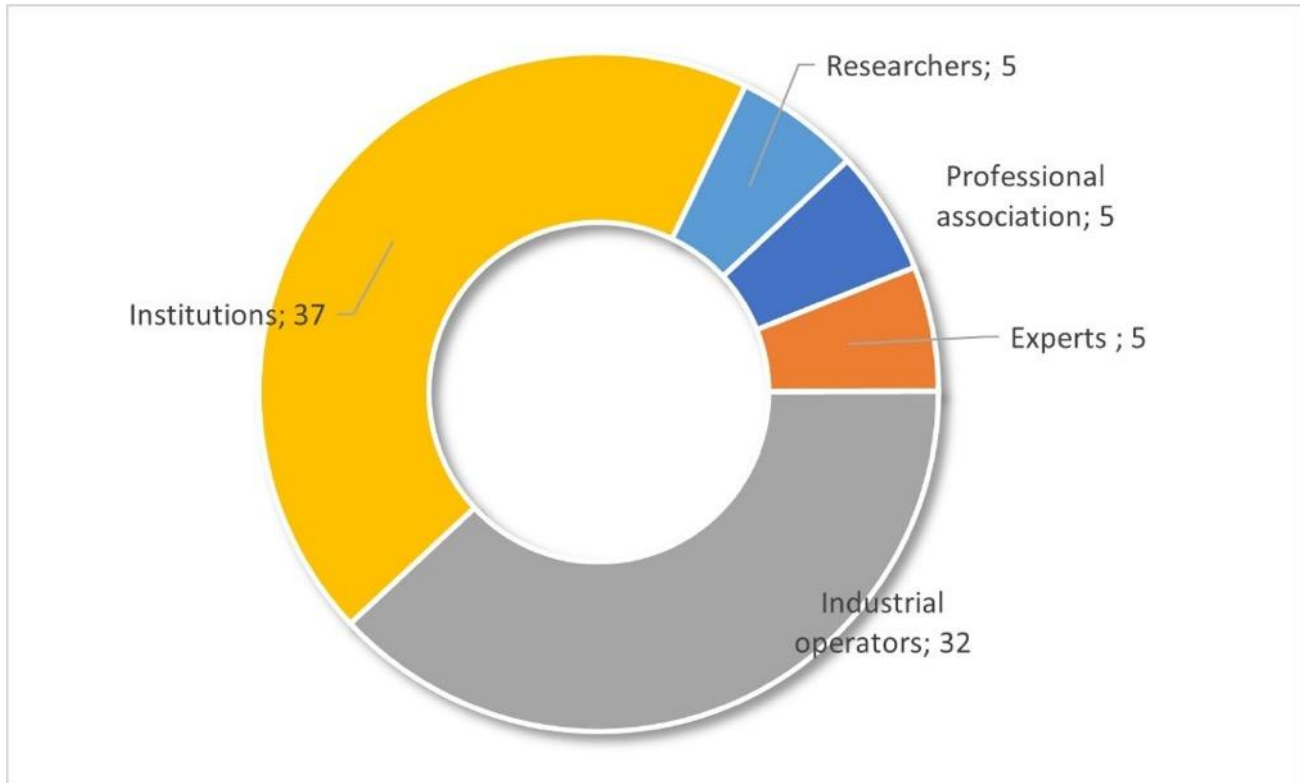


Figure 2 Attendance during the Opening Event – 22 March 2021

Nearly 90 people, including representatives of the Moroccan administration, the Delegation of the European Union and UNIDO, professional organizations, Moroccan industrialists in different branches of activity (canned, semi-preserved, frozen, fish meal and oil, etc.) as well as researchers and experts specialized in the field of valorization of fishery products attended the meeting.

The kick-off meeting was organized in three sessions. A first opening session in which the following took part:

- Mr Mohamed BENYAHIA, Secretary General - Ministry of Energy, Mines and Environment/Department of the Environment
- Dr. Abdelmalek FARAJ, Director General of the National Institute of Fisheries Research representing the Ministry of Agriculture, Maritime Fisheries, Rural Development and Water and Forests
- Mr Hassan SENTISSI, President of the National Federation of Industries of Processing and Valorization of Fishery Products (FENIP).
- Mr Jean-Christophe FILORI, Head of Cooperation of the Delegation of the European Union to the Kingdom of Morocco
- Ms Hanan HANZAZ, Country Representative, United Nations Industrial Development Organization (UNIDO)

The various speakers agreed on the importance of the theme of preservation and optimization of resources. The various sectoral strategies and plans undertaken by the Kingdom of Morocco are in line with the objectives of the SwitchMed Programme.

The second part, supported by UNIDO representatives, was reserved for the presentation of the SwitchMed Programme, its objectives, the expected results and the provisional timetable for the various activities planned within that framework.

The third part was conducted in the form of an interactive workshop facilitated by the national expert of the Programme, with the assistance of FENIP. This workshop was attended by a panel of speakers representing both the private sector and applied scientific research as well as experts in the field. This panel was made up of the following people:

Name and surname	Organisation	Activity
Dr Mohamed Bouayad,	AHP/ FENIP	Professional association Semi-preserve industry
Dr Meriem Kharroubi	CSVTPM-INRH	Applied scientific research
Ms. Lamia Znagui	FENIP	Professional association
Ms. Hind M'Kadem	CIBEL	Canning industry
Mr Abdessamad El Oumari	COFRIGOB	Freezing industry
Ms. Sanaa Attaoui,	COPELIT	Fishmeal and fish oil industry
Mr. Larbi El Hamami,	GIAC Fishing	Counselling and vocational training
Dr. Mohamed Naji	IAV Hassan II	Expert
Pr. Lahsen Ababouch	Independent consultant	Expert

The discussions focused on the following points:

- Current destination of co-products generated by the processing industry
- Potential avenues for a better exploitation of resources
- Conditions of success for a better valorization of co-products.

The exchanges between the various speakers were very constructive. The main findings can be summarized as follows:

- A strong interest in the SwitchMed Programme is evidenced by the number of participants who remained until the end of the workshop (52 people);
- The issue of resource efficiency is in line with the various current strategies of the Kingdom of Morocco (fisheries, sustainable development, blue belt, industrial acceleration plan, etc.);
- The co-products generated by the processing industries are currently returned to the fishmeal and fish oil industry which remains the main destination with a few exceptions,
- The valorization of co-products and innovation offer real prospects for diversification of the offer, which remains relatively limited.
- Applied research is highly developed thanks to the work of the CSVTPM-INRH carried out as part of the latter's research program or in collaboration with other professional partners such as AHP or FENIP. This work opens up good development prospects for the sector.
- Current applied research (CSVTPM) remains insufficient in the absence of a pilot unit for the manufacture of industrial pre-series and market tests before embarking on industrial manufacturing,
- Several works have been carried out in these areas, but which are not often valued. Priority could be given to projects and avenues already studied.
- Lack of funding dedicated specifically to fishing processing industries like other sectors such as agriculture or other industries. As such, it was suggested the creation of a

specific financing fund adapted to the "Crédit Maritime" sector which will be able to finance in particular investments related to the processing of fishery products.

- The market remains one of the handicaps for the development of new products, especially if they are new markets to be developed. SMEs do not have enough means to develop marketing strategies.
- Human resources are not a real constraint. Tools such as Maroc PME or the GIAC Pêche make it possible to take charge of technical assistance actions (Maroc PME) or training (GIAC Pêche).
- The CSVTPM, the AHP are key players in R&D and new product development;
- The AHP plans to carry out a study on the factory of the future. The issue of resource efficiency will be one of the objectives sought.

3.2 Bilateral meetings

3.2.1 Specialized Center for valorization and Technology of Seafood Products (CSVTPM) of the INRH

As part of the bilateral meetings, a first meeting was organized with the managers of the Specialized Center for valorization and Technology of Seafood Products (CSVTPM) of the INRH.

The main missions of the Centre as presented by its managers include:

- The development of seafood processing technologies,
- The contribution to increasing the added value of fishery products,
- Contribute to the improvement of quality and hygiene management,
- Improvement of laboratory analysis systems,
- Support for the profession and investors;
- The development of technological innovations.

Specific missions of the Centre may include:

- The development of new products and the diversification of fish production,
- The introduction of flexible packaging in the canned fish industry,
- Development of the manufacture of fish feed from ingredients available in Morocco,
- Processing tests of seafood by-products,

The Centre works in close collaboration with professionals within the framework of partnership agreements, in particular with FENIP and AHP. Among the Centre's achievements in relation to the objectives of the SwitchMed Programme, the Centre's managers cite the following projects:

- Smart Omega 3 project,
- Valorization of collagen scales: a technology that leads to a patent filed by the Center,
- Extraction of gelatin from sardine scales,
- Valorization of semi-canned co-products,
- Valorization of mussel shells,
- Mussel hydrolysates,
- Extraction of collagen from mussels,
- Production of protein hydrolysates,
- Improvement of the pickling process,
- Production of chitosane from shrimp shells,
- Food:

-Sardine steaks,
-Sardine sausage
-Sardine pâté

- Etc.

Although the Centre has the necessary know-how to develop the above products, industrial-scale production faces the following constraints:

- Lack of research structure for the production of industrial pre-series and market testing. As such, the Center plans to create a technological platform for the manufacture of industrial pre-series.

- Lack of visibility on the market, especially for exports. The local market remains relatively small and underdeveloped.
- Lack of incentives for the fishing industry

3.2.2 Agadir Haliopôle

A second meeting was held on April 13, 2021 with the managers of Agadir Haliopôle account of its role and missions as a competitiveness cluster at the service of the fisheries sector and the fish processing industry. This meeting was an opportunity to better know this pole and its activities and to exchange with its managers on the issues and topics of interest to the sector. Agadir Haliopôle was created to promote the development of in-depth cooperation between fishermen, industries, laboratories, training and research institutions on operational objectives allowing players to be competitive on the world market and respond to changes in the sector. Its main activities are:

- Training and capacity building of fishing professionals;
- The supervision of collaborative studies:
 - Identification of improvement levers for seafood processing companies based in the Agadir Souss Massa region.
 - Energy efficiency in processing industries for the benefit of small and medium-sized enterprises in the Agadir Souss Massa region.
 - Energy saving on board fishing vessels operating in the Agadir Souss Massa region.
- Promoting innovation
- Organization of seminars and workshops

AHP officials affirmed that the cluster's objectives are in line with those of the SWITCHMED programme, namely the promotion of a sustainable industry. As such, the cluster's missions cover the emerging needs identified by its members, in particular:

- The development of new products from co-products or scraps of raw materials from different treatments;
- Biotechnological valorization of marine by-products;
- Process optimization;
- Etc.

The future projects of the cluster cover the realization of "a factory of the future" as dubbed by the leaders of the pole. It is a factory that meets the various criteria of sustainable development, among others:

- Energy saving
- Raw material saving
- Comfort for employees (development of human resources)
- Factory connected with the market, employees, associates and the environment.

In terms of the valorization of fisheries by-products, AHP officials cite the following avenues that have already been studied between the CSVTP and the AHP or FENIP:

- Sardine sausage
- Sardine pâté
- Head and viscera valued by the production of Nuoc-mâm (Fish sauce).
- As for scales, their valorization requires state-of-the-art technology.

3.2.3 GIAC Marine Fisheries

Training is often identified as one of the barriers to innovation and the development of new products, which is why a meeting was held on 20 April 2021 with the Groupement Interprofessionnel d'Aide au Conseil Pêche (GIAC Pêche). This meeting was an opportunity to get to know this institution and its missions better.

As presented by its Director, GIAC Pêches Maritimes is a non-profit professional association. It is a mechanism, set up by the Moroccan public authorities, with the aim of raising awareness among companies on the importance of upgrading skills to improve their competitiveness and help them define their skills and training needs.

The GIAC Pêche Maritime, presents itself as a space of help and advice dedicated to companies in the Maritime Fishing sector and particularly SMEs / SMIs, and constitutes a lever for the promotion of continuing training in the sector.

GIAC Marine Fisheries could be identified later as a potential partner of this SwitchMed programme during the implementation of the pilot project(s).

3.3 Questionnaire surveys:

Preliminary investigations

A preliminary questionnaire (see annex) had been sent to companies operating in the priority subsectors (freezing, canning, fish meal and fish oil), in addition to other companies that participated in the kick-off meeting.

33 companies representing the three priority subsectors responded to the preliminary questionnaire. Geographically, the responding companies cover the main seafood valorization sites.

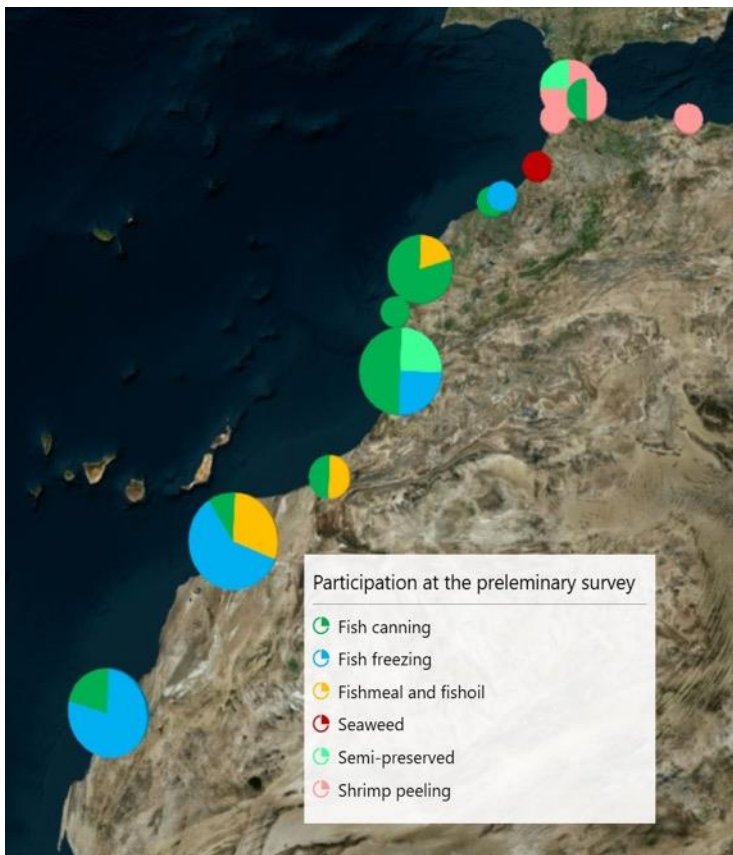


Figure 4 Geographical distribution of enterprises participating in the preliminary survey 1

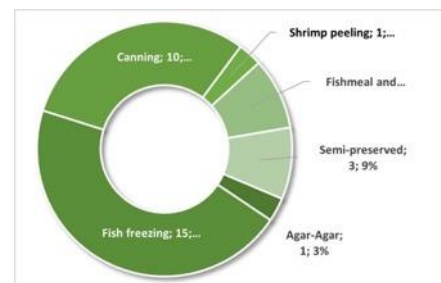


Figure 3 Distribution of enterprises participating in the preliminary survey by trade

The importance of resource efficiency

There is a growing awareness on the part of manufacturers with regard to resource efficiency (Figure 4). Similarly, the majority of enterprises attach great importance to environmental aspects (figure 3). However, only 18% of the companies surveyed have a certification in the environmental field.

Raw material supply

The raw material supplies of the companies surveyed remain dominated by fresh products (52% of responses), followed by a mix of fresh/frozen products (39% of responses) (Figure 5).

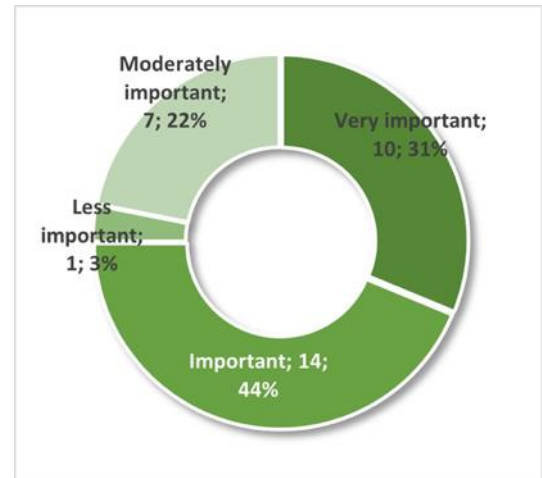


Figure 5 Importance of ecological aspects in the company

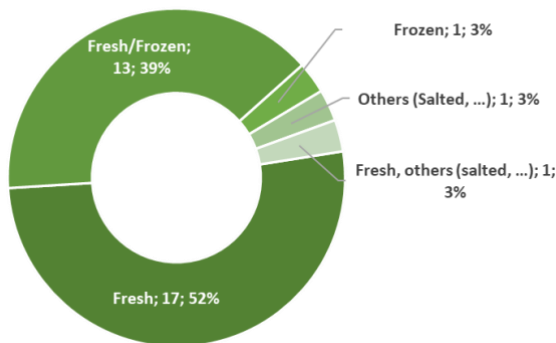


Figure 7 Nature of raw materials received

Monitoring of energy and water consumption

Almost all of the companies surveyed closely monitor their water and electricity consumption. 61% of respondents say they have cost accounting by product, particularly for utilities (water, electricity, fuel).

Ratios used to track energy consumption

Almost half of the companies surveyed track their consumption by appreciating energy expenditure (in MAD) in relation to the volume of finished product (49% of responses) or the volume of raw material (18% of responses) (figure 9). However, the proportion of companies that carry out energy audits remains relatively low (only 27% of respondents)

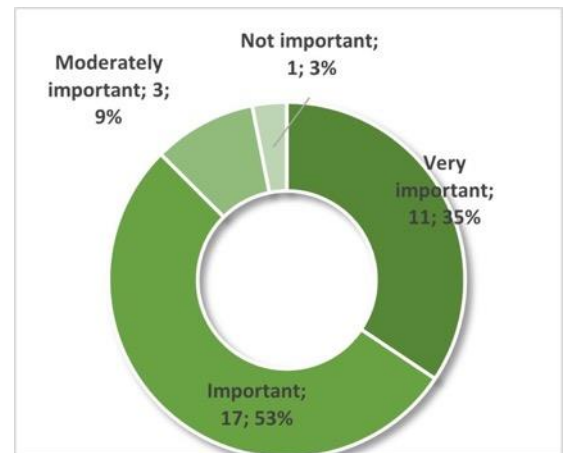


Figure 6 Importance of resource efficiency in your business

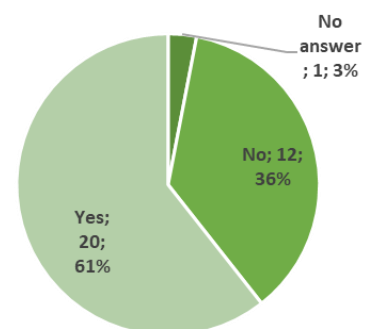


Figure 8 Existence of cost accounting

Energy-saving measures

The measures taken to optimize energy consumption vary from one company to another. Below is the list of measures cited by the companies surveyed:

Fuel change, boiler maintenance,
The use of photovoltaic energy, equipment changes by others with low consumption,
Complete revision of the electrical installation after a sizing of the needs in terms of wiring and lighting,

- Carrying out an energy audit to study the possibility of installing solar panels,
- Action plan for improving machine reliability,
- Scheduling of machine start-ups in discounted hours (off-peak time),
- Rationalization, regulators, temperature monitoring, SAS, staff awareness...
- Use of natural gas instead of fuel oil n°2 for the boiler room
- Use of progressive starters of appliances, limitation of heat loss, reduction of air conditioning expenses, use of economical and efficient appliances
- Project to recover fumes from dryers for evaporation.

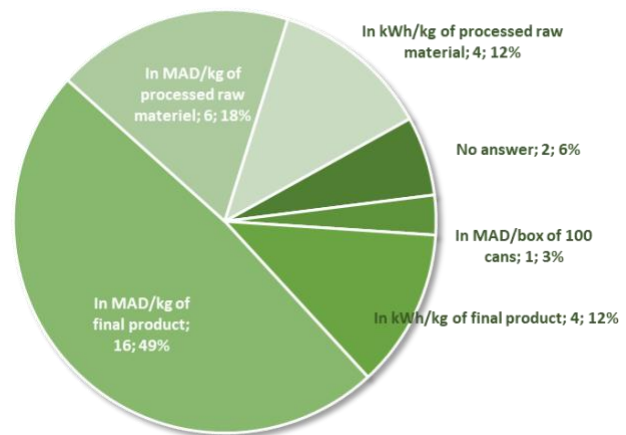


Figure 9 Ratios used to assess energy consumption

However, the impact of the measures taken by the companies surveyed remains low for the time being. Only 6% of respondents claim to have achieved a 20-40% reduction in their energy consumption.

Monitoring of finished product yields and generation of "co-products"

Almost all of the companies surveyed track their finished product returns.

Fishery products processing industries generate different types of waste called "co-products":

Whole fish: rejected by the units because they are not machinable,

Heads and viscera from head-feeding and evisceration operations (particularly in the canning and freezing industries),

Skins and bones: generated mainly by the canning industries that produce so-called skinless preserves without bones (SPSA) or fish filleting.

Shrimp shells in shrimp shelling units,

Algae residues at the level of the agar-agar production unit,

Other inorganic waste: cardboard, plastic, chemical packaging, etc.

The "co-products" are intended mainly for fishmeal units. Sometimes "co-products" are sent back to the landfill, such as shrimp shells. The waste from the semi-canned food is also sent back to landfill because it is not popular with the flour units because of its high salt content.

The use of **smart** technologies/digital surveillance systems for tracking "co-products" remains very marginal. **Only 9% of the companies surveyed** say they have them.

The development of a value chain for co-products is facing many difficulties. Among the reasons often given by the companies surveyed are the following points:

- Insufficient financial resources,
- Lack of technical expertise and support,
- Lack of surface at the unit level,
- Lack of qualified personnel; Insufficient financial resources,
- Lack of markets,
- Problem of minimum size of quantities to be treated.

When it comes to liquid waste treatment, only 39% of the companies surveyed say they treat their liquid discharges before they are evacuated.

The most commonly used processes are:

- Screening and de-oiling
- Settling and disposal of solid waste
- Only 2 out of 33 companies claim to have a Wastewater Treatment Plant (STEP).

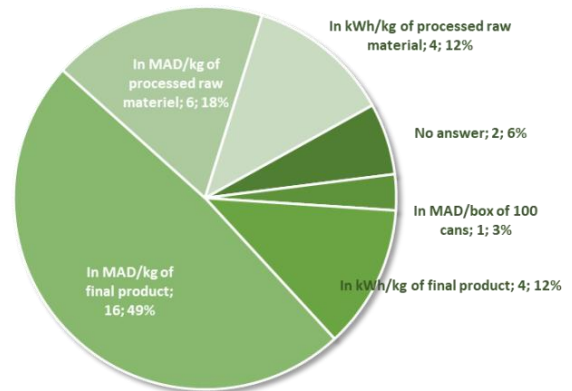


Figure 10 Smart Technologies / Digital Monitoring Systems for Waste Tracking

3.3.1 In-depth investigations

An in-depth questionnaire (Annex 2) was sent to companies interested in participating in the SwitchMed programme.

15 companies replied to the questionnaire representing the different priority subsectors (canned, frozen and fishmeal and fish oil) (Figure 9).

Geographically, the different valorization sites are represented (Dakhla, Laayoune, Tan Tan, Agadir, Safi, Tetouan) (Figure 11).

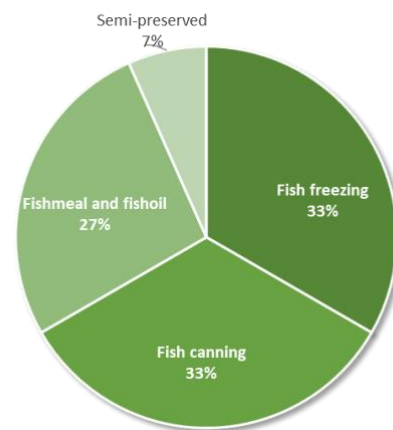


Figure 11 Distribution of enterprises participating in the in-depth survey by trade

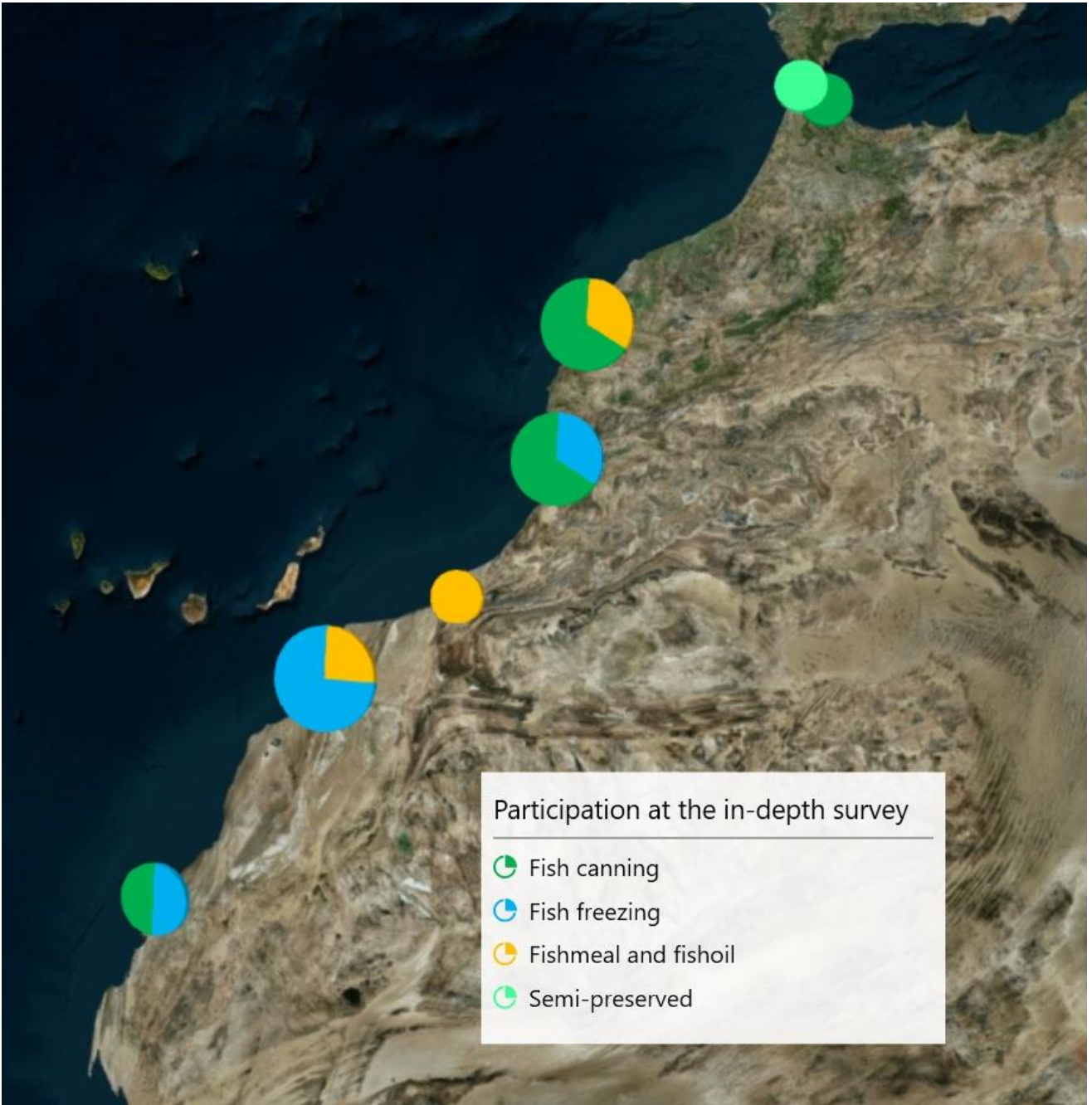


Figure 12 Geographical distribution of enterprises responding to the in-depth questionnaire

Corporate Strategy

In terms of business strategy, exploring new markets tops the list of priorities (20% of responses), followed by increasing production (18%) and developing new products (17%). The valuation of co-products was cited in 12% of the responses. As for the development of an own brand, it represents only 3% of the responses.

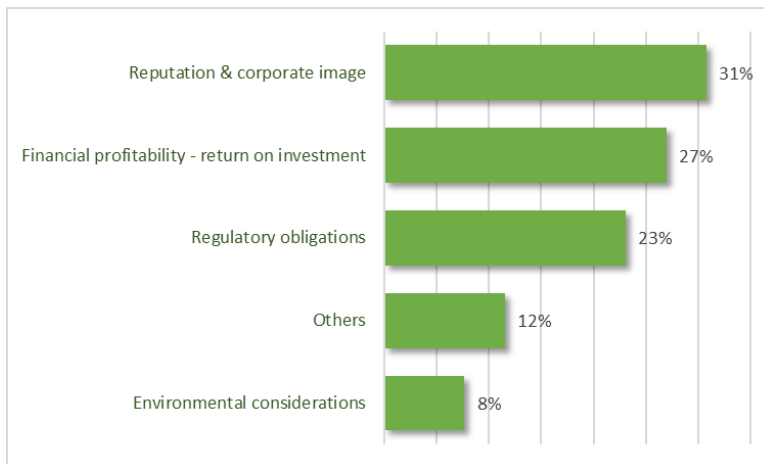
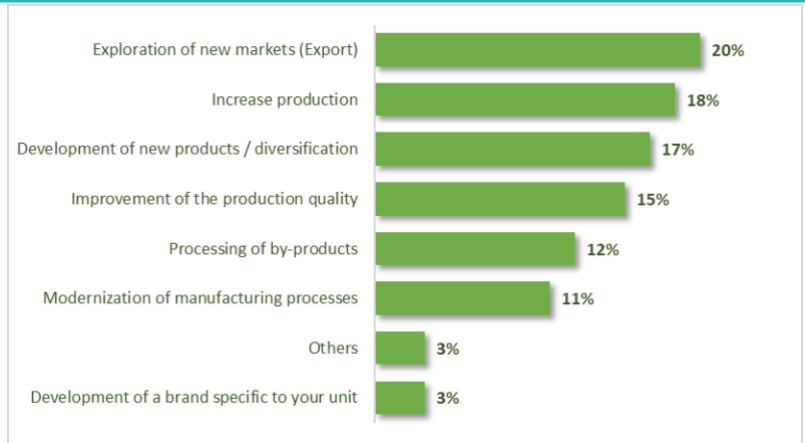


Figure 14 Key Motivations for Investment

About 2/3 of the companies interviewed are engaged in a modernization process.

The motivations for the investments undertaken as part of this modernization process are very diverse.

The reputation and image of the company is at the top of the motivations of companies (nearly a third of the responses). Financial profitability comes in second place (27% of responses) followed by compliance with regulatory obligations (23%).

Other:

- Product diversification - integrated project to enhance the value of the raw material
- Material needs of equipment
- Demand growth

Just over half of the companies surveyed (58%) claim to receive the benefits of the investments made. 59% of the companies surveyed are very satisfied or satisfied with the investments made

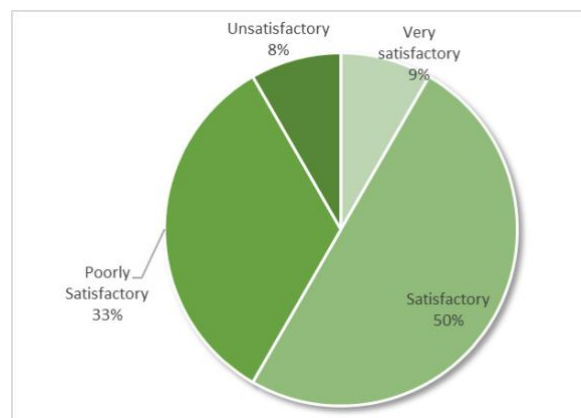


Figure 15 Satisfaction of investments made

The quality policy of companies

As far as the quality policy of enterprises is concerned, it varies according to the industrial sub-sectors and the destination markets. Various standards are adopted by the companies surveyed:

- **Qualité B2B** : IFS, BRC, FSSC22000, IFFO, GMP+, ISO 22000, ISO 9001
- **Ecolabels** : FOS, MSC
- **Ethnic labels**: HALAL, KOSHER
- **Health and Safety**: OHSAS 18001
- **Environment**: ISO 14001
- **Responsabilité sociale** : Business Social Compliance Initiative (BSCI), Sedex Members Ethical Trade Audit (SMETA)
- **Other**: Gluten free & non-GMO

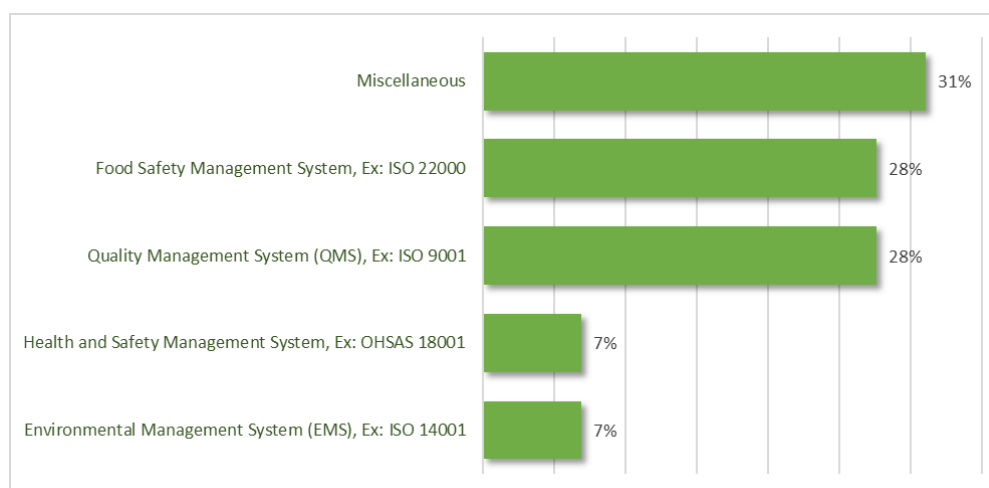


Figure 16 Quality Management Systems*

* Divers : IFS, BRC, FSSC22000, IFFO, GMP+, FOS, MSC, HALAL, KOSHER, BSCI, SMETA, Gluten free & non OGM

Valorization of co-products

Fish processing generates co-products (raw material not used in the production of the main product). The fate of these co-products varies depending on the species and the transformation that is made of them. The following table summarizes the share of co-products generated and their destination according to the species and the nature of the valorization.

Table 2 Typology of co-products generated by the main processing industries

Valorization	Co-products	% share	Destination
Semi-conserved	Anchovy co-products	40%	Landfill
Preserve	Co-products of small pelagics	45%	Fish meal and oil
Freezing	Co-products of small pelagics	40%	Fish meal and oil
Freezing	Co-products of cephalopods (cuttlefish)	20-30%	Landfill
Freezing	Co-products of cephalopods (octopus)	8-10%	Landfill
Other	Packaging waste		Recycling unit
	Metal waste		Sorting unit
	Household waste		Landfill

If fish meal and oil represent the main destination of the co-products of the canning. There are private initiatives, although rare, where some of these co-products are valued in food products (pâtés, sausages, etc.)

We will thus distinguish three types of value chains:

- An industry where co-products are mainly destined for fish meal and fish oil units. This is the case for the majority of small pelagic canning and freezing units;
- An industry where part of the co-products are recovered and then recovered. This is the case of a few rare canning manufacturers;
- An industry where co-products are sent back to landfill, this is the case of semi-canned co-products, shrimp shelling or cephalopod freezing.

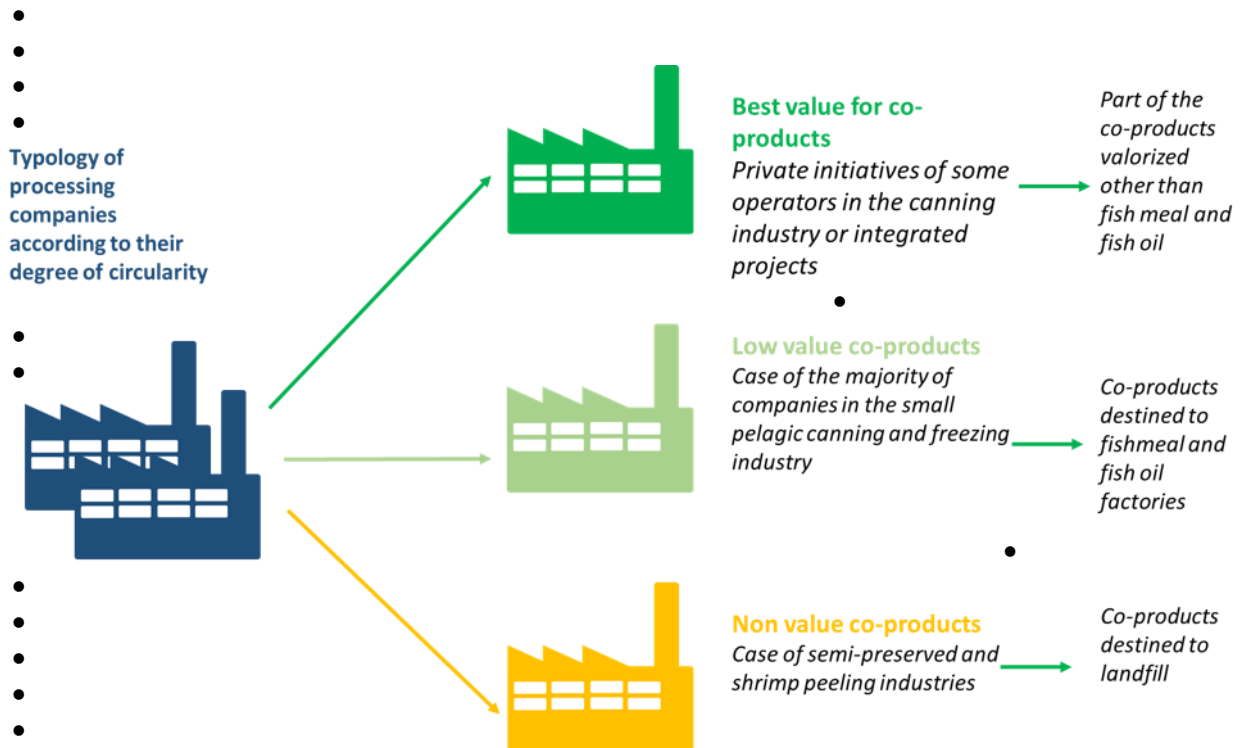


Figure 17 Typology of processing enterprises according to their degree of circularity

On the basis of data collected from enterprises (share of co-products) and export statistics (See in figures from the DPM and Exchange Office) and likely ratios (see list of ratios in the annex), an estimate of the co-products generated by all the sub-sectors studied (canned / semi-preserved, freezing, flour and fish oil).

The canning/semi-canning and small pelagic freezing industries generated on average (2019-2015) nearly 280,000 tons representing 94% of all co-products.

Based on an average tonnage of 20,000 tonnes of imported raw material, the shrimp shelling industry generates, on average, around 12,000 tonnes per year, or 4% of total co-products.

Cephalopods generate the least co-products, about 5100 tons on average per year, or 2% of the total.

Half of the co-products generated by the processing industry come from canning, followed by freezing (40%). The shrimp semi-canning and shelling industries account for 6% and 4% of total co-products respectively.

In terms of destination, the fishmeal and fish oil industry absorb on average about 260,000 tons per year (2015-2019), or 88% of the total co-products. The rest, or 12% of the total is often disposed of without valorization, this is the case of the co-products of semi-canned (6%), the freezing of cephalopods (4%) and shelling of shrimp (2%).

The participating companies were asked about possible initiatives taken for the valorization of co-products. The results show that 40% of the companies surveyed say they are still at the first stage of the process, i.e. looking for ideas for new products. 30% of companies are at the stage of detailed feasibility study and 30% have already reached the final phase of the process, i.e. production on an industrial scale. These results should be taken with caution for two reasons: (i) companies very rarely communicate about their R&D actions; (ii) the sample surveyed does not necessarily include the most innovation-dynamic enterprises.

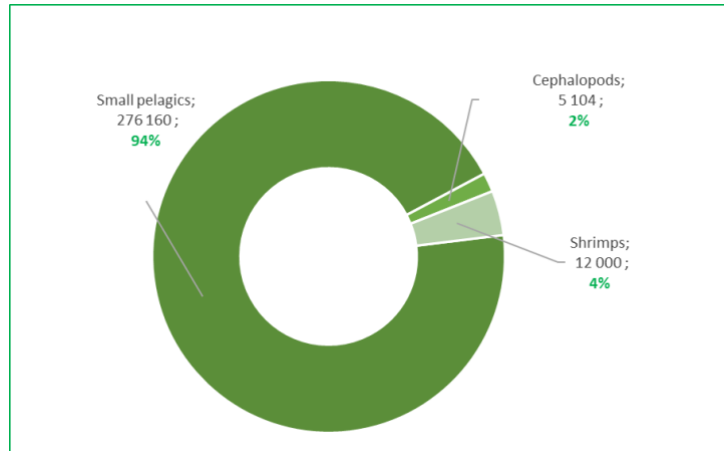


Figure 18 Co-products by species group (2015-2019)

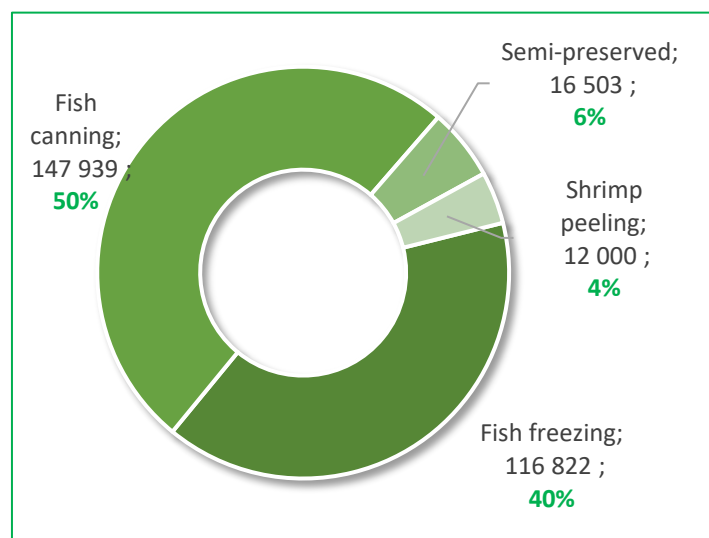


Figure 20 Co-products generated by industries (2015-2019)

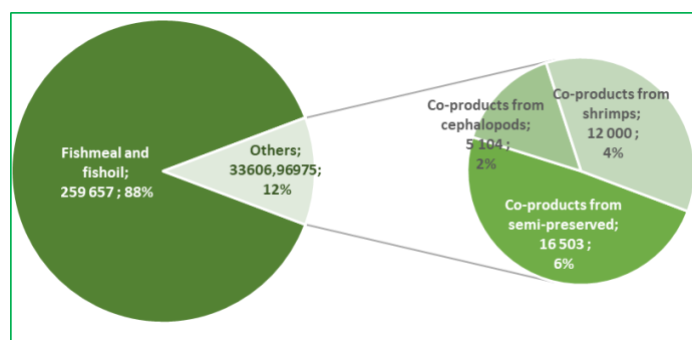


Figure 19 Destination of co-products (2015-2019)

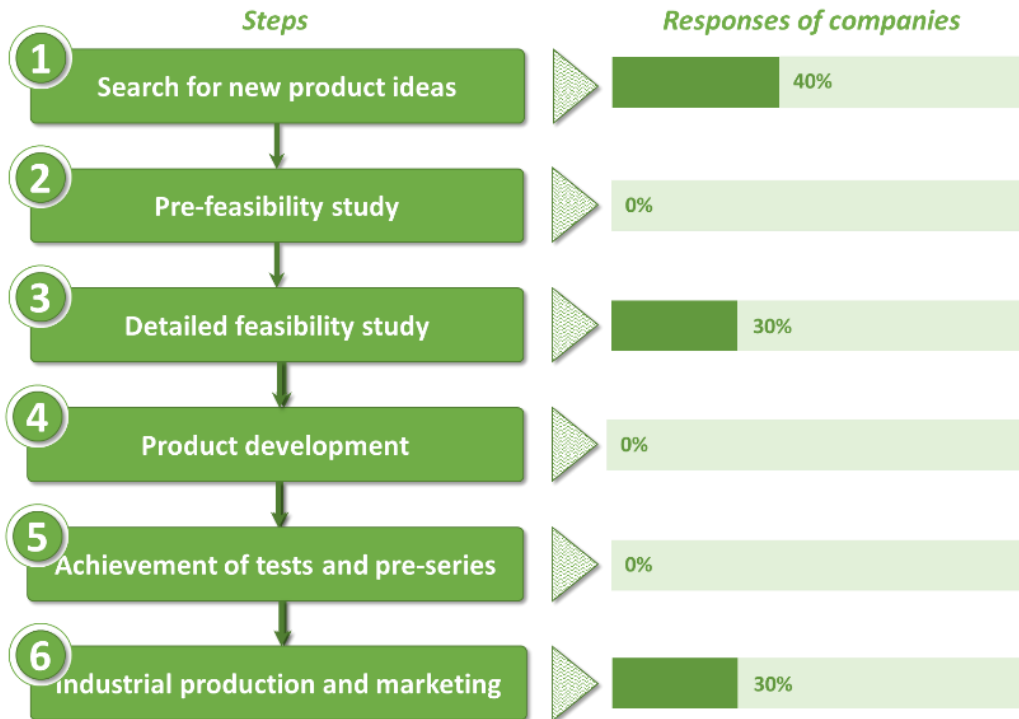


Figure 21 Current stage of the process of valorization of co-products

For the realization of their projects, companies rely largely on their internal resources (2/3 of the companies surveyed), while 22% are accompanied by research centers. The rest, or 11%, says they use specialized companies. This behaviour can be explained by the lack of incentives for companies to apply for private services.

The valorization of co-products through the development of new products faces various difficulties. The irregularity of supplies in both quantity and quality tops the list of constraints raised by the companies surveyed (27% of the responses), followed by the lack of technical knowledge (23%) and the absence of incentives/accompanying measures (19%). Market visibility can also be a handicap for companies (15%).

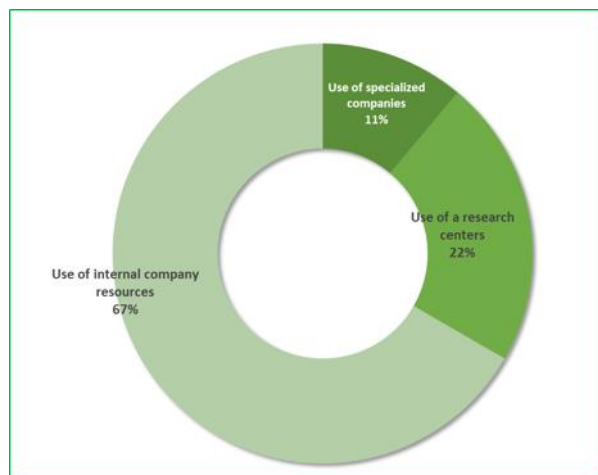


Figure 22 Support in the reflection on the valorization of co-products

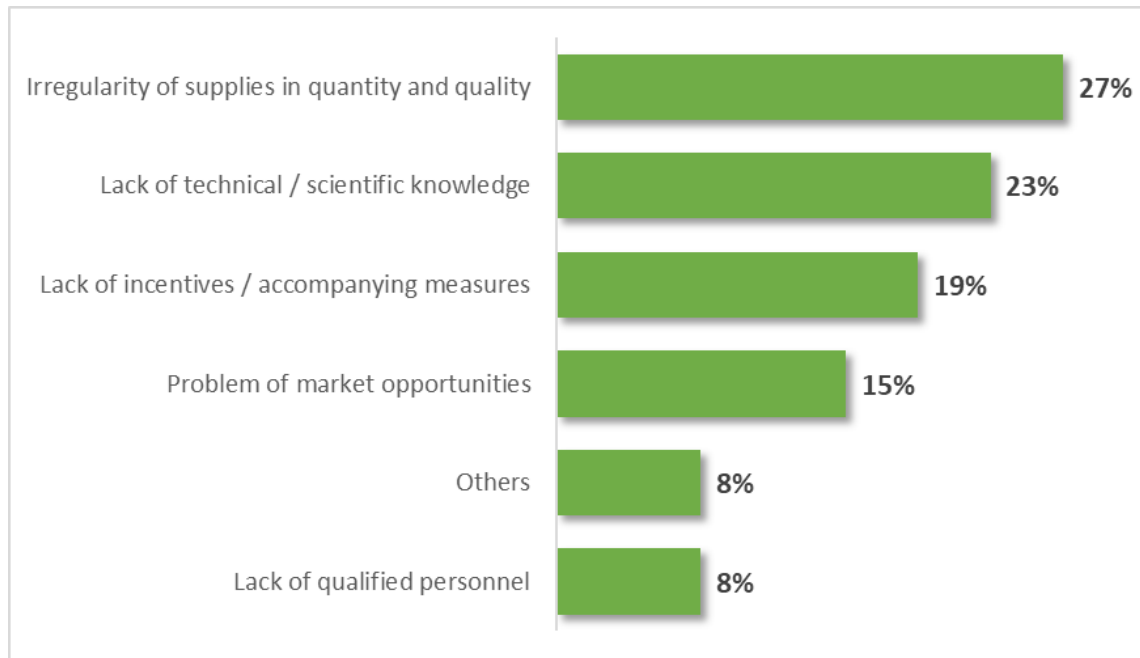


Figure 23 Obstacles to the development of the valorization of co-products

Other:

- Problem of health regulation and approval

Market access

As stated above, market visibility can also be a handicap for companies to embark on the development of new products. In this regard, 64% of the companies surveyed say they do not carry out or do not have market research for the targeted products. Only a quarter of survey companies report subscribing to databases or specialized journals.

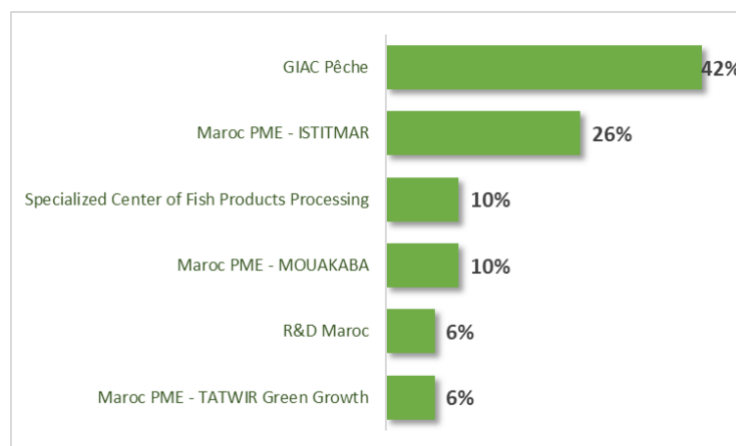


Figure 24 Knowledge of existing support tools in Morocco

Support tools

While support tools specific to the fisheries sector are almost non-existent (with the exception of the GIAC Pêche), there are support tools that are common to all industrial branches, all sectors combined. However, the survey revealed that these tools are little known by fishing industry. The GIAC Pêche remains the best known tool (42% of the responses) followed by the ISTITMAR and MOUAKABA programs of Maroc PME (respectively 26% and 10% of the responses).

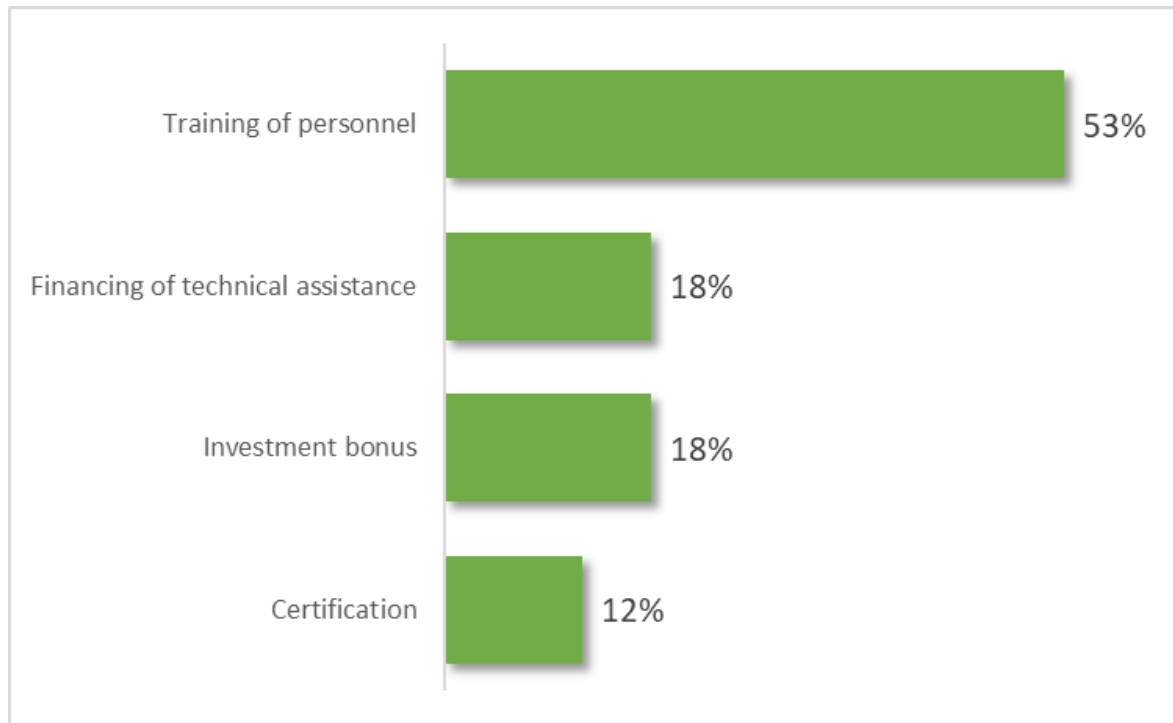
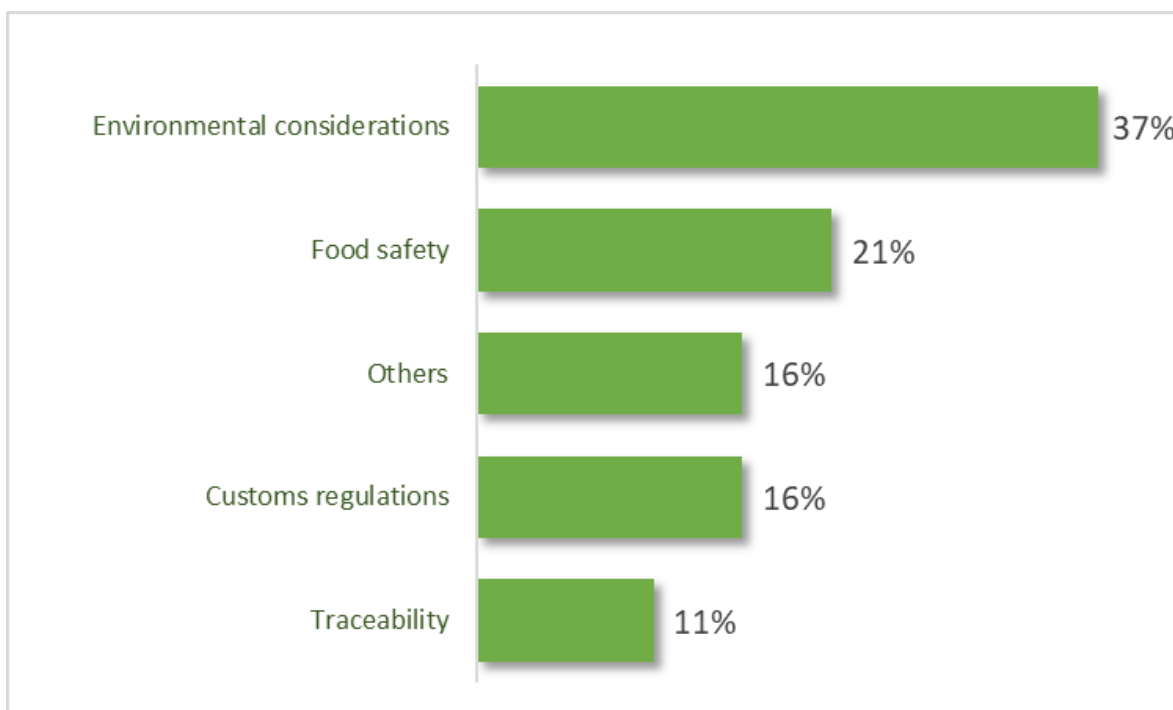


Figure 25 Reason for using accompanying tools

64% of the companies surveyed say they have used these support tools. Staff training remains the main reason (53% of responses). The financing of assistance or the request for an investment premium come in second place with 18% of the responses each.



*Figure 26 Nature of Regulatory Constraints**

Regulatory aspects

With regard to the aspects Regulatory Just over half of the companies surveyed say they face regulatory constraints related to resource efficiency. Environmental considerations top these constraints (37% of responses), followed by questions related to health security (21%). Other constraints cited by companies included issues of access to the resource (although not directly related to resource efficiency) and the reduction of water consumption with the treatment of liquid discharges (16% of responses).

Among the avenues of reflection recommended by the companies interviewed and which could be part of the solutions to the problems encountered:

- Provide the delegations of the PMs (Service des industries de la pêche) with the necessary means to support industrialists in making the transition and to facilitate their task for the extension of the approvals of their units for the activity of valorization of co-products),
- Support for local and health authorities,
- Strengthening infrastructure for the efficient consumption of resources (treatment of liquid discharges).

Human resources

All companies employ engineers and/or technicians. These human resources are recruited through various means:

- By ad
- Through knowledge
- Following a spontaneous application

The profiles sought cover the following areas:

- Quality Management/Accountability – Commercial
- Research & Development
- Maintenance
- Cold

Resource Efficiency:

- For energy consumption:
 - Quantitative data: not reported
 - Initiatives reported by a few companies:
 - Energy consumption reduction project,
 - Operational improvement,
 - Use of Photovoltaic Energy,
- For water consumption
 - Quantitative data: not reported
 - Reported initiatives:
 - Water recycling,
 - Line automation,
 - Replacement of water-intensive processes,
 - Operational improvement,

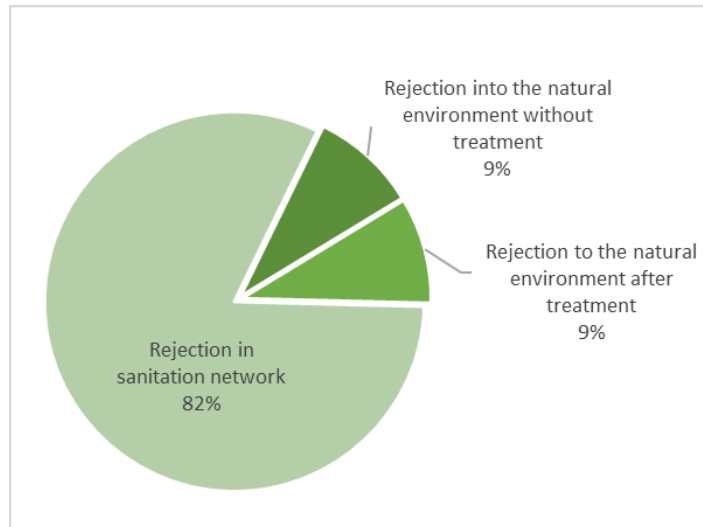


Figure 27 Fate of water used in the production

2/3 of the companies surveyed do not analyze the wastewater generated by their factories and only 1/3 of the companies surveyed count the volume of wastewater leaving their factories. When it comes to the fate of wastewater, almost the majority of responding companies claim to discharge wastewater into the community's network. Only 9% of the responding companies say they discharge water into the natural environment after treatment.

3.4 Sectoral workshops

In addition to the preliminary and in-depth questionnaires, it was agreed in consultation with FENIP to organize qualitative sectoral workshops bringing together a panel of professionals by sub-sector in order to discuss the challenges facing each sector and areas for improvement. Also, four workshops were organized in video-conference mode, as follows:

Table 3 Sectoral workshops according to sectors

	Sub-sector	Date
Workshop 1	Fish meal and oil	06/07/2021
Workshop 2	Freezing	07/07/2021
Workshop 3	Preserve	08/07/2021
Workshop 4	Shrimp shelling Semi-conserved	09/07/2021

The four workshops were held according to the following agenda:

- Technological innovation in the canning industry
- Challenges related to improving competitiveness and modernizing businesses
- Current or planned initiatives
- Innovative business models to improve the circularity of the value chain / resource efficiency in your sector
- Regulatory constraints related to resource efficiency and environmental issues

In the following, the main points collected during the sectoral workshops are presented. For each of the subsectors studied, a reminder of the main indicators is presented.

3.4.1 Fish Meal and Oil

3.4.1.1 Sector overview



Figure 28 Geographical distribution of fishmeal and fish oil units ¹

¹ The size of the bubbles corresponds to the installed processing capacity

The fishmeal and fish oil industry comprises 22 units based mainly in Laayoune and Tan Tan. Units are located in other cities such as Agadir, Safi or Dakhla for the treatment of co-products.

The average annual production (2015-2019) is 156,600 tons of flour and 44,000 tons of oil. This production is largely destined for export: 132,500 tonnes of flour and 37,800 tonnes of fish oil on average during the period 2015-2019.

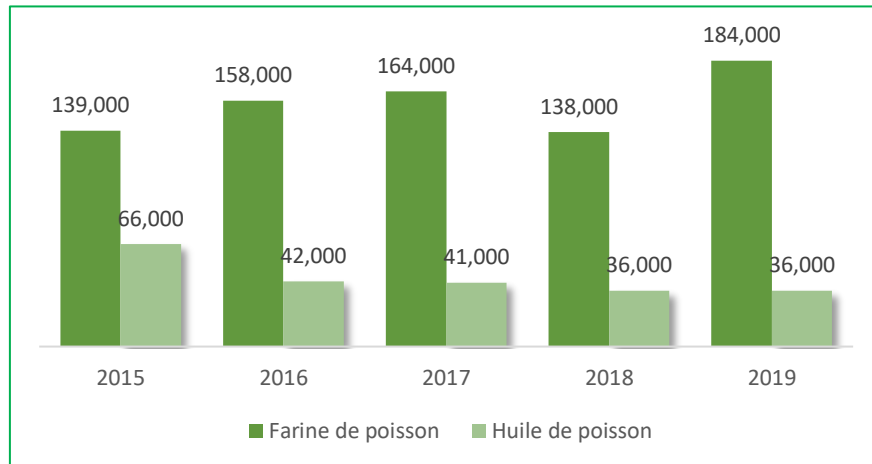


Figure 29 Industrial Production: Fish Meal and Fish Oil (tonnes of finished products)

The diagram below summarizes the main steps of the fish meal and oil manufacturing process.

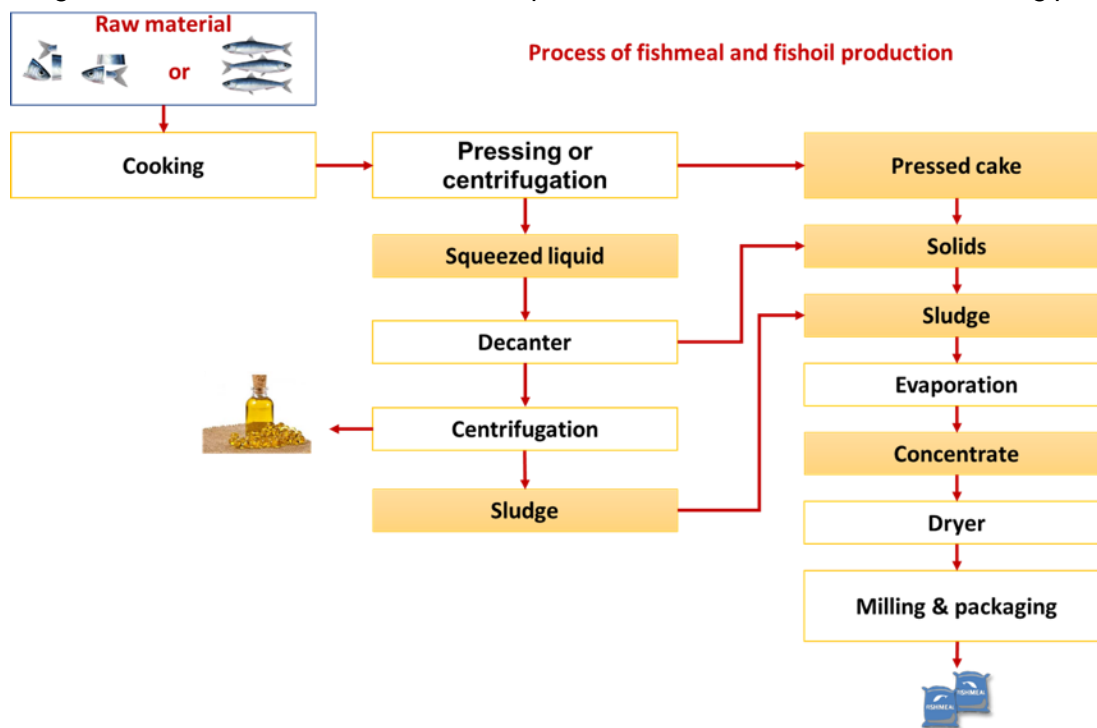


Figure 30 Simplified diagram of the fishmeal and oil manufacturing process

3.4.1.2 Technological innovations:

Technological innovations that would be relevant in the fishmeal and fish oil industry were, for participants, as follows:

- In the short term:
- In a context marked by the scarcity of resources (MP), the priority would be rather in the optimization of production costs. This includes energy saving issues, improving product quality, treating gaseous discharges).
- In the medium and long term:

- A restructuring of this industry with the development of new products with high added value.

Industrialists are not against modernization projects provided they do the feasibility study, market, etc.

3.4.1.3 Issues identified by companies

With regard to the challenges or limiting factors for companies in this sub-sector in order to improve their competitiveness/modernization and therefore aim for greater resource efficiency, the following major challenges should be mentioned:

1. Raw material supply:

The supply of raw materials is the major concern widely shared by the majority of operators. Indeed, the fish meal and oil industry is reputed to be very consuming of raw material (whether whole fish or co-products), since it takes 5 tons of raw material to produce one ton of fishmeal and 0.3-0.4 tons of oil. In addition, it is an industry with significant processing capacities that are not optimally exploited. Some companies even run at less than 50% of installed capacity. The lack of visibility in terms of supply hinders any modernization or investment action in this sub-sector.

There are three different business models:

- Horizontally integrated groups: grouping different processing activities (freezing, canning) whose co-products are processed by the group's flour unit (e.g. SOTRAGEL),
- Vertically and horizontally integrated groups (fishing-industry): where the fish caught by the group's boats and not machinable is processed in the meal unit of the same group (e.g. Pelagic King, CIBEL, UNIMER, COPELIT),
- Companies that process the co-products of sister companies. One of the participating companies relies on a cooperative that collects co-products at the port, restaurants, markets, etc.

The quality of the products depends on the quality of the raw material processed. Most companies produce flour with a protein content of 55-58%.

Industrial equipment is often used with the importance of maintenance.

2. Problem of the sea snipe

It is a species that has reappeared (appeared during the 70s) in abundance since 2016 with a wide spatial expansion that has caused concern among fishing professionals and the guardianship administration. The concern comes from the fact that the favorable hydro-climatic and trophic conditions favorable to the development of the woodcock could be unfavorable to that of the main pelagic species usually dominating the Moroccan Atlantic ecosystem, according to the INRH.

One of the participating companies (TANTASAR) claims to be starting trials for the valorization of this species. If the results are conclusive, this species could replace the small pelagics usually sought by fishmeal units.



Figure 31 Sea Snipe

3. Training needs

Only one company mentioned the lack of specific training dedicated to fishmeal and fish oil production technology.

3.4.1.4 Areas for improvement

In the short term:

- Valorization of the sea snipe:
- Support for operators in carrying out studies / trials to enhance the value of this new species. This project would have two major advantages:
- Ensure the sustainability of an industrial fabric composed of 22 companies;
- Reduce the pressure that the fishmeal and fish oil industry could put on the resources of small pelagics by substituting them with the sea snipe.

Value for money:

- To make fish meal and fish oil operators benefit from the TEST methodology to optimize production costs by focusing in particular on:
- Energy and water saving (TEST methodology)
- Improved product quality
- Improvement of raw materials
- Treatment of gaseous discharges

In the medium and long term:

- Deep restructuring of the sub-sector:
- The aim is to help companies move towards the most rewarding processes that consume less raw materials: manufacture of products with high added value (flour with high protein value, refining of oils, protein hydrolysates, etc.).
- Good cooperation between fish processing companies and fishmeal plants is needed. This concerns in particular the implementation of intelligent collection and refrigeration logistics to ensure the best possible quality of raw materials.

3.4.2 Freezing

3.4.2.1 Sector overview



Figure 32 Geographical distribution of freezing units²

² The size of the bubbles corresponds to the installed processing capacity

The fish freezing industry is composed of nearly 200 industrial units covering the different cities of the Kingdom, with a high concentration in the southern cities (Dakhla and Laayoune).

The average annual production (2015-2019) is 302 000 Tonnes. Exports averaged about 328,000 tonnes over the same period (including frozen products on board). Small pelagics and cephalopods make up the bulk of production. The diagram below summarizes the main stages in the freezing industry

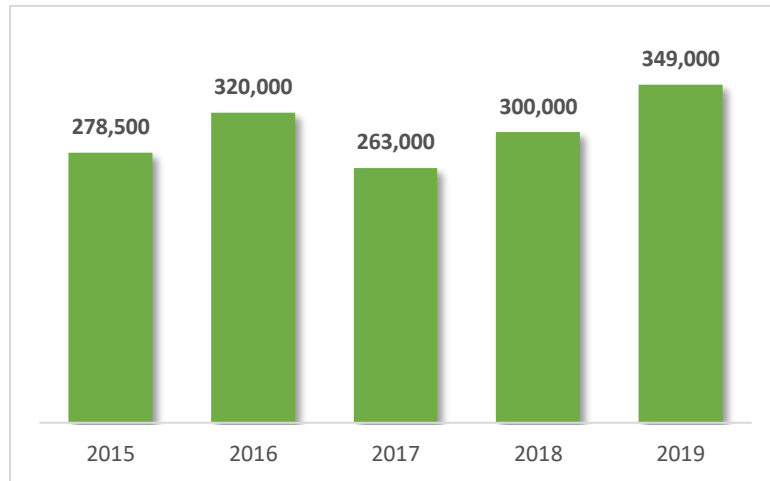


Figure 33 Industrial Production: Freezing on Land (tonnes of finished products)

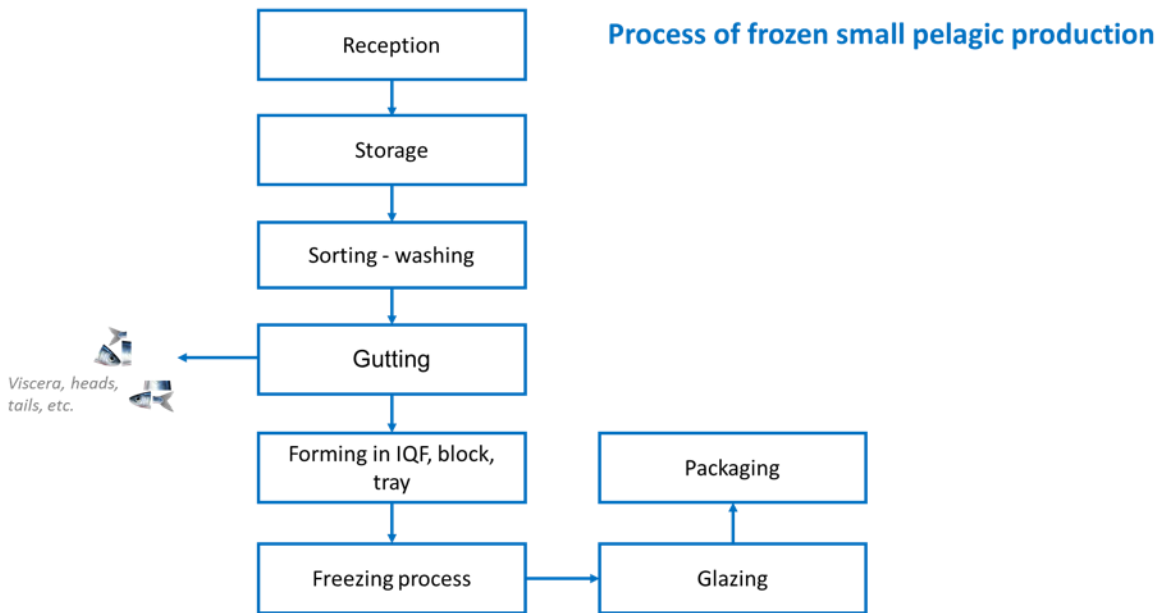


Figure 34 Simplified diagram of the manufacturing process for freezing small pelagics

The diagrams below show the mass balance for the two main activities: freezing of small pelagics and cephalopods.

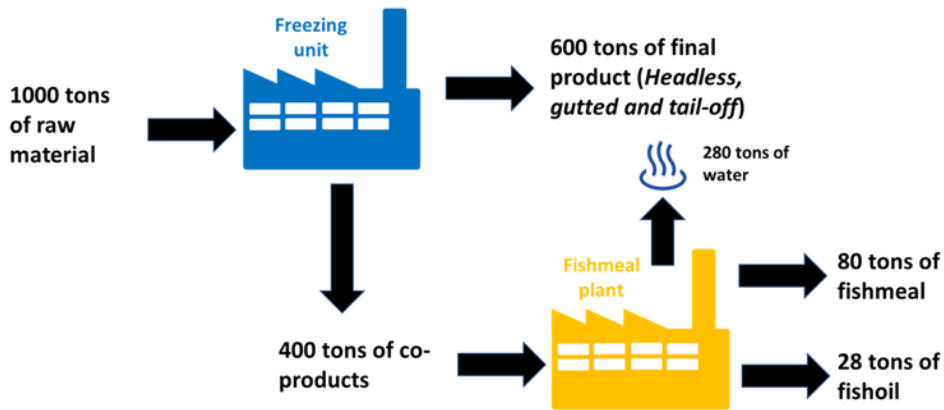


Figure 35 Small Pelagic Freezing Industry Value Chain

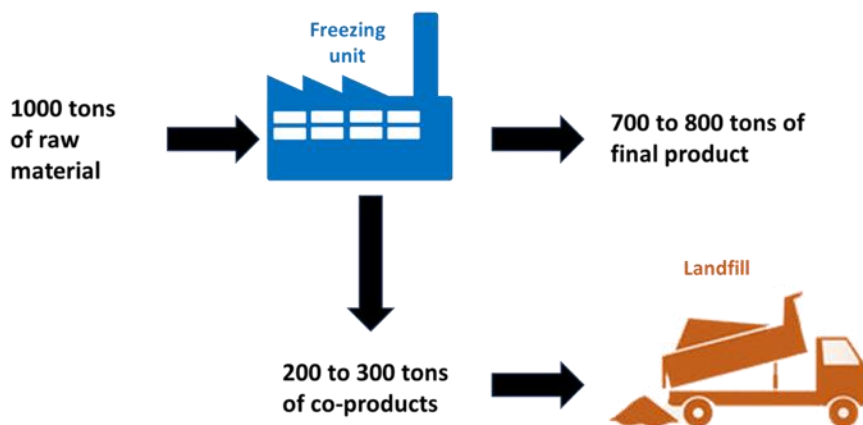


Figure 36 Cephalopod freezing industry value chain

3.4.2.2 Technological innovations:

Technological innovations that would be relevant in the fish freezing industry were, for participants, as follows:

The perception of technological innovation varies from one operator to another. For an industrialist, it is necessary to carry out a global diagnosis within the company to identify the sources of improvement (TEST Methodology).

Resource Efficiency Innovations:

- Innovations aimed at reducing energy and water consumption are in great demand by freezing manufacturers, especially those active in the south of the country.

Innovations related to the valorization of co-products:

- This concerns co-products derived from cephalopods which for the moment are not recovered and returned to the landfill. There are at least two companies that have found customers in China and the United States, respectively, who are said to have purchased the by-products. In the two known cases, legal/administrative obstacles prevented the operation from being carried out.

- As for the co-products of small pelagics, they are valued at the level of fish meal and fish oil units. One of the participating companies shared its experience in the valorization of small pelagic co-products through the manufacture of protein hydrolysates, but was confronted with too high quality requirements from the customer. This company prefers to move towards petfood type products. This example also illustrates the challenges of introducing new technologies and entering new markets. As a rule, even stricter standards must be met, which implies the quality of raw materials, the conditions of processing and the qualification of personnel.
- The experience of another participating company is interesting. It specializes mainly in second processing: smoking (salmon) and niche preserves. The skin of the fish from the process of making smoked salmon fillet is recovered by an artisan who uses it in the manufacture of leather goods. However, the low processing capacity and approach to the market limit the volume of skins valued by the craftsman. This smoking company generates between 5 and 10 tons of fish skin annually.
- In addition to "fish" by-products, the freezing industry uses large quantities of packaging:
 - Polypropylene / polyethylene packaging: whose recycling seems complicated because it is contaminated with fat. It would be appropriate to study the creation of a channel for the collection, sorting and recycling of such packaging. The packaging volumes involved would be very important if we count the packaging to be collected from the customers of these companies.
 - Polystyrene boxes: which occupy large volumes.

The problem of recycling packaging is certainly not specific to the fishing industry, but is a concern for many operators. The establishment of a recycling channel can create a lot of jobs and restructure the networks for collecting, sorting and recycling this waste.

3.4.2.3 Issues identified by companies

- The issues identified by companies vary according to the professions. In this sub-sector, a distinction is made between freezing:
 - Small pelagics (sardines, mackerel, horse mackerel)
 - White fish
 - Cephalopods (octopus, cuttlefish, etc.).

Issue related to access to water and water reuse:

Some companies claim to consume large amounts of drinking water or clean water (up to 200 tons of water per day). The problem arises for companies in arid semi-desert areas, where water availability is relatively limited. Some industrial areas have been poorly installed far from the coast to be able to pump seawater. This is why the use of water reuse is essential.

Energy issue:

The price of electricity charged to companies remains relatively high compared to other countries, according to one participating company. The latter would be interested in cheap solutions based on renewable energies, with if possible turnkey solutions (quantity, cost, subsidy, etc.)

Valorization of co-products

The co-products resulting from the freezing of the small pelagics elaborated can reach up to 50% of the treated volume. These co-products are usually sent back to the fish meal and oil units.

The problem arises for the co-products of cephalopods (viscera, bones, etc.) which are not acclaimed by flour and oil units because they are not suitable for the treatment of this type of co-products.

Knowledge of technologies and markets

There is certainly a lack of knowledge of processes and technologies, but much more in terms of innovation (R&D). Innovative technologies may well exist, but difficult to understand due to a lack of information on their technical-economic feasibility, or of outlets when it comes to developing new products. The problem arises especially for small and medium-sized enterprises. The latter are often faced with the problems of:

1. Financing
2. Technologies
3. Market

Raw material supply

The supply of raw materials has become identified by some industrialists. This concerns above all the freezing branch of small pelagics which are also sought after by other industries (canned food, fish meal and fish oil).

Lack of manpower

This is particularly the case for companies based in Dakhla that are unable to retain their workers. This phenomenon will be accentuated with the start-up of new industrial units that are very labour-intensive.

3.4.2.4 Innovative business models

The operators involved in this issue are in favour of collaboration between operators in the same industrial area because of the geographical proximity, the similarity of concerns and needs.

3.4.2.5 Regulatory constraints

Some operators encountered difficulties in obtaining the health certificate for cephalopod co-products that they had considered exporting.

3.4.2.6 Areas for improvement

- Energy saving / water saving (TEST methodology): this concerns practically all freezing operators,
- Valorization of cephalopod co-products
- Collection, sorting and recycling of packaging
- Fish skin recovery sector
- Separation of co-products according to uses and outlets: a track that has not been excluded by the participating companies and which could lead to a better valuation of the co-products.

3.4.3 Preserve

3.4.3.1 Sector overview



Figure 37 Geographic Distribution of Canned Units³

³ The size of the bubbles corresponds to the installed processing capacity

The fish canning industry is composed of nearly 50 industrial units covering the different cities of the Kingdom, with a concentration in the cities of Safi (historic capital of sardines) and Agadir (important fishing pole of the country). New units are being created at the level of Dakhla.

The average annual production (2015-2019) is 197,000 tonnes. Exports averaged about 165,000 tonnes during the same period. The canning industry is based on the triptych "Sardine – mackerel – tuna" with a predominance of sardines.

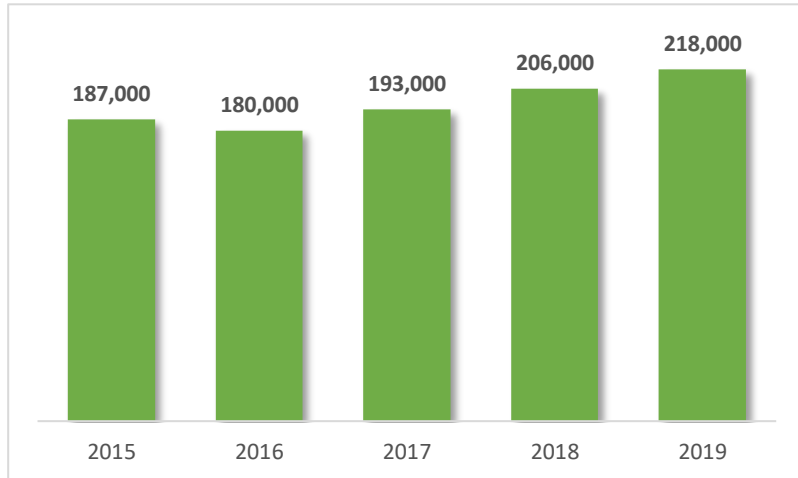


Figure 38 Industrial Production: Canned Fish (tonnes of finished products)

The diagram below summarizes the main steps of the canning manufacturing process.

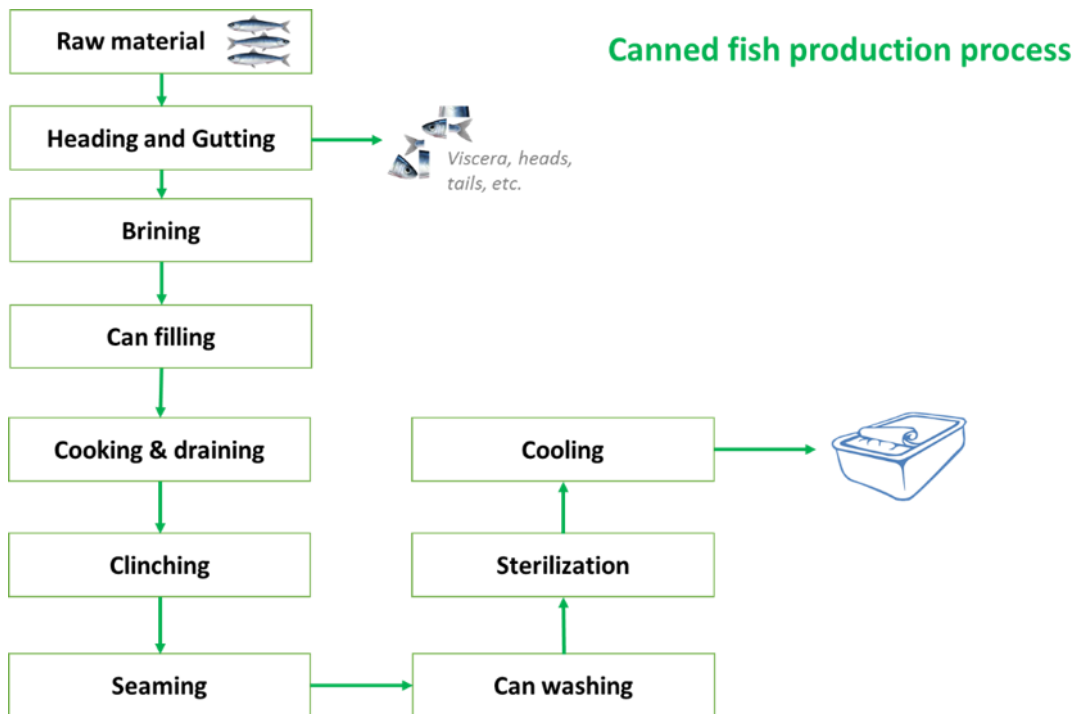


Figure 39 Canned fish production process

The following diagram shows the mass balance in the case of canned sardines.

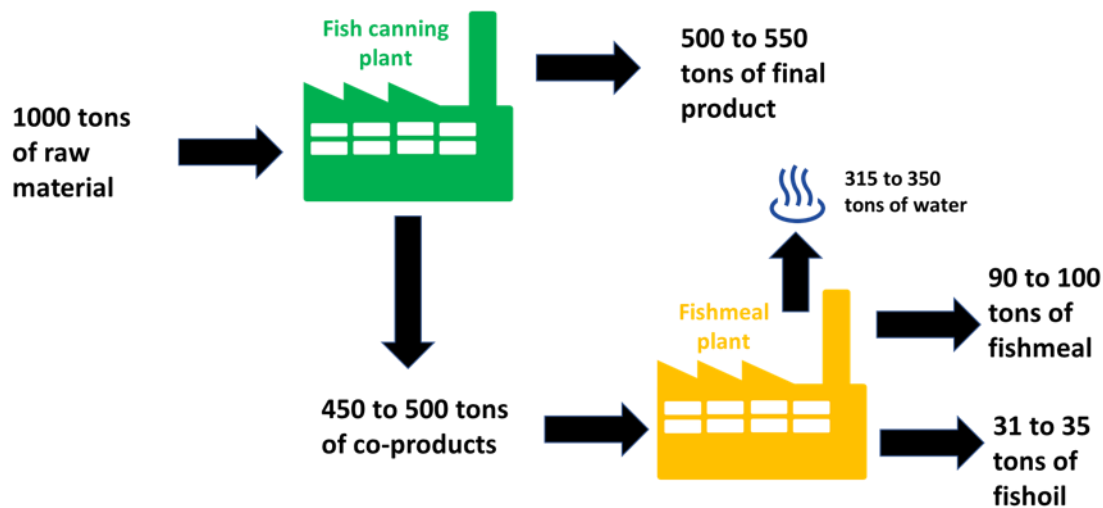


Figure 40 Fish Canned Fish Industry Value Chain

3.4.3.2 Technological innovations:

Technological innovation can include improving the quality and added value of products, enhancing the value of co-products and the efficiency of resources (water, energy, packaging, etc.).

However, the room for manoeuvre of manufacturers remains very limited due to the business model adopted by the majority of Moroccan canneries. Indeed, the latter often work as subcontractors on behalf of foreign contractors who dictate the conditions of production: volume, quantity revenues, etc. The local market, which could offer development opportunities for canning, is very limited and remains to be developed.

Moreover, when it comes to the supply of empty boxes, the conservers are in an oligopolistic situation, where a limited number of manufacturers set the prices. This dependence on suppliers and customers affects the competitiveness of the sector.

Innovations related to the valorization of co-products:

The co-products generated by canneries are prized by fish meal and fish oil units. Some units value certain parts of the co-products, including canned pieces of flesh (rouelles), fish pie, petfood, etc.

Product innovation (including the valorization of co-products) involves the development of the local market and the search for new markets.

Resource Efficiency Innovations:

Water and energy saving issues were also raised by industrialists. The canning industry is known to consume a lot of clean water and energy.

Innovations aimed at reducing energy and water consumption are in great demand by freezing manufacturers, especially those active in the south of the country.

3.4.3.3 Issues identified by companies

Limiting factors for canning businesses to improve their competitiveness/modernization include:

- Supply of rawmaterials, a factor common to all branches of valorization of fishery products,
- Dependence of suppliers of packaging (empty boxes) and oil and customers.

3.4.3.4 Innovative business models

The item "packaging" represents up to 40% of the cost price. To deal with this, it has been proposed, for example, the grouping of canning companies with a view to creating oil storage or packaging platforms.

3.4.3.5 Regulatory constraints

In terms of the valorization of co-products, snares / wheels can be recovered as products for human consumption, while oil produced from these same co-products can not benefit from the designation "edible oil" which is reserved for oil produced from whole fish only.

Sometimes, some operators complain about the interpretation by inspection officers of certain regulatory provisions. This could be an isolated case, otherwise a reformulation of these provisions would be necessary so as to avoid any form of interpretation.

3.4.3.6 Areas for improvement / pilot projects

-
- Valorization of parts of co-products (rouelles) in canned, fish pie or others that are forms of valorization compatible with the core business of the conservers. This requires a separation of the co-products and compliance with hygienic conditions to allow a food valorization of these co-products.
- Innovation through packaging: improving the attractiveness of products by improving packaging.
- Energy saving:
- Water saving / water recycling

For energy and water economics an approach according to the TEST methodology is recommended. Consideration should be given to finding joint solutions for industrial zones here with several companies, also in several sectors. This results in economies of scale that allow for more cost-effective solutions, for example for the installation of solar systems.

3.4.4 Shelling of shrimp

3.4.4.1 Sector overview



Figure 41 Geographical distribution of shrimp shelling units⁴

⁴ The size of the bubbles corresponds to the installed processing capacity

The shrimp shelling industry consists of a dozen industrial units located almost all in the north of the country (Tangier, Tetouan and Nador). Average capacity Installed is 33,000 tonnes, with new investments underway. According to statistics from the Office de Changes, Morocco imported an average of 20,000 tons per year during the period 2015-2019.

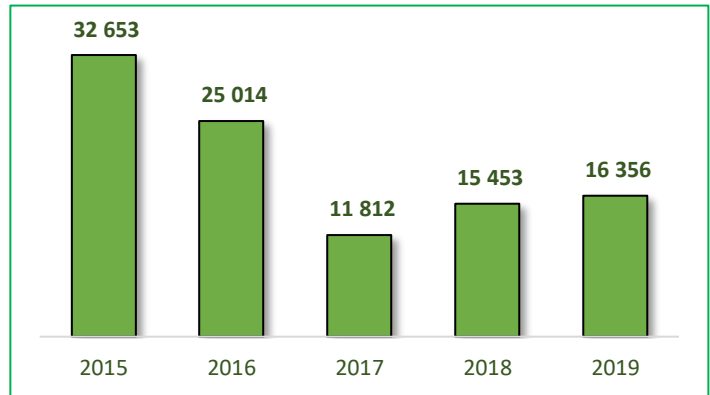


Figure 42 Moroccan imports of shrimp

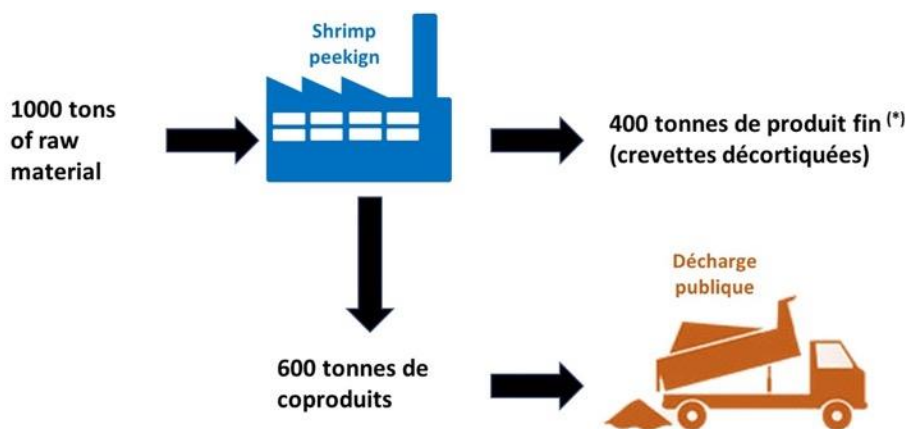


Figure 43 Shrimp Shelling Industry Value Chain

3.4.4.2 Technological innovations

The business model of the majority of shelling units consists of importing fresh shrimp from Europe, shelling them manually and then re-exporting them fresh to their places of origin (Netherlands, Belgium) with low added value.

It is an industry that generates large quantities of co-products up to 60-70% of the raw material. These volumes of co-products are not recovered and are simply incinerated or returned to the landfill.

Technological innovation is perfectly justified both for the improvement of added value and the valorization of co-products.

Innovations related to improving product quality

This industry will have to evolve towards a better valorization of products starting first with the manufacture of frozen shrimp, then cooking, etc. this will also have to be accompanied by innovation in packaging.

Innovations related to the valorization of co-products

The importance of shelling co-products offers real opportunities for development. We can start by drying the shells in order to constitute feed for shrimp farming, then evolve towards more valuable forms (extraction of Chitosane).

However, according to a professional, the investment in a unit for the recovery of co-products would not be profitable if the processing capacity exceeds 100 T/day of co-products.

3.4.4.3 Issues identified by companies

Limiting factors for shelling companies to improve their competitiveness/modernization include:

- Dependence on a limited number of raw material suppliers (based in Europe).
- Dependence on a single product
- Importance of the mass of workers. Some units had to set up in relatively remote cities in order to find labour,
- Dependence on road transport and its impact on the carbon footprint,
- Access to finance
- Lack of skilled labour (senior technicians). Sometimes, we call on technicians from abroad for interventions of 3 man-days, a cost of 3000 to 4000 €.

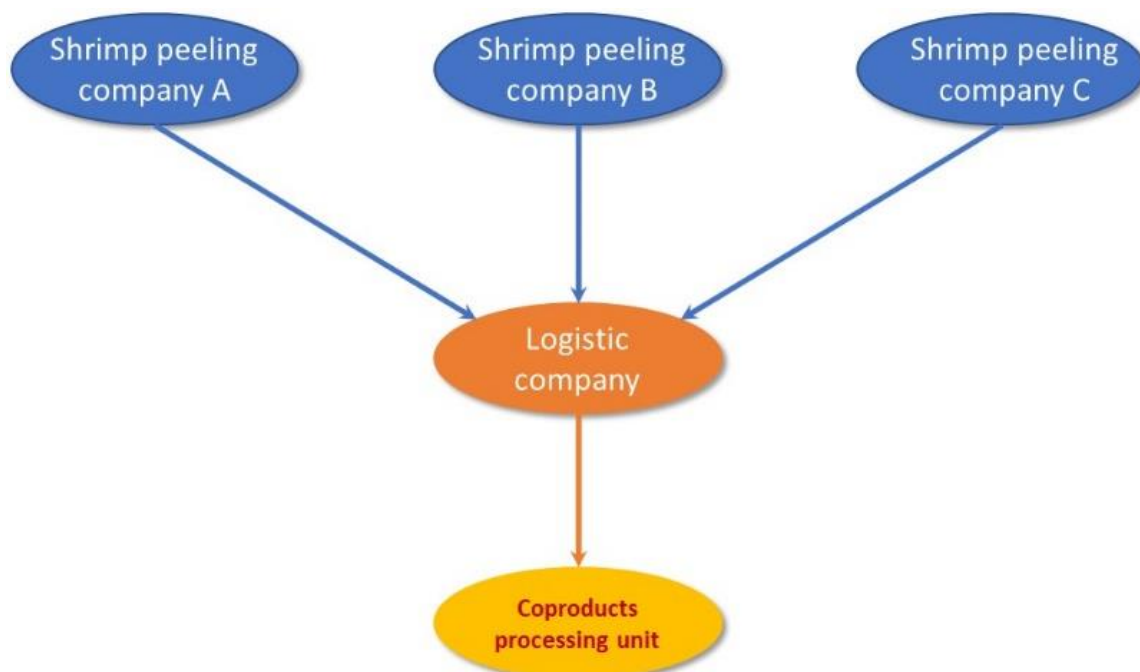


Figure 44 Logistical scheme for valorization of shrimp shells,

3.4.4.4 Innovative business models

For the valorization of shrimp shells, it has been proposed, for example, the creation of a cooperative for the treatment of the co-products of the various shelling units by associating a logistics company that will take care of collection and delivery to the place of recovery.

3.4.4.5 Regulatory constraints

- Risk of regulatory constraints making the processing of co-products mandatory,
- Carbon footprint due to road transport

3.4.4.6 Areas for improvement / pilot projects

- Valorization of shrimp shells (animal feed or advanced technologies such as chitosan production)
- Valorization of finished products: by packaging, freezing, cooking, etc.

4 Synthesis of the challenges of the priority sub-sectors

The following table summarizes the issues identified during the sectoral workshops.

Table 4 Issues identified during the sectoral workshops

Sub-sector	Issues
Common issues	<ul style="list-style-type: none"> Raw material supply Access to finance and innovative technologies Saving water and energy
Preserve	<ul style="list-style-type: none"> Often subcontracting position with dependence on a limited number of customers and suppliers Cost of metal packaging
Freezing	<ul style="list-style-type: none"> Access to and reuse of water Cost of energy Valorization of cephalopod co-products Recovery of packaging waste
Shrimp shelling	<ul style="list-style-type: none"> Atypical sector: based on the import of raw material, manual shelling and then reshipment to the destination of origin with low local added value Dependency on a single product and a very limited number of customers Importance of non-recovered co-products (60-70% of PM) Importance of the mass of workers and unavailability of qualified technical personnel
Fish meal and oil	<ul style="list-style-type: none"> Diversification of raw materials Creating more added value Staff training / technology transfer

5 Development prospects Circular Blue Economy

5.1 Restructuring of the fish meal and fish oil sector

This is the most important scenario. Indeed, the fishmeal and fish oil industry has its place in the industrial fabric of processing fishery products. Indeed, it is an activity that makes it possible to process the tonnages of co-products generated by the freezing and canning industries in the absence of other forms of recovery of co-products. It is an industry that processes, according to estimates, nearly 90% of the co-products generated by the Moroccan fishing industry.

However, the volumes of these co-products remain below the processing capacities installed at the plant level and do not meet the global demand for fish meal and fish oil. For this reason, flour factories use, in addition to co-products, a supplement of whole fish, thus exerting pressure on pelagic resources. This pressure is all the more important as pelagic resources are acclaimed by several users: the canning, freezing and fish meal and oil industries as well as the consumer market for fresh fish. Any possible scarcity or scarcity of pelagic resources therefore directly or indirectly jeopardizes the sustainability of this industry.

Faced with this situation, a restructuring of the fishmeal and fish oil industry is necessary. Such a restructuring could be structured around the following axes:

- Diversification of sources of supply,
- A mastery of the quality of raw materials,
- Diversification of products and outlets

Diversification of sources of supply

The proliferation of the sea snipe in recent years has led the supervisory administration and professionals to reflect on the forms of exploitation and valorization of this invasive species. The valorization of fish meal and fish oil could be a way to exploit and enhance this species and thus reduce its impact on traditional pelagic species.

The equipment at the level of fishmeal and fish oil units is probably not adapted to treat this new species characterized by its rigidity. Units must be equipped with separation equipment to treat this species. This separation will result in two products:

- On the one hand, fish meat that can be transformed into flour with high protein value;
- On the other hand, bones / bones that would be valued in protein hydrolysates, gelatin, collagen, etc. that have many uses, but which nevertheless require new and sometimes complex technologies.

Control of the quality of raw materials

The quality of raw materials is often poor along the chain, especially for meal intended for animal feed. The entire supply chain (collection, transport and storage) must be modernized with respect for the cold chain.

Separation of raw materials

Co-products must be separated from whole fish. Similarly, co-products must be separated at freezing or canning plants into different products: pieces of flesh, bones, viscera and heads. Each by-product would result in a different finished product.

This separation would result in an additional cost for the flour units, but this would be offset by the value of the finished products. It must be taken into account that at each stage of the separation process, new by-products are created, for which recycling must be found. In addition, they are never standard products. Feasibility studies and cooperation with potential international customers, for example in the fields of nutrition, cosmetics and chemistry, seem to make sense here.

Diversification of products and markets

The upstream separation of raw materials would make it possible to give rise to different products subject of course to market opportunities:

- Fish meat to produce high protein flour and oil,
- Bones and skins for the production of collagen or gelatin
- Viscera for the production of enzymes,
- Heads to produce protein hydrolysates or aromatic extracts,

These avenues of valorization have already been studied by the Specialized Center for the Valorization and Transformation of Seafood Products (CSVTPM) of the INRH. This know-how must be complemented by market research to better orient the industry towards the most promising niches.

The modernisation and restructuring of the entire sector reveals a variety of potential pilot projects:

- Optimization of existing processes and products to become more competitive in the global market
 - Process optimization, efficiency of energy, water consumption, raw materials (Quality), e.g. by TEST methodology
 - Replacement of old equipment with modern and efficient equipment (Hedinn, GEA, etc.)
 - Optimization of collection logistics and the cold chain in close collaboration with the processing industry and the fishing sector.
- Development of new products and associated projects with analysis of potential markets and customer structures (this includes the process optimization measures listed above)
 - Protein-enriched flour
 - Protein hydrolysates, bioactive peptides
 - Oils enriched with Omega 3
 - Collagen, gelatin
- Use of the sea sandpiper
 - Separation of bones for valorization such as (for example) collagen, gelatin, hydrolysate,
 - Oil and protein flour of the sea snipe.

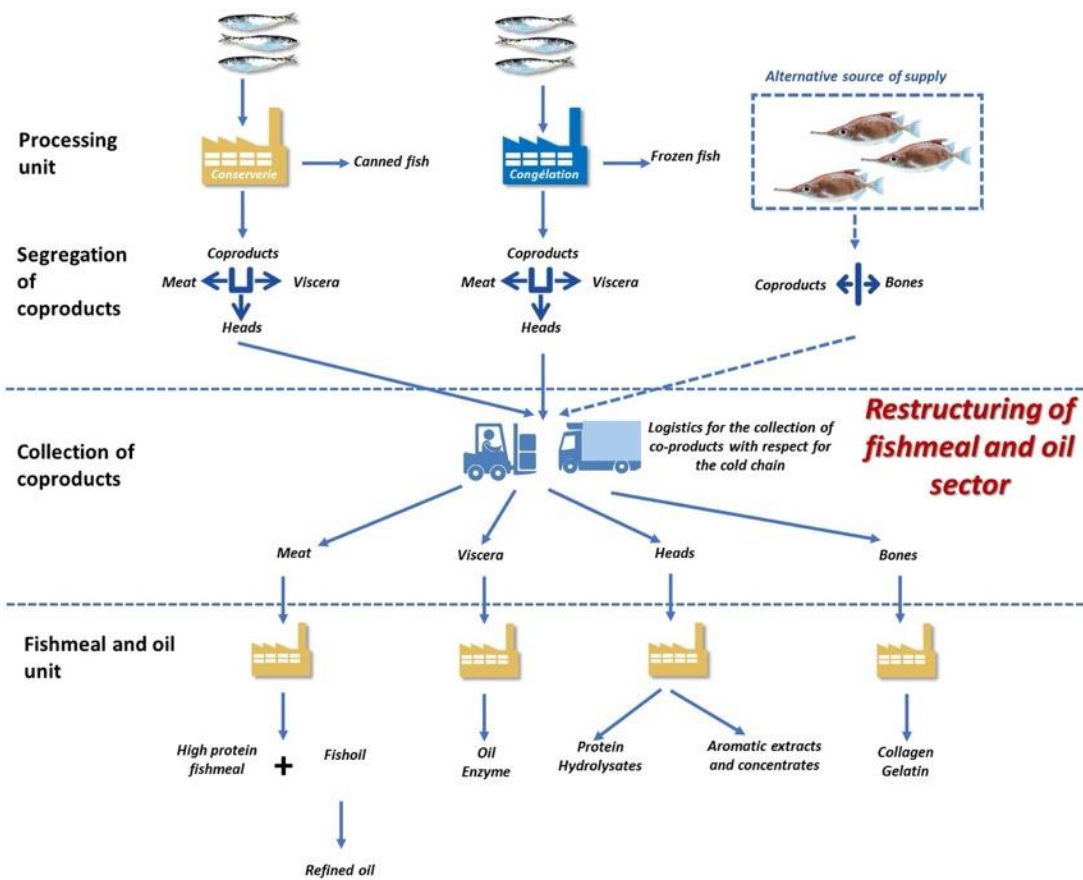


Figure 45 Summary diagram for restructuring scenario for the fishmeal and fish oil industry

5.2 Shelling of shrimp

The business model of the majority of shelling units consists of importing fresh shrimp from Europe, shelling them manually and then re-exporting them fresh to their places of origin (Netherlands, Belgium) with low added value.

It is an industry that generates significant quantities of co-products up to 60-70% of the raw material. These volumes of co-products are not recovered and are simply incinerated or returned to the landfill.

Technological innovation is perfectly justified both for the improvement of added value and the valorization of co-products.

There are already established recycling options around the world that can be a source of inspiration. There are already experiments and developments in Morocco aimed at promoting co-products (partnership between the MaSciR research center and the Klaas Puul Company). The recovery of shrimp shells on an industrial scale requires the implementation of a collection system from the various shelling units.

The nature of the co-products

The shells still contain a certain residual amount of flesh (to be evaluated). This flesh contains protein, but also oil with a significant level of Omega 3. These shells also contain partially protein-bound chitin and minerals. Due to their perishable nature, co-products must be handled in accordance with the cold chain.

Opportunities for value creation / Avenues for improvement

- **Use of whole shells** for feeding animals. Simply dry or freeze, grind/cut. Shrimp shell meal is already a product (established for the feeding of domestic animals, poultry or shrimp. In the absence of a shrimp farming activity in Morocco, the manufacture of feed for farmed shrimp would be less relevant in the very short term provided that the international market is prospected.
- **Separation of flesh** from shells (technology available):
 - The flesh is a product rich in protein and oil (omega-3) – a very suitable product for feeding fish, and other animals. In addition, it would be possible to separate oil from meat
 - For residual shells, there are several opportunities:
 - ✓ Shell flour (as described above)
 - ✓ Further processing in products such as chitosan, mineral powder⁵
- Use for animal feeding would be the easiest track to establish. For this, there are prerequisites to satisfy:
 - Cooling/freezing or drying systems in shelling units,
 - Collection systems,
 - Drying/freezing centers (if not established in shelling plants),
 - Means for the development of the market (including food tests).
- In order to achieve greater value creation beyond direct use, it would be necessary to:
 - Cooling/freezing or drying systems in shelling units

⁵ <https://bioresourcesbioprocessing.springeropen.com/articles/10.1186/s40643-019-0243-y>

- Collection systems,
- Drying / freezing / separation centers of the flesh from the shells (if not established in the factories)
- Develop/adapt processes for the extraction of chitosan, minerals, etc. requiring large investments, expertise of research institutes or international partners
- Means for the development of the market for all co-products.

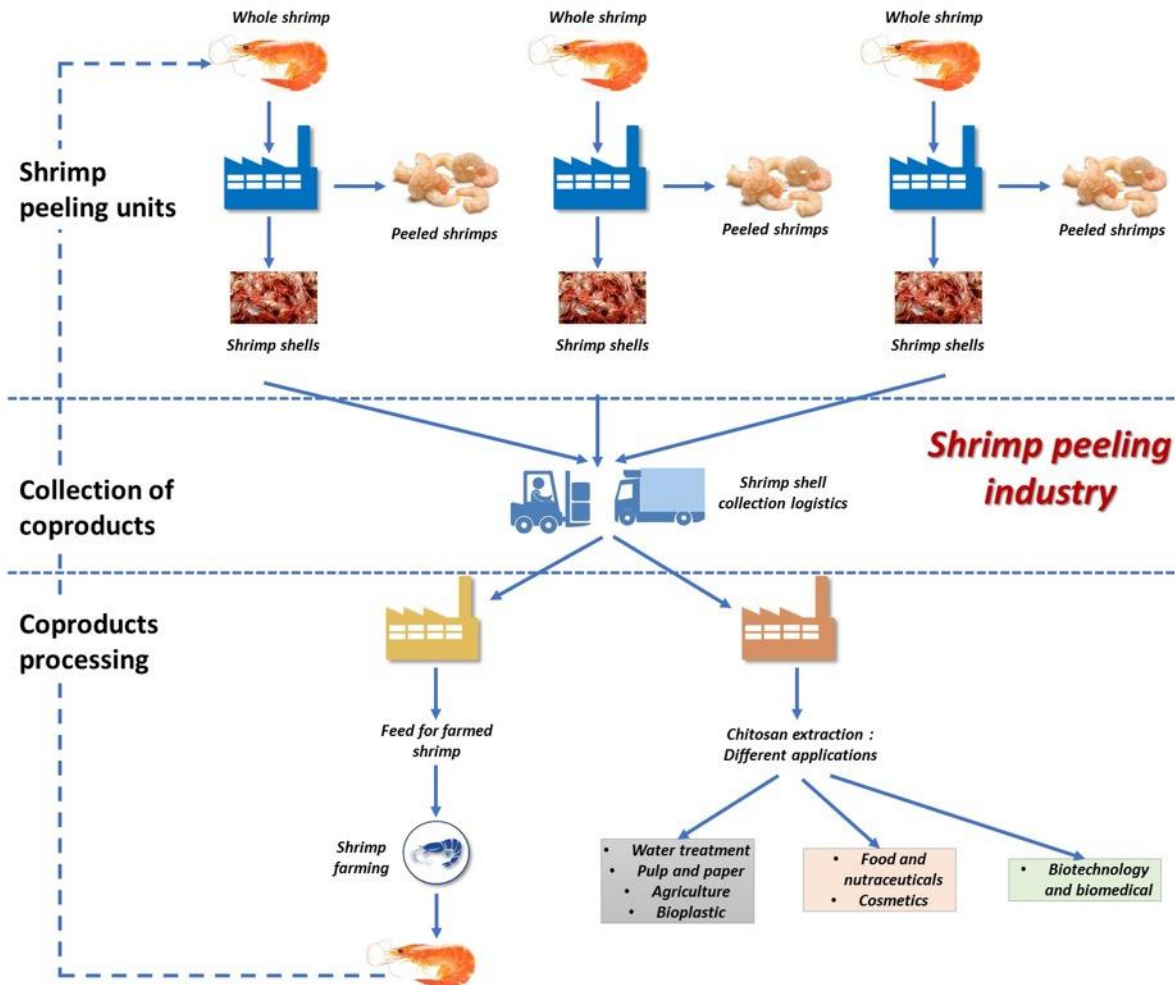


Figure 46 Summary diagram of the shrimp shell recovery scenario

The spectrum of possible solutions for shell recycling ranges from relatively simple solutions (animal feed) to technologically sophisticated and complex solutions with high development and investment costs. It therefore appears necessary to carry out a feasibility study for the different approaches as well as a market study for use as animal feed.

5.3 Valorization of cephalopod co-products

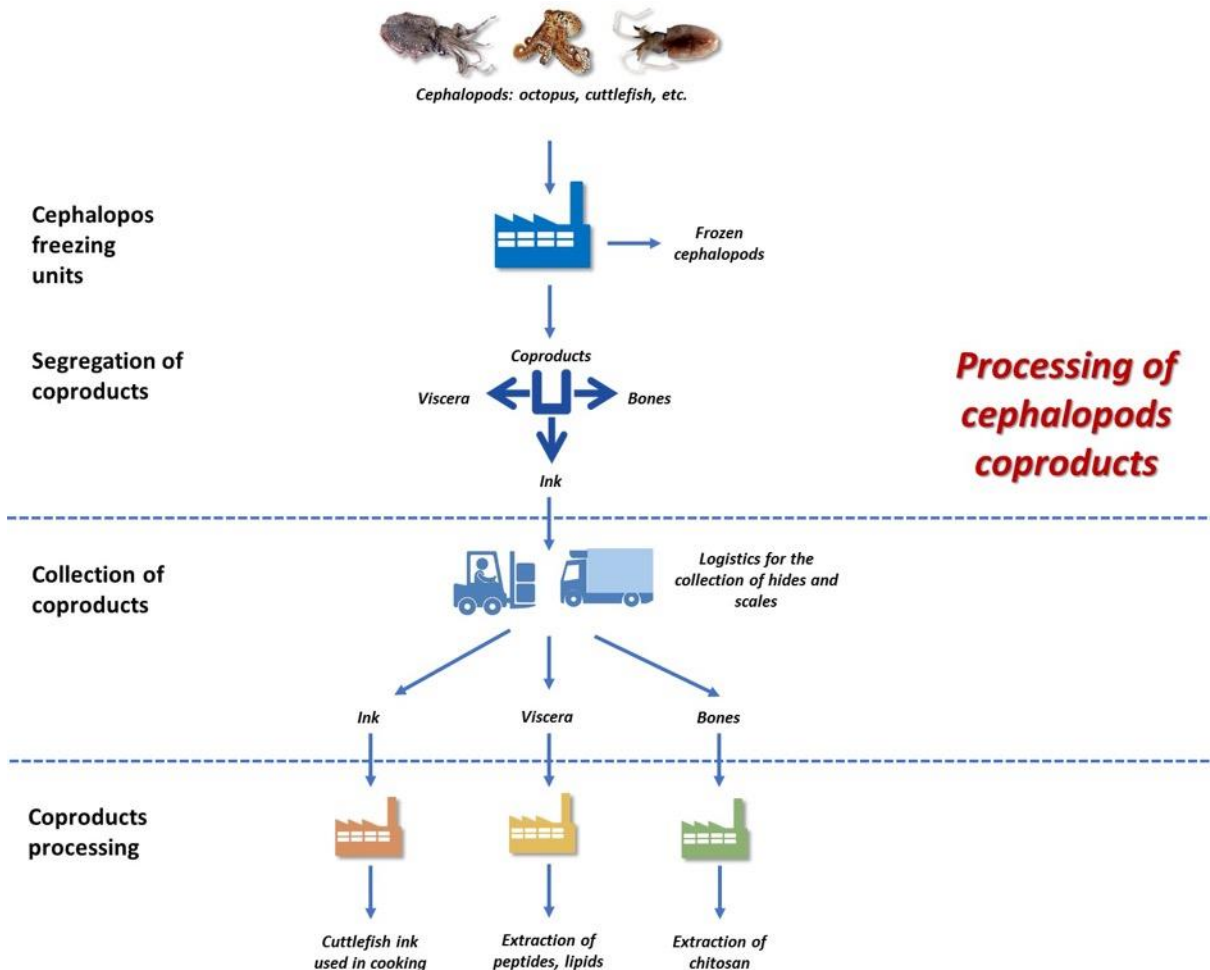


Figure 47 Summary diagram of the cephalopod co-product recovery scenario

It must be taken into account that at each stage of the separation process, new by-products are created, for which recycling must be found. In addition, they are never standard products. Feasibility studies and cooperation with potential international customers, for example in the fields of nutrition, cosmetics and chemistry, seem to make sense here.

Some avenues of valorization have already been studied by the Specialized Center for valorization and Transformation of Seafood Products (CSVTPM) of the INRH. This know-how must be complemented by market research to better orient the industry towards the most promising niches.

Apart from that, there is virtually no information on the specific recycling of cephalopod residual materials.

It should be mentioned once again that there are at least two companies that have found customers in China and the United States, respectively, who would have purchased the by-products. In the two known cases, legal/administrative obstacles prevented the operation from being carried out. It would be wise to first try to influence the political and administrative processes in order to make these potential recycling routes possible, especially since the quantities of residual materials concerned are relatively small.

5.4 Valorization of skins and scales

This is a scenario for the collection of scales and skins from industrial units, especially those that carry out threading operations.

The skins can be used as a raw material for the manufacture of leather goods. Two startups have specialized in the valorization of fish skins. One of them, Cuimer, mainly treats salmon skin from smoking plants. It uses other species such as sole or skate from suppliers at the port of Casablanca. This startup has been processing an average of 10 tons of fish skin per year for the past four years. These startups benefit from the image and know-how of Moroccan craftsmanship.

The creation of an industrial activity around the valorization of fish skins is probably not justified. This is a niche market-based scenario in which marketing action is highly recommended to support these young startups, or even create others, which translates into the creation of productive and sustainable jobs.

Next to the fish skins, there are also the scales that can be collected and valued. Two avenues of valorization can be explored:

- Collagen / gelatin production:

The technology is well known in Morocco. The INRH is at the origin of two patents for inventions in Biotechnology that can be made available to future buyers:

- Process for extracting and purifying native marine collagen type i from the scales of *sardine Sardina pilchardus*;
- Process for extracting marine gelatin from the scales of *sardines Sardina pilchardus*.

- Production of building materials:

It is possible to turn scales into building materials. Indeed, in 2018, a French startup, SCALE, invented a marbled-looking material entirely and exclusively made of fish scales. She named it SCALITE, by analogy to the first plastics such as bakelite, ebonite or galalith.⁶

⁶ <https://www.scale.vision/fr/accueil>

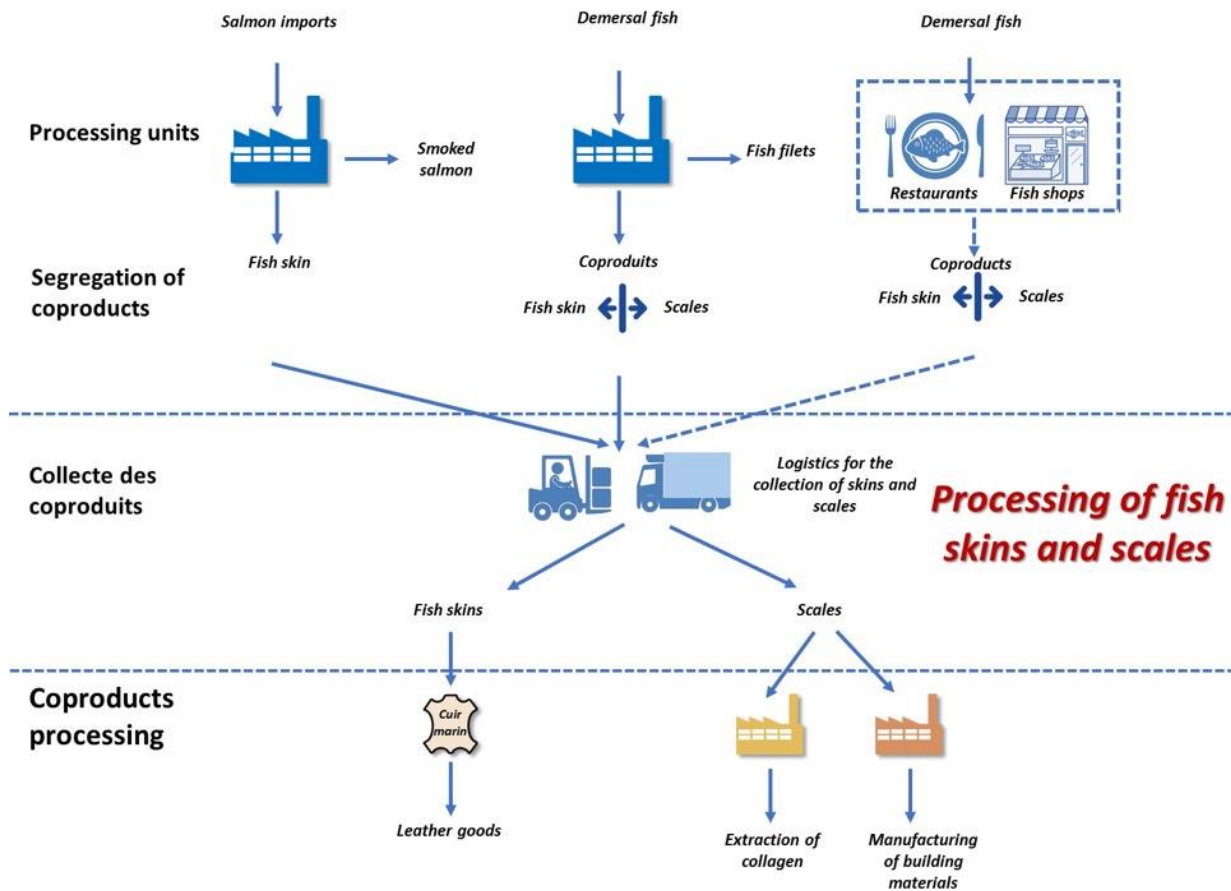


Figure 48 Summary diagram of the fish skin and scale recovery scenario

Special scenario for the business / restaurant

The SwitchMed programme primarily targets industrial activities in the processing of fishery products, where the potential to create a circular economy is very significant.

These avenues for collecting and recovering scales, skins or others can be transposed to the co-products generated by the tertiary sector (catering, fishmongers, etc.).

In the absence of data on these activities, it is difficult to estimate the exact quantities that are lost and end up in the trash. Nevertheless, the quantities involved are considerable. For the recovery of by-products, there would be a relatively simple way to recover these quantities of waste and transform them into a simple fish hydrolysate, which can be used, for example, in animal feed or as fertilizer. This is an opportunity for these smallholders to create added value from this waste.

The principle is simple, it consists in adding an organic acid (formic acid, lactic acid) to fish waste to preserve it so that it is hydrolyzed in about a week by the action of naturally present enzymes.

Small units could store containers or small transportable containers to which the necessary amount of acid has already been added. These are then filled with fish residues collected at regular intervals and transported to a central unit.

This model would offer the following advantages:

- Reduction of fish waste from small units,
- New jobs in logistics,
- New jobs in the "Hydrolysis" sector,
- Cheap food or fertilizer for local agriculture,
- Short distances and closed loops in the regional economy

A feasibility study is needed to evaluate this model. This study should answer the following questions:

- What would be the minimum quantity for economic operation?
- What size can or should the radius within which the collection takes place be had?
- What are the possible means of transport (e.g. bicycles, cargo bikes, cars, vans)?
- What temperature range is possible for storage?
- Can fermentation take place in transport containers or is it carried out centrally?
- What are the safety rules to follow when handling acid?
- Which potential buyers are in the immediate environment? What size can or should the market have, what price would be possible?
- Are these potential buyers really interested?
- Are there any legal obstacles (e.g. feed and fertiliser regulations)?
- Is there enough manpower? what qualifications are required?
- Etc.

5.5 Collection, sorting and recycling of packaging waste

The fish processing industry, like many other industries, has significant amounts of packaging waste, including:

- Polypropylene / polyethylene packaging: whose recycling seems complicated because it is contaminated with fat. The volumes of packaging involved would be very important if we count the packaging to be collected even from customers (restaurants, supermarkets, etc.). Of these companies.
- Polystyrene boxes: which occupy large volumes.
- Carton packaging,
- Metal packaging,
- Etc.

Although this is not an axis specific to the fisheries sector, but common to all industrial branches, it would be appropriate to initiate the creation of a packaging recovery, sorting and recycling sector currently dominated by the informal sector.

It is recommended that packaging waste be separated "at source" at company level to facilitate collection. Similarly, a restructuring of the collection activity is recommended through the organization of these agents into cooperatives.

Such a model, if duplicated at the level of all industrial zones throughout the kingdom, could create a large number of sustainable employment positions and improve the living conditions of the populations targeted by this activity.

5.6 Study of the "factory of the future"

This is a concept initiated by Agadir Haliopôle. According to the latter, markets are increasingly volatile, unpredictable and demanding in terms of the quality of products and associated services, delivery times, innovation, ethics and consumption patterns. Globalization, the accelerated evolution of technologies and environmental challenges are forcing manufacturers, says the AHP, to rethink the design of factories that must not only be profitable, competitive, efficient and job creators but at the same time meet economic, organizational, societal and environmental demands.

The factory of the future, as perceived by the AHP, would be interconnected. This allows it to "dialogue" or exchange information with the different parts of its production tools and with the external environment (customers, suppliers, service providers).

The result is:

- Optimization of production resources and cycles thanks to the numerical simulation of the manufacturing organization according to customer demand;
- Reduced costs;
- Better product traceability;
- Better management of stocks and production cycle time;

A modern factory or "factory of the future" would be a response to the challenges identified in this study in relation to circularity and resource efficiency, which is based on the concept of "consume less to produce better". This should result in:

- Energy saving with the use of renewable energies,
- Water saving through the use of water-efficient processes and the use of water reuse,
- Treatment of liquid and gaseous effluents,
- Valorization of co-products.

These are only avenues of reflection that deserve to be deepened through the realization of a feasibility study within the framework of this programme.

The development of a circular economy within the fisheries sector could lead to the emergence of regional poles for the valorization of co-products:

- North pole around the valorization of shrimp shells,
- Pôle Centre (Agadir) set up as a biotechnological pole benefiting from the expertise of the CSVTPM of the INRH and the Cité d'innovation,
- Laayoune pole around the fishmeal and fish oil sub-sector
- Dakhla pole dedicated to the valorization of cephalopod co-products.

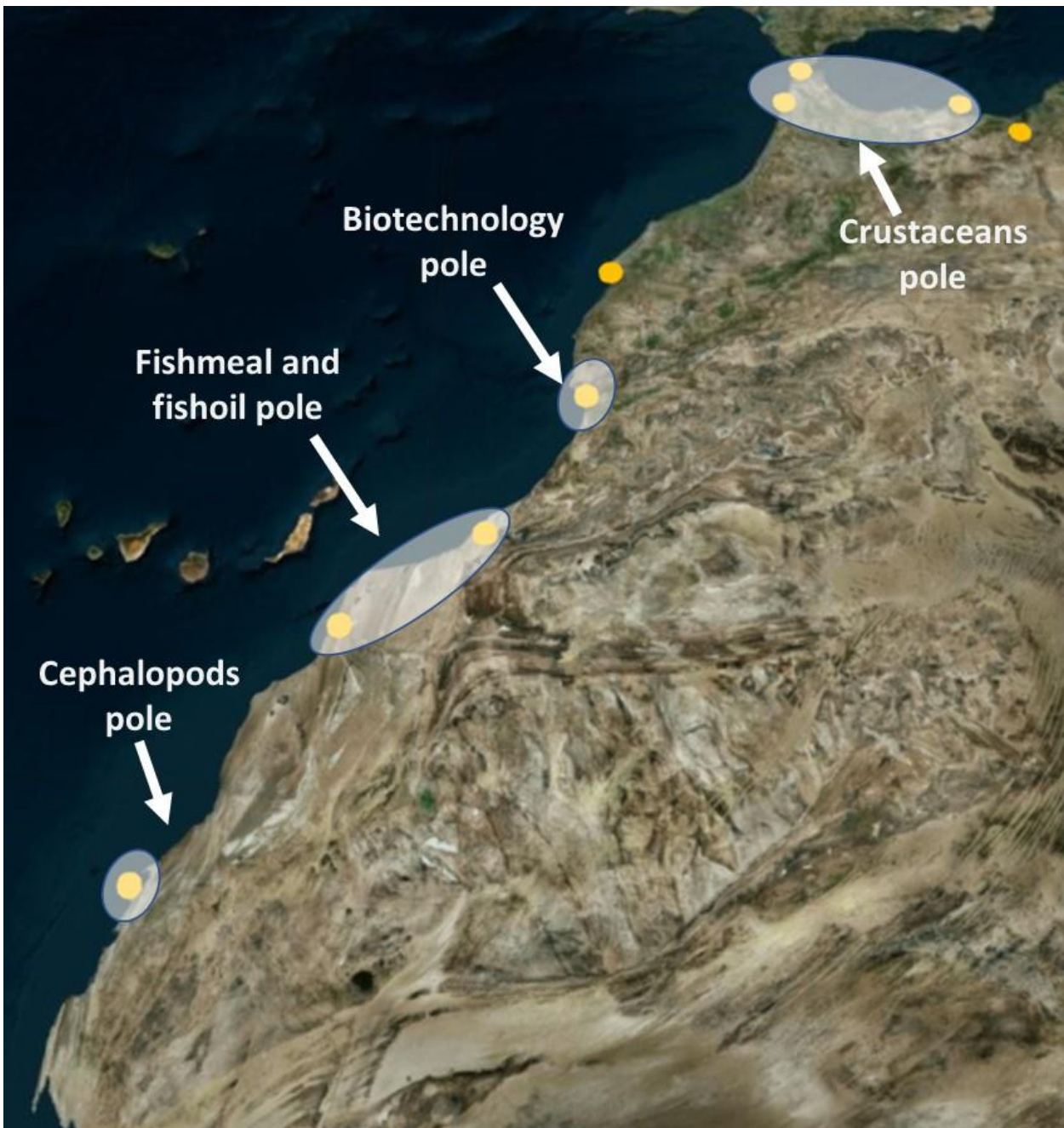


Figure 49 Specialized regional centers for the valorization of co-products

6 Annex

6.1 Appendix 1: Preliminary Questionnaire

SWITCHMED II

Development of the Blue Economy in the value chain of processing of fishery products in Morocco

Survey of Moroccan enterprises processing fishery products
Questionnaire

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 footprint of existing economic activities in the Southern Mediterranean. This initiative consists of stimulating the development of industrial projects focused on 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 established and emerging sectors of the blue economy. In this context, we are conducting a survey of Moroccan companies processing fishery products in order to identify projects/initiatives with high potential for sustainable development that can be supported as part of this initiative. Also, we kindly ask you to fill out the questionnaire below. It will only take you 10-15 minutes. Individual information collected from companies will remain completely confidential.

1. PRESENTATION OF YOUR COMPANY:

Company name	.....
Address	..........
Contact (person(s) responsible)	..... .....
Phone number	.....
Trade	<input type="checkbox"/> Fresh packaging <input type="checkbox"/> Freezing <input type="checkbox"/> Preserve <input type="checkbox"/> Semi-serve <input type="checkbox"/> Fish meal and oil <input type="checkbox"/> Shrimp shelling

	<input type="checkbox"/> Shells <input type="checkbox"/> Algae
Main products	..........
Average annual production capacity? <i>In tonnes of raw material</i>	..........
Average annual turnover <i>In MAD /year</i>	.....
Number of employees (permanent and seasonal)	Permanent:..... Seasonal:.....

2. GENERAL

How would you describe resource efficiency in your company?

- Very important
- Important
- Moderately large
- Less important
- Not important

How do you describe the ecological aspects in your company?

- Very important
- Important
- Moderately large
- Less important
- Not important

Do you have certifications in the environmental field (for example: ISO 14001)

- Yes
- No

How do you receive your raw materials?

- Fresh
- Frozen
- Other (salty, ...)

2.1. Operating Resources

Follow, in a general way, your consumption by:

	Yes	No
Water	<input type="checkbox"/>	<input type="checkbox"/>
Gas	<input type="checkbox"/>	<input type="checkbox"/>
Fuel	<input type="checkbox"/>	<input type="checkbox"/>
Electricity	<input type="checkbox"/>	<input type="checkbox"/>

Do you have an analytical accounting by product especially for utilities (water, electricity, fuel)?

- Yes
- No

What ratios are you used to using to appreciate your consumption?

For example, for your electricity consumption

- In kWh/kg of raw material processed?
- In kWh/kg of finished product?
- In MAD/kg of raw material processed?
- In MAD/kg of finished product
- Other:

Do you carry out energy audits?

- Yes
- No

If so, what measures have you put in place to improve your energy consumption?

.....

.....

.....

.....

Have these measures reduced your energy consumption?

A reduction of:

- 0-20%
- 20-40%
- 40-60%
- 60-80%
- More than 80%
- No impact

2.2. Management of co-products

Do you track your FP performance?

- Yes
- No

What type(s) of solid waste is generated by your company?

- Heads, viscera
- Skins, bones
- Non-machinable whole fish
- Shells (crustaceans)
- Other:

What is the average annual amount of solid waste generated by your unit?

.....
.....

Do you separate your solid waste?

- Yes
- No

How is solid waste collected and stored at your unit level?

.....
.....
.....
.....

Do you have a logistics system for solid waste in your unit?

- Waste collection system
- Cold storage: cold room dedicated to waste
- Other:

Do you use smart technologies/digital monitoring systems to track your unit's waste?

- Yes
- No

What is the future of your company's solid waste?

- Stored for sale or sale to third parties?
- Valued by your own unit or unit of your group?
- Sent back to the landfill?
- Other:

In the event that the waste in your unit is recovered, what type of recovery have you opted for

.....
.....
.....
.....
.....
.....
.....

In the event that you do not recover the waste from your unit, what do you think are the constraints that prevent you from doing so?

- Lack of surface area at unit level
- Lack of qualified personnel
- Insufficient financial resources
- No market
- Lack of technical expertise and support
- Other:

Do you know of any other companies that recycle their own waste?

- Yes
- No

Do you process liquid discharges from your unit?

- Yes
- No

If so, how?

.....

.....

.....

.....

.....

A kick-off meeting for this programme will be held shortly to present in detail this initiative (objectives, expected results, etc.). The date of holding this event will be communicated to you as soon as possible.

Would you be interested in participating in this event?

- Yes
- No

If so, who will represent your company

Name and surname	.....
Email address	.....
Function within the company	<input type="checkbox"/> Managing director <input type="checkbox"/> Production Manager <input type="checkbox"/> Sales Manager <input type="checkbox"/> Quality Manager <input type="checkbox"/> Other:
Phone number	.....

Thank you for your cooperation,

6.2 Appendix 2: In-Depth Questionnaire

SWITCHMED II

Development of the Blue Economy in the value chain of processing of fishery products in Morocco

Survey of Moroccan enterprises processing fishery products

Maintenance Guide

*This document is intended to be an aid to carry out the analysis of your company.
In order to facilitate the discussion with the experts who will meet you, it would be desirable that you inform him before the arrival of them.
The discussions you have with the experts will be completely confidential.*

1. General information

Unit Name:	.....
Person contacted	.....
Function	.....

2. Key figures of the activity:

		2018	2019	2020
<ul style="list-style-type: none"> • MP tonnages purchased by cash: <ul style="list-style-type: none"> ○ Species 1: ○ Species 2: ○ Species 3: 	<ul style="list-style-type: none"> • • • • • • 	<ul style="list-style-type: none"> • • • • • • 	<ul style="list-style-type: none"> • • • • • • 	<ul style="list-style-type: none"> • • • • • •
<ul style="list-style-type: none"> • Overall tonnage produced (finished products): <ul style="list-style-type: none"> ○ Output 1: ○ Output 2: ○ Output 3: 	<ul style="list-style-type: none"> • • • • • 	<ul style="list-style-type: none"> • • • • • 	<ul style="list-style-type: none"> • • • • • 	<ul style="list-style-type: none"> • • • • •
<ul style="list-style-type: none"> • Turnover 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
<ul style="list-style-type: none"> • % of turnover 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •

		2018	2019	2020
generated by exports				
• Current main export target countries
• Brands

3. Company strategy

- What is the strategy of your company / Group in the short and medium term?

- Increase production
- New product development / diversification
- Improved production quality
- Development of a brand specific to your unit
- Modernization of manufacturing processes
- Exploration of new markets (Export)
- Valorization of co-products

- Is your company engaged in a modernization process?

- Yes
- No

- If not, what is currently limiting the expansion/modernization of your business? Please name 3 in order of priority?

1.
2.
3.

- What are the main obstacles to innovation/use of technologies (see question 13)

- Lack of technical/scientific knowledge
- High investment cost
- Absence of the market
- Lack of market knowledge
- Exploration of new markets (Export)
- Valorization of co-products

- What are the latest investments made by your company?

	Investment 1	Investment 2	Investment 3	Investment 4
Type :				
Cost:				

-
- What were the main motivations for these investments?
 - Financial profitability - return on investment
 - Environmental considerations
 - Regulatory obligations
 - Reputation & image of the company
 - Other to be specified:
-
- Do you already see the expected benefits of this investment:
 - Yes
 - No
-
- Do you assess the return on investment of these measures?
 - Yes
 - No
-
- If so, what was the result?
 - Very satisfying
 - Satisfactory
 - Unsatisfactory
 - Unsatisfactory
-
- In terms of quality policy, what management systems does your company have?
 - Quality Management System (QMS), *Ex: ISO 9001*
 - Environmental Management System (EMS), *Ex: ISO 14001*
 - Energy Management System (EnMS), *Ex: ISO 50001*
 - Health and Safety Management System, *Ex: OHSAS 18001*
 - Food Safety Management System, *Ex: ISO 22000*
 - Other? to be defined:
 If "Other" please let us know if the management system is:
 - Certified
 - Under construction
 - Planned

4. Valorization of co-products

4.1. Importance of co-products

- Co-products generated by your company (nature and quantity):

Nature	Quantity	Part in % of incoming MP	Destination	Cost of treatment or collection

-
- Is there an initiative to reduce the amount of waste generated/create added value:

.....

.....

.....

4.2. Potential avenues for the valorization of co-products

- In the event that you plan to recover the co-products, which product(s) will you opt for?

Valuation market	Product
Agriculture	<input type="checkbox"/> Compost / Fertilizers <input type="checkbox"/> Minerals <input type="checkbox"/> Chitin <input type="checkbox"/> Other:.....
Animal feed	<input type="checkbox"/> Fishmeal <input type="checkbox"/> Fish oil <input type="checkbox"/> Protein hydrolysates <input type="checkbox"/> Other:.....
Agri-food / human food	<input type="checkbox"/> Fish pie <input type="checkbox"/> Frozen mince <input type="checkbox"/> Fish pulp <input type="checkbox"/> Fish oil <input type="checkbox"/> Surimi base <input type="checkbox"/> Gelatin <input type="checkbox"/> Other:.....
Dietetics and nutraceuticals	<input type="checkbox"/> Collagen <input type="checkbox"/> Chitin / Chitosan <input type="checkbox"/> Keratin <input type="checkbox"/> Other:.....
Medicine, pharmacy and biotechnology	<input type="checkbox"/> Chitin / Chitosan <input type="checkbox"/> Gelatin <input type="checkbox"/> Peptides bioactifs <input type="checkbox"/> Other:.....

-
-
- Do you know the technologies to produce/process co-products? Which?
 1.
 2.
 3.
-
- What are the highest priority avenues for your company?
- Rank in descending order of priority the first 3 co-products you would like to develop
 1.
 2.
 3.

-
-
-

- What production volume will you aim for for these products?

Product	Production volume
Product 1:
Product 2:
Product 3:

- If you have already embarked on a process of valorization of co-products, what stage are you currently in? => Fill in the table by project

<input type="checkbox"/>	Stage 1	Search for new product ideas
<input type="checkbox"/>	Stage 2	Pre-feasibility study
<input type="checkbox"/>	Stage 3	Detailed feasibility study
<input type="checkbox"/>	Stage 4	Product Development
<input type="checkbox"/>	Stage 5	Conduct of tests and pre-series
<input type="checkbox"/>	Stage 6	Industrial-scale production and placing on the market

-

- What approach have you opted for (or will you opt) for the realization of your project to enhance the value of your co-products?

- Use of internal company resources
- Use of a research centre
- Use of specialized companies
- Other to be specified:

-

- In your opinion, why is the valorization of co-products not sufficiently developed?

- Check the corresponding box(es)

- Problem of outlets
- Lack of incentives/accompanying measures
- Lack of technical/scientific knowledge
- Irregularity of supplies in quantity and quality
- Lack of qualified personnel
- Other to be specified:.....

- Do you know in your close environment any companies (other than fish meal and fish oil) that would be interested in the co-products generated by your unit?

- Yes
-

No

4.3. Market knowledge

- Have you studied the market of the products you are targeting?

- Yes
- No

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-

- If so, how?

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.....
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- Are you subscribed to databases or specialized journals?

- Yes
- No

-
-

4.4. Support tools

- Do you know the existing support tools in Morocco?

- Morocco SME
- ISTITMAR
- MOUAKABA
- TATWIR Green Growth
- Specialized Center for the Transformation and Valorization of Seafood Products (CSVTPM)
- GIAC Fishing
- R&D Morocco
- Other to be specified:

.....
.....
.....
.....

-

- Have you ever asked them?

- Yes
- No

-

- If so, for what purpose did you ask them?

- Investment premium
- Financing of technical assistance
- Staff training
- Certification
-

Other:.....
.....

.....
.....

-
-

- What was the result?

.....
.....
.....
.....

-
- If not, why don't you use these support tools?

.....
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4.5. Regulatory aspects

- From the point of view of resource efficiency and environmental issues, are you faced with any regulatory constraints that limit your company's development initiatives?

- Yes
- No

-

- If so, what regulatory aspects do you think are the most problematic for your unit?

- Health security
- Traceability
- Environmental considerations
- Customs regulations

Other to be specified:

-

- From the point of view of resource efficiency and environmental issues, would you like to describe some avenues of reflection on regulatory barriers that could be part of the solutions to the problem encountered?

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4.6. Qualification of staff

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- Do you employ Technicians and/or Engineers?

- Yes
- No

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- If so, how do you recruit them?

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- Which profiles are you looking for the most?

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- What is the turnover rate within your company?

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5. Water and energy consumption

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- An estimate of the amount of energy used:



	Energy sources, e.g. grid electricity, company-owned generator, natural gas, renewable energy (solar panel or other)		
	Source 1 : National Network	Source 2 : Energy via generator set of the unit	Source 3 : Renewable energies (solar, etc.)
Annual consumption (kWh)			
Cost (in MAD/year)			



-
- Is there an initiative to reduce the cost/amount of energy used?

-
-
-



- An estimate of the amount of fresh water used

	Water source, e.g. pumping directly by the company (then owned by the company), Autonomous desalination, other		
	Source 1: Drinking Water	Source 2: Borehole water	Source 3
Volume (in^{m3})			
Source			
Cost (in MAD/year)			



- Is there an initiative to reduce water consumption (e.g. treatment/reuse):

-
-
-



- Do you count the volume of wastewater leaving your process?

- Yes
- No

- If so, how many m³?

2020	2019	2018

- Do you analyze the discharged water?

- Yes
- No

- If so, what types of analysis?

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- What is the fate of the water used in the production process?

- Release to the natural environment without treatment
- Rejection in the community network
- Releases to the natural environment after treatment)

-
-
-

- If who, what treatments?

-
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- Are there penalties for non-compliance

- Yes
- No

- If so, how high are the penalties?

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- Are you planning to establish processes for the treatment or reduction of wastewater?

- Yes
- No

- If so, which ones?

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6. Participation in a pilot project

- Would you be interested in participating in a pilot project related to the valorization of co-products and/or resource efficiency (raw materials, water, energy) in your unit?
- Yes
- No

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7. Feedback

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The reports we produce will not include any specific company personalised data. This data will be used for sector consolidations.

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