



SOCIO-ECONOMIC IMPACTS of the fishmeal and fish oil industry in the Gambia, Mauritania and Senegal



***Copyright RAMPAO,
January 2024***

Cover photo © Tann artisanal fish smoking site (Joal-Senegal), abandoned by women's fish processing groups/RAMPAO 2023.



SOCIO-ECONOMIC IMPACTS of the fishmeal and fish oil industry in the Gambia, Mauritania and Senegal

FINAL REPORT

This study was carried out
in the project context



funded by :



January 2024

TABLE OF CONTENTS

List of tables	6
List of figures	6
Liste of photos	6
1 Introduction	7
2 General framework of the study	8
2.1 Context of the study	8
2.2 Objectives of the study	8
3 Methodological approach of the study	9
3.1 Literature review	9
3.2 Data collection	9
3.2.1 Secondary data collection	9
3.2.2 Interview with factory directors/managers	9
3.2.3 Perception survey with other stakeholders	10
3.2.4 In situ observations and audiovisual recording	11
3.3 Analysis of collected data and information	12
3.3.1 Quantitative data analysis	12
3.3.2 Analysis of qualitative information	12
3.3.3 Proposal of appropriate measures	12
4 Key features of the fishmeal and fish oil industry	13
4.1 Recent trends in the number of factories	13
4.2 Overview of fishmeal and fish oil production	15
4.2.1 Raw material sourcing strategies	15
4.2.2 Fishmeal and fish oil production process	17
4.2.3 Fishmeal and fish oil production volume	19
4.3 Destination for fishmeal and fish oil	20
4.3.1 Destination for fishmeal and fish oil from Mauritania	20
4.3.2 Destination for fishmeal and fish oil from Senegal	20
4.3.3 Destination for Gambian fishmeal and fish oil	20
4.4 Socio-economic contribution of the fishmeal and fish oil industry	21
4.4.1 Contribution to community livelihoods	21
4.4.2 Contribtution to countries' national economies	22
5 Perceptions of the factories installation and follow-up process	25
5.1 Perceptions of environmental and social impact assessments	25
5.2 Perceptions on the managment of post-installation effects of factories	26

6	Perceptions of impacts on the exploitation of fishery resources	28
6.1	Perceptions of the impact of fishing pressure	28
6.2	Perceptions of the impact on value-adding and marketing	31
6.3	Perceptions of impacts on employment and income	33
6.4	Perceptions of the impact of post-capture links on actors	35
7	Perceptions of impact on the local environment	37
7.1	Perceptions of water pollution impacts	37
7.2	Perception of soil pollution impacts	38
7.3	Perception of air pollution impacts	40
8	Perceptions of impacts on community well-being	42
8.1	Perception on the impact of noise and odour pollution	42
8.2	Perceptions of the impact on the threat to public health	43
8.3	Perceptions of the impacts on the occurrence of local conflicts	43
8.4	Perceptions of impacts on improving basic infrastructure	45
9	Perceptions of impacts on fish consumption	48
9.1	Importance of animal protein sources for consumers	48
9.2	Factory impacts on fish availability and accessibility	50
9.3	Impact on consumers' adaptive strategies	50
10	Perceptions of stakeholders on the measures to be implemented	54
10.1	Perceptions on the limitation of factory capacity	54
10.2	Perceptions on the restriction of factory activities	55
10.3	Perceptions on the regulation of factory activities	58
11	Conclusion and recommendations	60
11.1	Conclusion	60
11.2	Recommandations	60
	Références	62
	Appendix 1 : Questionnaire 1 – Basic country sector data	63
	Appendix 2 : Questionnaire 2 – Interviews with factory directors/managers	64
	Appendix 3 : Questionnaire 3 – Survey of professional actors	73
	Appendix 4 : Questionnaire 4 – Survey of fish consumers	79

Tables

Table 1. Distribution of the survey sample of professional actors	11
Table 2. Distribution of consumers by site and main fish purchase location	51
Table 3. Distribution of consumers by site and frequency of fish purchases	52
Table 4. Key recommendations and guidelines for implementation	61

Figures

Figure 1. Evolution of the number of fishmeal and fish oil factories in the three countries ..	13
Figure 2. Major steps in the fishmeal and fish oil production process	19
Figure 3. Evolution in fishmeal and fish oil production in Mauritania and Senegal	19
Figure 4. Evolution in the destination of exported fishmeal and fish oil	21
Figure 5. Evolution in the value of fishmeal and fish oil exports	24
Figure 6. Opinions of professional actors on impact studies	25
Figure 7. Opinions of professional actors on the organization of local consultations	27
Figure 8. Opinions of professional actors on increasing fishing effort	28
Figure 9. Opinions of professional actors on the increase in juvenile fishing	30
Figure 10. Opinions of the professional actors on the increasing scarcity of round sardinella ...	31
Figure 11. Opinions of professional actors on post-capture waste recovery	32
Figure 12. Opinions of professional actors on improving landed prices	33
Figure 13. Opinions of professional actors on job creation factories	34
Figure 14. Opinions of professional actors on income generation for employees	35
Figure 15. Opinions of professional actors on competition with processors	36
Figure 16. Opinions of professional actors on reducing fish discards at sea	37
Figure 17. Opinions of professional actors on wastewater discharges into the sea/river	38
Figure 18. Opinions of professional actors on reducing fish discharges on the beach	39
Figure 19. Opinions of professional actors on wastewater discharge to land	39
Figure 20. Opinions of professional actors on toxic smoke emissions	40
Figure 21. Opinions of professional actors on odor emissions	42
Figure 22. Opinions of professional actors on the threat to public health	43
Figure 23. Opinions of professional actors on the increase in conflicts between fishermen ...	44
Figure 24. Opinions of professional actors on the increase in conflicts between fishermen ..	45
Figure 25. Opinions of professional actors on improving the sanitation system	46
Figure 26. Opinions of professional actors on improving healthcare infrastructure	47
Figure 27. Consumers' opinions on the importance of protein sources	48
Figure 28. Consumers' opinions on the importance of the main species	49
Figure 29. Consumers' opinions on the impact of factories on fish accessibility	50
Figure 30. Consumers' opinions on alternative solutions to fish scarcity	53
Figure 31. Opinions of professional actors on a total ban on factories	54
Figure 32. Opinions of professional actors on freezing the number of factories	55
Figure 33. Opinions of professional actors on the ban of fresh fish	56
Figure 34. Opinions of professional actors on limiting factories output	57
Figure 35. Opinions of professional actors on the flour/oil export ban	57
Figure 36. Opinions of professional actors on the relocation of factories	58
Figure 37. Opinions of professional actors on factory waste treatment	59
Figure 38. Opinions of professional actors on tighter factory control	59

Photos

Photo 1. Overview of fishmeal and fish oil plant component	14
Photo 2. Overview of raw material supply to factories	16
Photo 3. Overview of the fleet supplying Nouadhibou's factories	29
Photo 4. Overview of the empty stalls of small pelagic artisanal processors in Joal	36
Photo 5. Overview of the smoke emitted by a fish meal and oil factory in Nouadhibou	41
Photo 6. Fisherman repairing a monofilament gillnet	44

1 - INTRODUCTION

On a global scale, population growth, urbanization and changing dietary preferences have resulted in greater demand for animal products, mainly from livestock and farmed fish. To cope with this situation the main strategy has been to develop intensive livestock farming and aquaculture based, however, on the use of animal feed products made from fish meal and/or fish oil. However, the production of such ingredients in West Africa is increasingly raising concerns at local and national levels (Corten et al., 2017; Avadí et al., 2020; FAO, 2020, Thiao & Bunting, 2022, 2022).

Although the livestock sector is a major consumer of fishmeal and fish oil, it is the aquaculture sector that has dominated demand in recent years (Hecht and Jones, 2009; Mullon et al., 2009; Freon et al., 2014). Since the 1970s, fishmeal and fish oil have been increasingly used in fish and shrimp feeds, and are the main components of fish-derived ingredients (FDIs) worldwide. Although fish waste from mishandling and processing by-products are used to produce FDIs, studies conducted worldwide show that the majority comes from good-quality, and therefore edible, fish (Cashion et al., 2017).

Small pelagics are particularly targeted by both industrial and artisanal fisheries, providing the bulk of raw material for the FDP industry (New and Wijkström, 2002). Although these species are sometimes referred to as low-value fish (Edwards, Tuan & Allan, 2004), most of them are socially, nutritionally and economically essential for many local communities in developing countries, particularly in West Africa (Corten et al., 2017; Avadí et al., 2020; Thiao & Bunting, 2022, 2022). Their increasing use in the fishmeal and fish oil industry (Hua et al., 2019) and its potential consequences on resource exploitation, food and nutritional security, livelihoods and public health have become a major concern in the sub-region.

In this context, RAMPAN (Regional Network of Marine Protected Areas), in collaboration with its partners, has decided to provide support to analyze the major issues related to fishmeal and fish oil production in three West African countries (Mauritania, Senegal and Gambia). The results of this study are intended to improve understanding of the impacts of this industry, and to help decision-makers identify appropriate measures to be taken. This report is structured around nine main sections, covering the general framework, the methodological approach, the characteristics of the fishmeal and fish oil industry, as well as stakeholders' perceptions of its major impacts and the potential measures to be taken to eradicate or mitigate negative effects.

2 - GENERAL FRAMEWORK OF THE STUDY

2.1 Context of the study

Small pelagics, in particular sardinella and ethmalose, play a vital role in terms of income generation and food security for millions of people in West Africa. Whether fresh, dried or smoked, these species are one of the main sources of animal protein for the region's populations. What's more, they are the main fish stocks targeted by artisanal fishing, a sub-sector on which a whole sector of players depends, including fishermen, fishmongers, retailers and fish product processors.

Over the past decade, the exploitation of small pelagics has increased with the proliferation of fishmeal and fish oil production plants in Mauritania, Senegal and the Gambia. The rapid expansion of this industry in the sub-region is putting further pressure on already overexploited stocks. The development of the fishmeal and fish oil industry is all the more worrying given that the raw material used is sardinella and ethmalose. These are the species most widely consumed in West Africa. What's more, the industry's production is essentially destined for export, and does not benefit the aquaculture and livestock sectors of the region's countries. It also has many negative socio-economic impacts, which are increasingly denounced by those involved in the fishing industry and by the local communities where these factories are located. More recently, there have been several cases of protests in this regard, such as in Cayar (Senegal), Sanyang (Gambia) and Nouadhibou (Mauritania). It is in this context that RAMP AO has commissioned a study that will focus on the negative socio-economic impacts of the fishmeal and fish oil production industry in three countries of the sub-region: Gambia, Senegal and Mauritania.

2.2 Objective of the study

The general objective of the mission is to carry out an in-depth analysis of the negative social and economic impacts of the fishmeal and fish oil industry in Gambia, Mauritania and Senegal.

The mission has the following five specific objectives :

- **Specific objective 1** : understand the organization and functioning of operational fishmeal and fish oil production units (owners, suppliers, quantities processed, species used, export locations, commercial circuits, etc.);
- **Specific objective 2** : Find out how industrial fishermen, artisanal fishermen, fishmongers, retailers, women processors, consumers, etc. perceive the activities of fishmeal and fish oil production units;
- **Specific objective 3** : Find out the perceptions of national institutions (fisheries, maritime economy, environment, etc.) involved in setting up, running and monitoring fishmeal and fish oil production plants;
- **Specific objective 4** : compile documentation (audiovisual testimonials, illustrative photos, figures, etc.) on negative socio-economic impacts and environmental risks for RAMP AO communication purposes;
- **Specific objective 5** : propose appropriate measures to reduce the social and economic impacts and environmental risks of fishmeal and fish oil production plants in each target country.

3 - METHODOLOGICAL APPROACH OF THE STUDY

3.1. Literature review

The document review is a major component in achieving the mission's expected results. It involved gathering and exploiting relevant documents on fishmeal and fish oil production and its social, economic and environmental impacts and risks. It provided an opportunity to review the various studies already carried out, in order to gather quantitative data and qualitative information relevant to the specific objectives of the study. The references targeted are diverse in nature and origin. They include institutional and regulatory documents, technical reports, scientific articles, dissertations and theses, etc. Much of the documentary research was carried out online (websites). However, some documents not available online were sought from national and international institutions, including the FAO. In addition, internal reports and documents from the fishmeal and fish oil production plants visited were also sought from the relevant managers.

3.2. Data collection

3.2.1. Secondary data collection

To get a better idea of the actual or potential impacts of the fishmeal and fish oil industry, it was necessary to use basic secondary quantitative data. Depending on their availability, these covered various aspects of the fishmeal and oil industry (number of plants in operation, volume and value of production, number of jobs, income, etc.). Some of the secondary data concerned essential statistics on the fishing sector in the countries covered by the study (volume and value of catches, number of jobs, income generated, etc.). In addition to the secondary data found in the literature review, the data collection process mainly involved the use of sector-specific databases available online. On

the other hand, data not available online were requested directly from fishmeal and fish oil factories and national institutions.

3.2.2 Interview with factory directors/managers

To gather detailed information on the fishmeal and fish oil industry, interviews were conducted with the heads or managers of the production plants. These interviews focused on the organizational and functional mechanisms of the plants. These included identification of owners and suppliers, assessment of production volume and value, species used as raw materials, raw material supply channels, product destination and marketing channels, number and structure of jobs, amount and method of remuneration, working conditions of employees, waste volume and management strategy, measures to mitigate socio-economic impacts and environmental risks, etc.).

Given the sensitivity and reluctance of the fishmeal and fish oil industry, the managers interviewed were selected on the basis of their willingness to provide the information requested. To this end, a semi-structured questionnaire (Appendix 2) was specially designed to facilitate and channel the discussions. In all, only ten plant managers agreed to respond to the survey questionnaire, following a series of negotiations which seriously delayed data collection. Of the factories that responded, four were in Mauritania and three each in Senegal and the Gambia. However, most of them were content to provide qualitative information, including their opinions on perception issues. On the other hand, they were generally very reluctant, if not opposed, to providing quantitative data on their activities. Those who did agree to do so, did so very late in the process, sometimes with key data missing.

3.2.3 Perception survey with other stakeholders

The perception survey was a key component in achieving the objectives of the study. At this level, the stakeholders concerned are agents of the public institutions involved in the process of managing and regulating fishing activities, the main local professionals (fishermen, processors, fishmongers, retailers) and consumers of fish products. The perception survey provided important statistical data for characterizing opinions on fishmeal and fish oil production activities and their socio-economic impacts and environmental risks. Various major aspects were addressed in this survey, including, among others:

- the impact on fishing effort and resource exploitation;
- competition in the supply of fish as a raw material;
- the impact on job creation/loss and livelihoods;
- impact on availability of fish for consumption;
- effects on the health of local populations;
- environmental risks;
- mechanisms and means for mitigating harmful impacts and risks;
- proposals for improving the current and future situation,

The perception survey was carried out using stratified sampling. Thus, in the case of fishing stakeholders, while targeting those working on small pelagics, a stratification was made according to the type of activity, distinguishing in particular between fishermen, fishmongers, micro-fishmongers (retail resellers) and processors. For consumers and institutional agents, each category constitutes a single stratum. However, for the latter, priority was given to local agents, who are in tune with local realities on the ground.

For each stratum, a random sample was selected in each country from sites or localities strongly marked by the exploitation of small pelagics and the fishmeal and fish oil industry. In the case of the fishing industry, the sample was drawn from fishermen aboard pirogues targeting small pelagics, and women involved in artisanal processing. In the case of consumers, the survey mainly targeted women who buy fish for household consumption. The breakdown of the sample surveyed is detailed in the table below (Table 1).

Table 1. Distribution of the survey sample of professional actors

Countries	Site	Institutional Agent	Fisher-man	Processing	Whole-sale fish-monger	Retailer fishmon-ger	Consumers	Total
<i>Mauritania</i>	Nouadhibou	5	15	15	4	7	11	46
	Nouakchott	5	10	10	2	7	9	34
	Sub Total	10	25	25	6	14	20	80
<i>Senegal</i>	Saint Louis	2	7	7	1	4	6	21
	Cayar	3	7	7	2	4	3	23
	Bargny	2	5	6	0	2	6	15
	Joal	3	6	7	2	4	5	22
	Sub Total	10	25	27	5	14	20	81
	Tanji	1	5	5	1	4	4	16
	Sanyang	0	7	4	0	6	4	17
<i>Gambia</i>	Gunjur	4	6	5	2	3	5	20
	Kartong	3	6	7	1	3	4	20
	Sub Total	8	24	21	4	16	17	73
	Overall total	28	74	73	15	44	57	234

To conduct the perception survey, two questionnaires were drawn up (Appendices 3 and 4), including one specifically for consumers. The questionnaires consist mainly of closed, single-choice questions corresponding essentially to scales of appreciation. However, open-ended questions were also included to enable respondents to justify their level of appreciation in detail. Other open-ended questions were also included where necessary to gather more detailed explanatory information and suggestions for action. Filter questions have also been integrated to easily manage the specificities of different stakeholder categories. To facilitate field operations and minimize errors, most answers were presented in the form of checkboxes with a coding system. For most stakeholders, the survey was mainly conducted in local

languages, with the support of national assistants to help respondents understand the questions and formulate their answers.

3.2.4 In situ observations and audiovisual recording

Field operations provided an opportunity to make observations in order to gain a visual appreciation of some of the tangible impacts of the fishmeal and fish oil industry. In addition, testimonies were collected from professional players and local populations impacted. In addition, photos and videos were taken to better illustrate the situation. All these audiovisual elements were then compiled and handed over to RAMPAO, which turned them into a media library for communication purposes.

3.3 Analysis of collected data and information

3.3.1 Quantitative data analysis

All primary and secondary quantitative data were captured, processed and analyzed. This includes data collected via the perception survey, on the one hand, and via the literature review and sectorial databases, on the other. In the case of the perception survey, data were entered into a specially developed Access database. They were then transferred to SPSS statistical software for processing and analysis. Data from the literature review and sector databases were first compiled in Excel workbooks. The processing and analysis procedure then involved checking the data for any errors and correcting them. The data were then aggregated to arrive at a good characterization of the major socio-economic impacts and environmental risks of the fishmeal and fish oil industry. The results were visualized in the report in a user-friendly, easy-to-understand way through statistical tables and graphs.

3.3.2 Analysis of qualitative information

With regard to qualitative information from the three sources (document review, inter-

views and in situ observations), note-taking in the field was combined with data entry into the database. Next, the data were subjected to a content analysis consisting of a triangulation to highlight the coherence and relevance of all the information in relation to the mission's issues. Finally, the process culminated in the synthesis and grouping of coherent and relevant information according to the different domains that will structure the study report.

3.3.3 Proposal of appropriate measures

The study led to the proposal of major recommendations for reducing socio-economic impacts and environmental risks. These recommendations were identified and formulated primarily on the basis of the results of the analysis of the data and information collected. However, other previous works as well as innovative experiences and initiatives were also considered as sources of inspiration. The various measures proposed are of a technical, economic and regulatory nature, among others.

4 - KEY FEATURES OF THE FISHMEAL AND FISH OIL INDUSTRY

4.1 Recent trends in the number of factories

Recent data collected in the three countries show that most fishmeal and fish oil plants are based in Mauritania (Figure 1). In this country, 37 factories have been counted since 2020, compared with 36 during the previous two years. However, it was reported that five of these plants were inactive. In addition, most of the factories are based in Nouadhibou, while the others are located some thirty kilometers from Nouakchott. In the case of Senegal, according to official data provided, the number

of factories has fallen from 11 in 2018 to 6 in 2022. This represents a considerable gradual decline following the gradual closure of some of them for lack of sufficient raw material. In this country, factories are set up in various locations, generally along the coast (Saint Louis, Cayar, Dakar, Joal and Sandiara). In Gambia, the number of factories has remained at 3 since 2018. These are respectively based in Sanyang, Gunjur and Kartong. It should be noted that in all three countries, plant managers' responses on legal status show that they are generally limited companies.

Figure 1. Evolution of the number of fishmeal and fish oil factories in the three countries

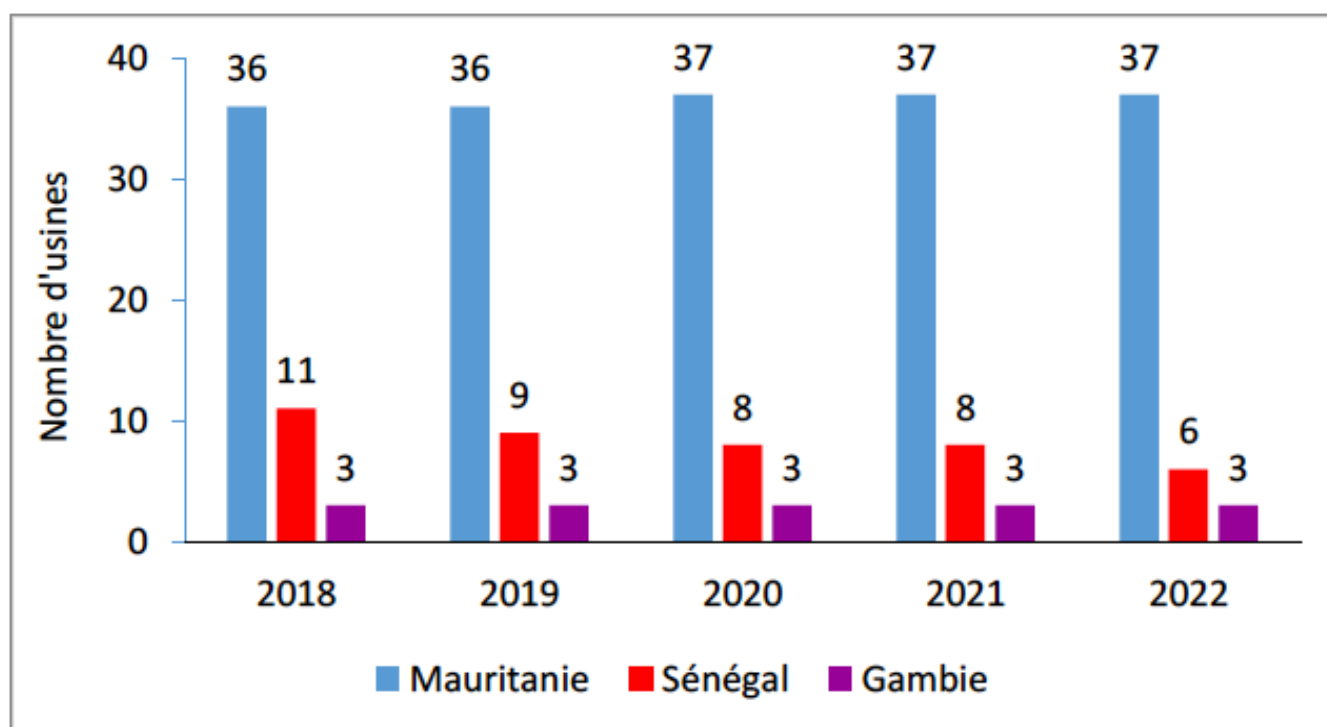


Photo 1. Overview of fishmeal and fish oil plant components





4.2 Overview of fishmeal and fish oil production

4.2.1 Raw material sourcing strategies

In all three countries, the raw material used to produce fishmeal and fish oil consists mainly of fresh or more or less deteriorated whole fish (Thiao & Bunting, 2022). These include small pelagics such as sardinella, ethmalose and sardine. In the specific case of Mauritania, other species such as yellow mullet (carcassed after gonad extraction) also play a major role. However, it should also be noted that in some cases, as in Senegal, by-products or waste from industrial processing are used by certain factories.

In Mauritania and the Gambia, the supply strategy essentially involves chartering and contracting pirogues and pelagic fishing boats. In the case of pirogues, these are mainly purse seines from Senegal. In Mauritania, there were a total of 204 pirogues exclusively supplying factories in 2019 (Thiao & Bunting, 2022). In the field, there are also a multitude of women who pick up fish that have fallen to the ground when they land, to sell to the factories. Unlike Gambia, where factories rely solely on Senegalese purse seines and a few Gambian gillnets, in Mauritania there are industrial fishing boats (mainly Turkish and Chinese) that supply certain factories. In 2019, the number of boats was 77, having peaked at 87 in 2017 (Thiao & Bunting, 2022). As far as Senegal is concerned, Senegalese factories generally do not have artisanal pirogues or industrial vessels dedicated to their raw material supply. They work with individual suppliers who supply them with fresh fish and/or waste collected from the country's main landing sites (Thiao & Bunting, 2022).

Photo 2. Overview of raw material supply to factories





4.2.2 Fishmeal and fish oil production process

Fishmeal is the clean, dried and ground tissue of whole fish (not decomposed) or fish cuts/parings, one or the other or both, with or without extraction of part of the oil (FAO, 2001). It can take the form of powder/flour, pellets or granules. To guarantee optimum quality, the International Fishmeal and Oil Organization (IFFO) recommends that 75% of fishmeal should be made from whole fish, with the remainder coming from by-products. On average, it takes 4.5 kg of fish to produce 1 kg of fishmeal, which corresponds to a conversion factor of 22% (Tacon and Metain, 2008; Péron, Mittaine and Le Gallic, 2010).

En ce qui concerne l'huile de poisson, elle est généralement un liquide brun/jaune clair obtenu par le pressage de poissons cuits suivi d'une centrifugation du liquide obtenu (Green, 2016; FAO, 2020a). Elle correspond aux graisses et aux huiles, raffinées ou non (à l'exclusion des produits chimiquement modifiés) issues de fractions de poissons ou de mammifères marins. Comme pour la farine de poisson, de nombreuses espèces sont utilisées pour la production d'huile de poisson mais les poissons gras, tels que l'anchois et autres petits pélagiques sont privilégiés (Green, 2016). Le facteur de conversion n'est que de 5% en moyenne, ce qui signifie que pour 1 kg d'huile, il faut compter environ 20 kg de poisson (Tacon et Metain, 2008).

The fishmeal and fish oil manufacturing process is fairly standardized worldwide. Comprising the following nine major stages (Figure 2), it consists of thermal coagulation combined with mechanical fat separation and thermal dehydration procedures (Einarsson et al., 2019).

1. Chopping

The first step is to chop the raw material. The mincer cuts the material uniformly to obtain a good particle size. However, this depends on the raw material, as whole fish needs to be minced, while other materials such as offal do not.

2. Heating

Heating is a cooking mechanism that is carried out to extract oils and moisture, but also to inactivate bacteria, viruses and parasites that can damage the product. Generally speaking, heating should be carried out at around 75°C for 20 minutes to obtain optimum results.

3. Filtering

After heating, the oil and most of the water are released. This produces two streams: press liquor and wet press cake. Press liquor consists of oil, water-soluble nitrogen compounds (proteins, peptides, amino acids, putrefaction products, etc.), vitamins and minerals, as well as fine suspended particles.

4. Pressing

After the filtering process, the moist press cake is introduced into a press which extracts the remaining liquids. The press cake is then ready for drying, while the press liquor undergoes further processing.

5. Centrifugation of solids

Decanter centrifuges are used to remove solid particles from the press liquor. In practice, there are two types of decanter

centrifuge. Firstly, the two-phase centrifuge, which separates the liquid and solid phases. Secondly, the three-phase centrifuge, which separates the liquid, solid and oil phases.

6. Liquid centrifugation

Liquid centrifugation involves the separation of water and oil. The liquor sludge is then fed into the evaporation system, while the oil is sent for refining.

7. Evaporation

After separation of the solids in decanters or other centrifuges, a large proportion of the oil and solids are removed from the press liquor. The next step is to treat the excess water by evaporation.

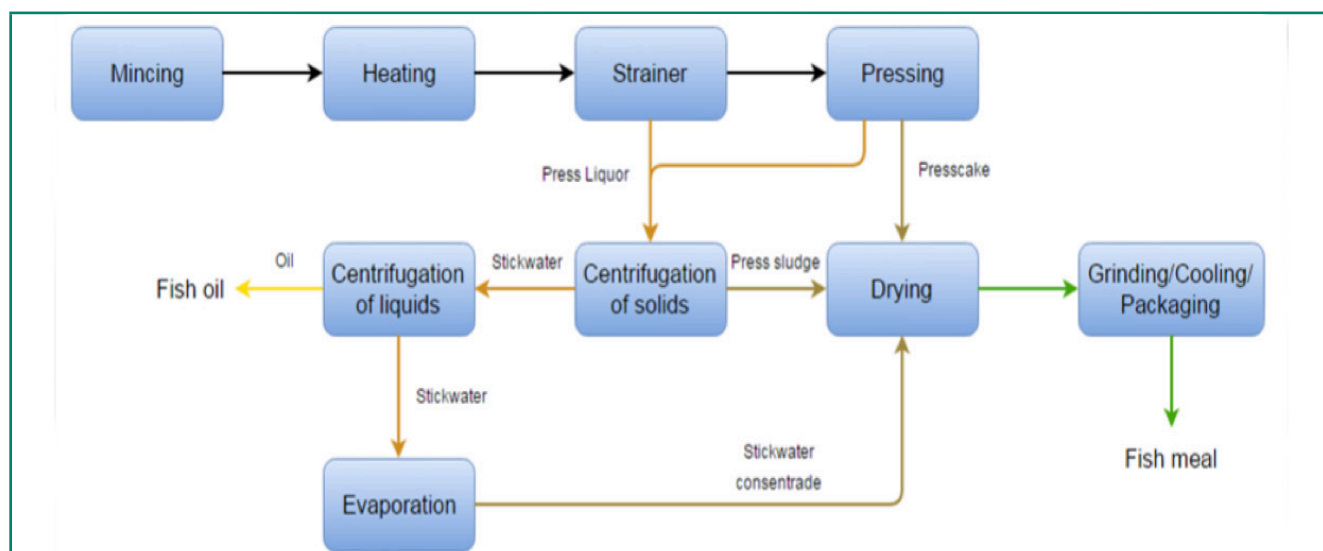
8. Drying

The dryer receives the press cake, which is made up of sludge from the centrifugation stages and concentrated condensation water from the evaporators. The target moisture content at the dryer outlet is less than 12%.

9. Cooling

When the flour exits the dryer, it has a temperature of around 80°C. The air inside retains a lot of moisture, which must be removed as quickly as possible, otherwise the product may absorb this moisture, which facilitates spoilage. Cooling will reduce the moisture content by 1-2%, giving fishmeal with a moisture content within the recommended range of 9-11%.

Figure 2. Major steps in the fismeal and fish oil production process



Source : Einarsson et al., 2019

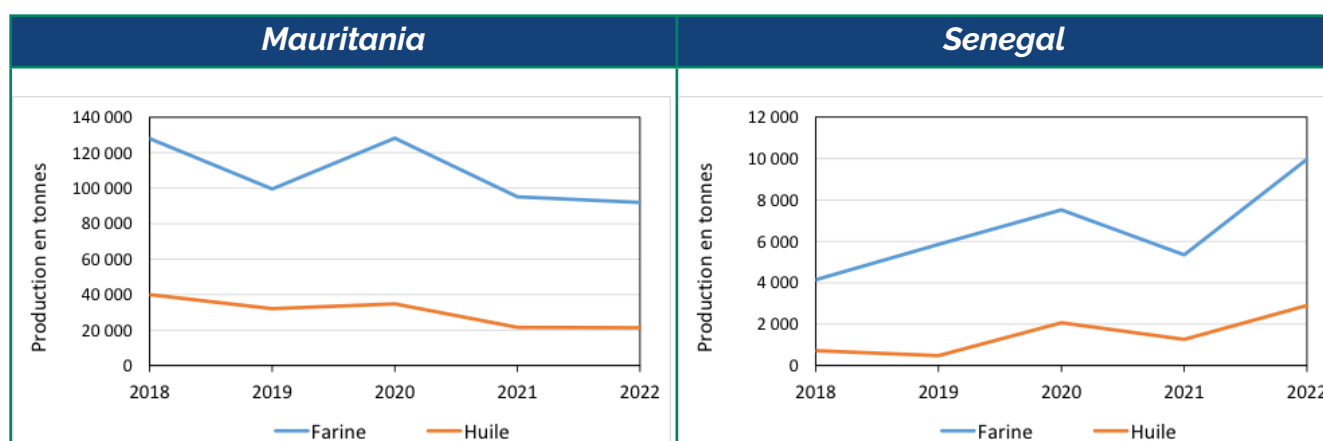
4.2.3 Fishmeal and fish oil production volume

With regard to production volumes in recent years, there has been some variability in time and space (Figure 3). In Mauritania, the last five years have been characterized by a general downward trend for both fishmeal and fish oil. For these two products, quantities have fallen from 127,940 and 40,045 tonnes in 2018 to 91,954 and 21,320 tonnes in 2022 respectively. For oil, this corresponds to almost a halving. However, Mauritanian flour production peaked at 128,197 tonnes in 2020.

In Senegal, the available data show an increase in fishmeal and fish oil production over the last five years. For flour, the quantity produced has more than doubled, rising from 4,140 tonnes in 2018 to 9,968 tonnes in 2022. Oil production has quadrupled over the same period, reaching 2,905 tonnes in 2022, compared with 719 tonnes in 2018.

In Gambia, the available data are rather patchy and not up to date. However, they show an increase over the recent period. For flour, the quantity produced rose from 1,969 tonnes in 2018 to 4,838 in 2021, more than doubling in four years. In the case of oil, the volume of production, which was just 823 tonnes in 2018, reached 2,551 tonnes two years later.

Figure 3. Evolution in fishmeal and fish oil production in Mauritania and Senegal



4.3 Destination for fishmeal and fish oil

4.3.1 Destination for fishmeal and fish oil from Mauritania

The fishmeal and fish oil produced in the three countries is mainly exported (Thiao & Bunting, 2022). However, an examination of data from the International Trade Centre (ITC) reveals considerable variability in destination over the last two decades (Figure 4). For fishmeal produced in Mauritania, Russia (around 60% in 2011) was the main customer until 2012, when it was briefly overtaken by Denmark. Thereafter, China emerged from 2015 onwards and very quickly dominated the other importing countries. As a result, since 2020, China has been the destination for around 75% of exports of fishmeal produced in Mauritania. On the other hand, for fish oil produced in this country, France and, to a lesser extent, Denmark have been the main customers since 2013. France's share has risen steadily in recent years, reaching 56% by 2022.

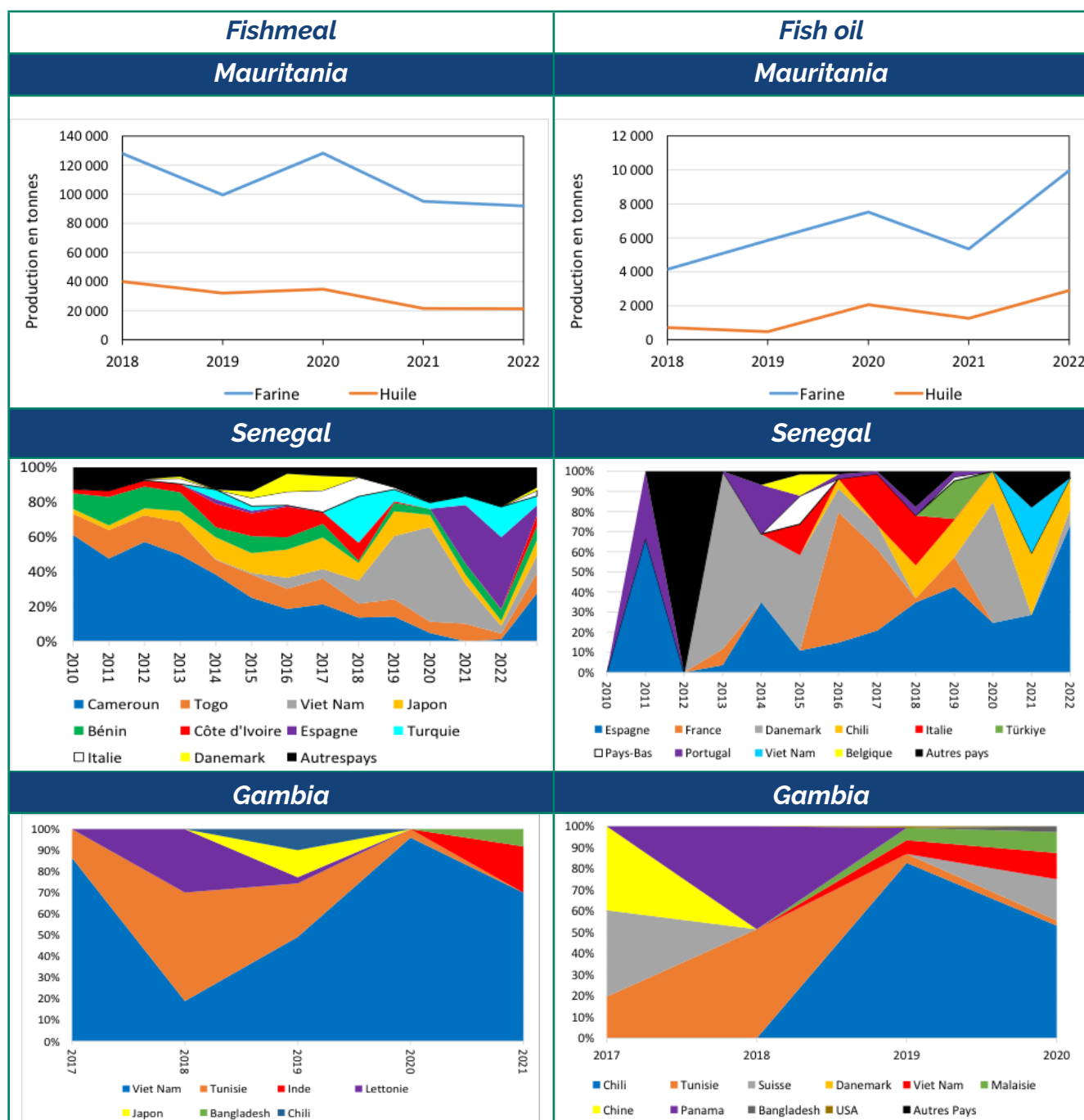
4.3.2 Destination for fishmeal and fish oil from Senegal

In the case of Senegal, Cameroon, which was the main destination with 60% in 2010, has gradually lost its place to other customers. This is particularly true of Vietnam, whose share reached 36% in 2019, but was recently supplanted by Spain (34% in 2021). For fish oil produced in Senegal, there is a diversity of customers who are unable to maintain structural dominance. Examples include Denmark, France and Chile. Despite fluctuations, it is Spain that has been able to maintain relatively considerable market share over the medium and long term. In fact, by 2022, Spain was the recipient of 73% of Senegalese fish oil.

4.3.3 Destination for Gambian fishmeal and fish oil

For Gambia, exports of flour and oil seem to have started fairly recently. Vietnam is the main buyer of flour, accounting for up to 96% of exports in 2021. Only Tunisia and Latvia imported a considerable proportion of flour in 2018-2019. In the case of fish oil exports from the Gambia, Tunisia, Panama and, more recently, Chile are the main exporters. Chile accounted for 53% of Gambian fish oil exports.

Figure 4. Evolution in the destination of exported fishmeal and fish oil



4.4 Socio-economic contribution of the fishmeal and fish oil industry

4.4.1 Contribution to community livelihoods

The contribution of the fishmeal and fish oil industry to community livelihoods is very difficult to assess accurately in its entirety. Although it creates direct and indirect jobs from which beneficiaries derive income, the industry also threatens the activities of thousands of professional players in the fishing sector.

In Mauritania, the recent FAO study (Thiao & Bunting, 2022), the number of direct jobs created by fishmeal and fish oil factories increased from 900 in 2015 to 1,972 in 2019. There is also a clear predominance of permanent jobs, which have risen from 67% to 74% over this period. What's more, in addition to these direct jobs, the livelihoods of a number of other workers depend on this industry. This is the case, for example, of the fishermen working aboard the

pirogues and boats supplying the factories. In addition, many other players, such as collectors, shippers and transporters, are involved in handling and transporting the fish that is the raw material for the factories. However, contrary to what is often claimed by factory managers, a large proportion of existing jobs are actually temporary and most often allocated to foreigners (Tarbiya and Mouhamédou, 2011). In general, the workers are Senegalese, Chinese and Turkish nationals who work not only on chartered pirogues and fishing boats, but also within the factories themselves. The industry also competes directly with players dependent on post-capture activities. This is particularly true of wholesale and retail fish merchants, as well as women processors, whose livelihoods are currently under threat. According to recent data collected in Mauritania as part of this study, the number of retail fishmongers and women processors is estimated at 2,291 and 2,849 respectively in 2022.

In Senegal, field surveys indicate that a total of 129 permanent and 264 temporary workers were identified in 2018 (Thiao & Bunting, 2022). In addition to these direct jobs, there are dozens of collectors, loaders and transporters who work in the process of supplying factories with fresh fish, waste and processing by-products. It should be noted that unskilled employees are generally recruited from local communities. As far as the industry's negative impact on livelihoods is concerned, competition with the thousands of professional players active at the post-capture level is a major problem. Indeed, with fish resources becoming increasingly scarce, the demand for fish from factories further reduces the availability of raw material for fishmongers and women processors. Most of these players generally have no alternative opportunities, and are therefore at greater risk of impoverishment. According to the available data collected as part of this study, the number of wholesale and retail fish merchants is estimated at 1,664 in 2022.

In The Gambia, the fishmeal and fish oil industry also creates direct and indirect jobs. With regard to permanent and non-permanent direct employment in the three existing plants, the data collected as part of this study enabled us to estimate 269 people in 2023. In addition, there are dozens of people who are directly involved in the supply and handling of raw material at the local plant, and who derive their income from it. However, previous information from interviews reveals that the factories employ local workers at lower levels, with skilled employees generally being foreigners (Avadi et al., 2020; Thiao & Bunting, 2022). In addition, the fish corresponding to the raw material is mainly supplied by Senegalese fishermen. Moreover, in a context of dwindling fishery resources, the industry could structurally threaten post-capture activities, notably by depriving women processors of raw material. However, during the seasonal fishing season, the arrival of Senegalese dugout seine boats chartered by the factories significantly facilitates the availability and accessibility of fish to all players in the post-capture chain.

4.4.2 Contribution to countries' national economies

The fishmeal and fish oil industry contributes to national economies through a number of channels. However, the most significant channel is the inflow of foreign currency through exports of fishmeal and fish oil. In Mauritania, foreign currency inflows make a huge direct contribution to the economy. According to ITC data (Figure 5), fishmeal, which brought in just US\$2.936 million in 2010, peaked at US\$153.891 million in 2018. Over the same period, fish oil exports rose from US\$649,000 to US\$45.503 million. By way of comparison, in 2018 the amount of IIP exports accounted for 15 percent of total fishery product exports, then valued at US\$1.3 billion (www.fao.org/figis). In recent years, however, there has been a downward trend, with combined export earnings from fishmeal and fish oil totaling US\$151.264 million in 2022, compared with US\$199.394 million in 2018.

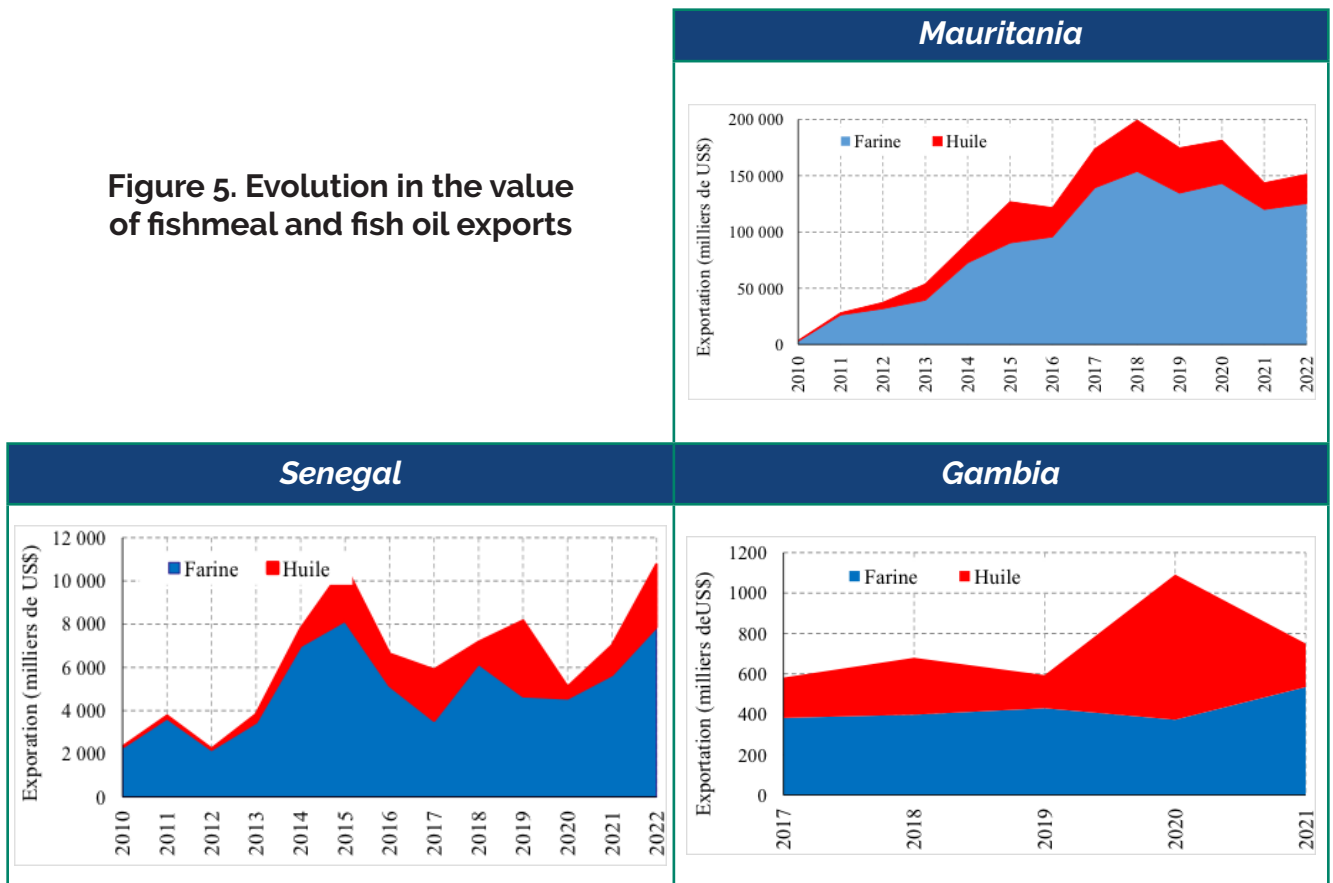
For Mauritania, it should be noted that in addition to exports, the taxes paid by factories to the public treasury also make a significant direct contribution to the economy. According to Tarbiya and Mouhamédou (2011), these taxes represented 5% of total value added in the fishing industry in 2010, corresponding to 16 million ouguiya (MRU) (around US\$432,000). However, a number of interviews with fisheries administration officials revealed that, in the absence of effective controls, factory managers constantly try to underestimate the amount of taxes payable. In addition, fishing boats chartered by the factories also pay fishing permits, which are royalties collected by the government.

In Senegal, the fishmeal and fish oil industry also contributes to the national economy mainly through exports and taxes. ITC export data show that since 2010, the cumulative value of fishmeal and fish oil exports has fluctuated between US\$2 and US\$11 million (Figure 5). Over the last three years, fishmeal exports have increased considerably, rising from US\$6.192 million in 2018 to US\$7.895 million in 2022. Over

the same period, oil exports have more than doubled, reaching 2,858 million in 2022. However, by way of comparison, the US\$7.162 million generated by exports in 2018 represented just 2% of total fishery product exports (www.fao.org/figis). On the other hand, although the industry pays taxes, officials from the Ministry of Fisheries and Maritime Economy have highlighted the likelihood of tax evasion due to weak controls.

In the Gambia, according to ITC data, fishmeal and fish oil exports remained below the US\$400,000 mark between 2017 and 2020 (Figure 5). During this period, the level of fishmeal exports represents less than 0.1% of the total value of the country's fishery product exports (www.fao.org/figis). However, in the particular case of fish oil, an exceptional export record of US\$719,000 was recorded in 2020. More recently, in 2021, the estimated value of fishmeal exports reached US\$750,000. According to fisheries administration technical officers, the factories pay taxes to the government, but the amount remains unknown, and the likelihood of tax evasion has been raised.

Figure 5. Evolution in the value of fishmeal and fish oil exports



5 - PERCEPTIONS OF THE FACTORIES INSTALLATION AND FOLLOW-UP PROCESS

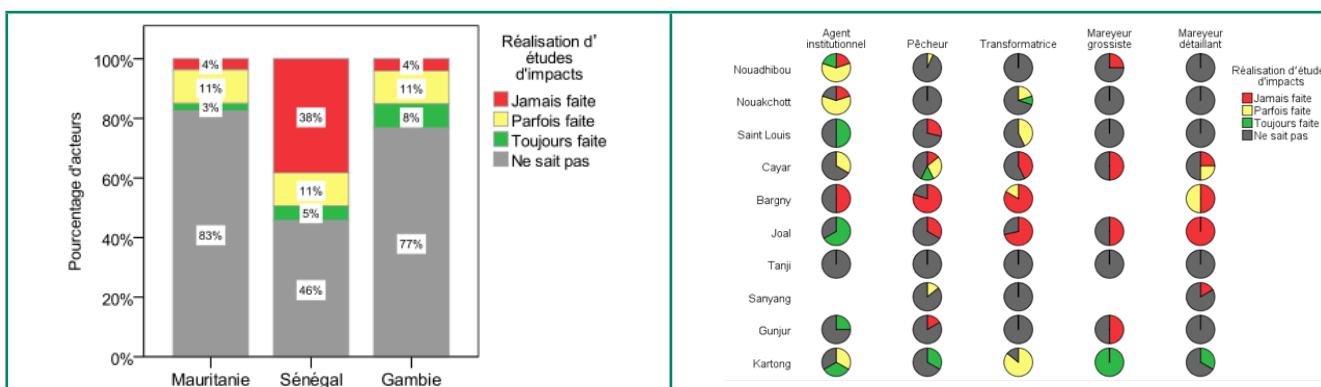
5.1 Perceptions of environmental and social impact assessments

In most countries, the setting up of an industrial unit, whatever its nature, is normally subject to a prior environmental and social impact assessment (ESIA). In addition, such studies must normally be made public in order to gather and take into account the concerns of local communities. In the case of the fishmeal and fish oil plants in Mauritania, Senegal and The Gambia, this process seems to be facing gaps in its implementation. This is reflected in the perceptions of the various local stakeholders surveyed at ten major sites in the three countries. Indeed, even if ESIA are carried out, the vast majority of professional stakeholders are totally unaware of them (Figure 6). In Mauritania and the Gambia, more than three quarters of the stakeholders surveyed did not know whether such studies were actually carried out prior to the installation of fishmeal and fish oil plants. In Senegal, in addition to nearly half the stakeholders not knowing that ESIA exist, 38% of them believe that they have never been carried out. These highly negationist views are strongly present at the Bargny and Joal sites.

With regard to the public presentation of ESIA, stakeholders are also generally uninformed about the process. What's more, the vast majority are also unaware that the concerns of local communities are taken into account. This is also true in Senegal, where over a third of stakeholders believe that these two principles are never respected before fishmeal and fish oil plants are set up.

Stakeholders believe that if all ESIA principles were respected, there would not be so many problems, sometimes leading to demonstrations and petitions against the plants. Moreover, the few stakeholders who maintain that such studies are carried out claim that local communities are not sufficiently informed and involved in the process. What's more, they believe that the reports resulting from these studies are generally inaccessible and even complacent, just to validate the installation of the plants and present the populations with a *fait accompli*. For some players, the reality is that the installation of factories is mainly favored by local authorities such as mayors, village chiefs, imams and notables, who almost entirely hold the decision-making capacity in this respect. So, at local level, it's generally these authorities who are fully consulted and involved by the promoters of factory projects.

Figure 6. Opinions of professional actors on impact studies



It is worth noting that of the ten plant managers interviewed in the three countries, only half claimed that the environmental and social impact studies had been fully completed and submitted.

5.2 Perceptions on the management of post-installation effects of factories

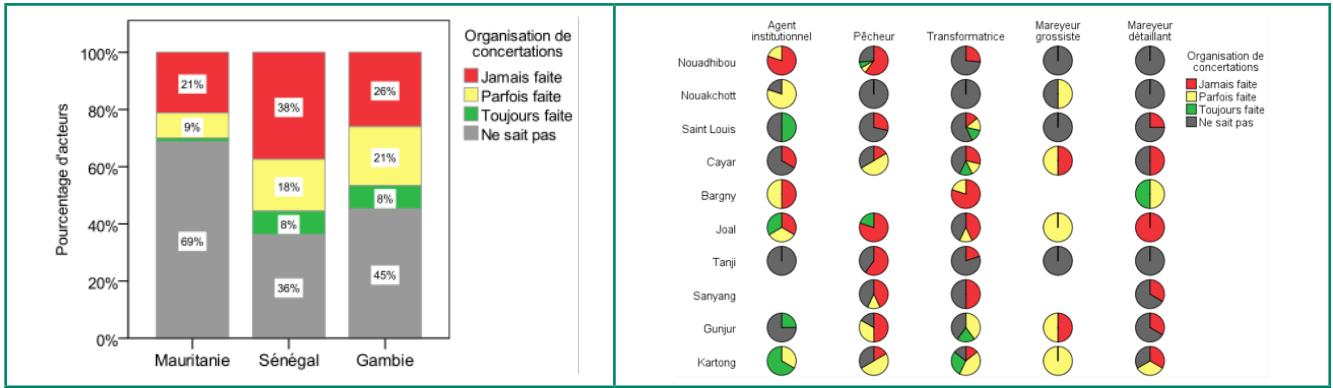
The organization of consultations with local communities should be a key mechanism for preventing but also managing crisis situations brought about by the installation of fishmeal and fish oil factories. It could be an ideal opportunity to analyze problems together and find concerted solutions adapted to each local context. However, it should be noted that the opinions of the professional players surveyed reveal overall weaknesses in this direction (Figure 7). The level of ignorance regarding the holding of consultations is very high, even reaching 69% in Mauritania. This was the case for all the fishermen, processors and retail fishmongers interviewed in Nouakchott. In Senegal and the Gambia, in addition to ignorance, a significant proportion of stakeholders (38% and 28% respectively) believe that consultations have never been organized. This perception was particularly strong among the fishermen and retail fishmongers we met in Joal.

The few professional actors who mentioned the existence of consultations affirm that they are mainly held with local authorities, sometimes with the involvement of stakeholder representatives who do not report back to the grassroots. These consultations mainly take place in the wake of serious conflicts with local communities, and are aimed at finding short-term solutions to calm the situation.

There are, however, some good initiatives in certain localities. In Joal, for example, it was reported that at the start of each fishing season, the local factory organizes meetings with members of the CLPA board to better regulate competition with processors, wholesalers and consumers. In Kartong too, similar meetings are held with local communities. In the case of Sanyang, the factory had held meetings which led to the principle of a memorandum of understanding with the communities, but since then this has not been signed. In Nouadhibou and Nouakchott, in addition to annual discussions with fishermen to set fish prices and equipment requirements, some factories sometimes consult with the NFF (National Federation of Fishermen) and NGOs to try and find solutions to mitigate negative effects.

When it comes to monitoring factories and their impact on the environment, stakeholders know very little about their effectiveness. In fact, a large proportion of them in Senegal believe that nothing is done in this respect, otherwise there wouldn't be so many problems. In the case of Mauritania, however, stakeholders reported that control and monitoring of industrial discharges and their potential impact on the aquatic environment were being carried out. The same sentiments were also noted with regard to the effectiveness of penalties for factories that fail to comply with regulations. Many stakeholders in Senegal and The Gambia consider that plants are never sanctioned, and that their infringements are not managed in a transparent manner. However, real cases of sanctions consisting in the temporary closure of factories have been reported in Gunjur, Joal and Nouakchott, generally due to the discharge of industrial waste into the sea.

Figure 7. Opinions of professional actors on the organization of local consultations



It should be noted that in each of the three countries, only one of the managers interviewed claimed to organize regular consultations with local populations. In addition, only two of the ten managers stated that mechanisms for resolving conflicts with local populations were fully in place. Furthermore, five of them claimed that plant

operations were regularly monitored by the relevant departments, while the others mentioned that such operations were less frequent and irregular. Only one manager based in Senegal claimed that his plant had never been sanctioned, while the majority reported the existence of sanctions, although these were rare.

6 - PERCEPTIONS OF IMPACTS ON THE EXPLOITATION OF FISHERY RESOURCES

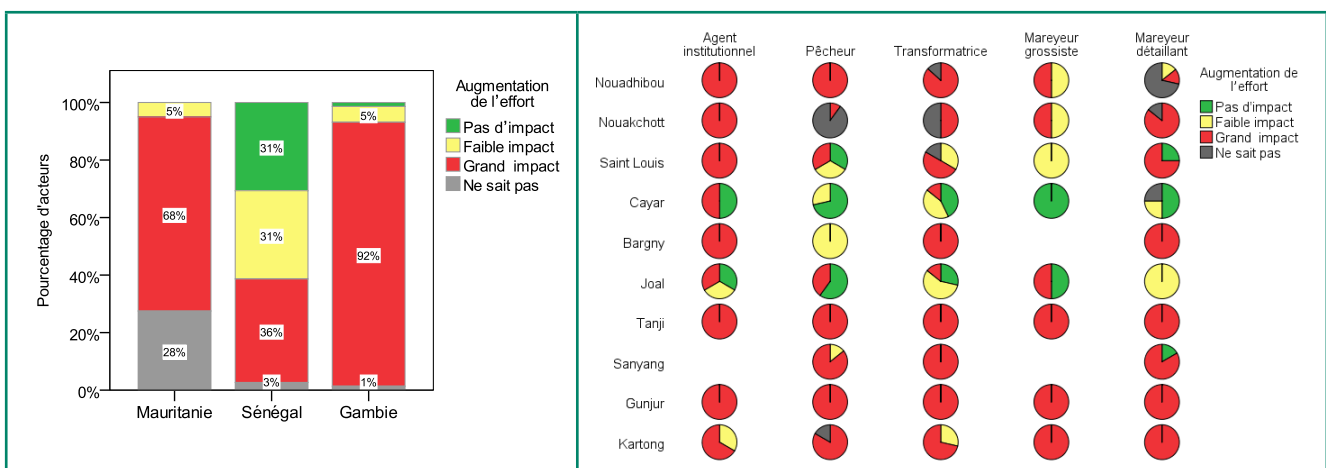
6.1 Perceptions of the impact of fishing pressure

One of the impacts most generally attributed to fishmeal and fish oil plants is their contribution to increasing fishing pressure, especially on small pelagics. The perception survey of professional stakeholders seems to corroborate this criticism (Figure 8). This is particularly the case in Mauritania and Gambia, where 68% and 92% respectively of the professional stakeholders questioned felt that they were contributing to an increase in fishing pressure, especially on small pelagics. In the particular case of Gambia, there was unanimity among most categories of stakeholder. It should be noted that in these two countries, the fishmeal and fish oil industry plays a major role in the presence of a large number of pirogues and fishing boats. In fact, at the start of the small pelagic fishing season, the factories charter, under contract, a large number of dugout seine boats from Senegal, to which they sometimes provide financing for fishing equipment. Moreover, even pirogues without contracts are attracted by the guarantee of outlets for their catches. In Mauritania, in addition to pirogues, there are also several Chinese and Turkish boats that fish exclusively to

supply fishmeal and fish oil factories. In the areas where the factories are located, these two practices are characterized by a considerable increase in fishing effort, especially during the season of abundance of small pelagics.

It's in Senegal where opinions on the contribution of plants to the increase in fishing effort are very diverse (Figure 8). Admittedly, a large proportion of professional stakeholders (36%) consider that fishmeal and fish oil production have greatly contributed to the increase in fishing effort. However, almost two-thirds of players maintain that this impact is low, or even non-existent. Indeed, even if there are factories that finance a few pirogues, the practice of chartering through the exclusive supply of fish is not very common in Senegal. What's more, given the huge unmet national demand, fish products no longer have a problem finding outlets in the absence of factories. In addition, most players point out that the fishing effort was already very high long before the development of the fishmeal and fish oil industry. For them, this was due to the constant construction of pirogues and the arrival of foreign boats, many of which were eventually nationalized.

Figure 8. Opinions of professional actors on increasing fishing effort



As for the opinions of the ten plant managers interviewed, four acknowledge that fishmeal and fish oil production have a major impact on the increase in fishing effort. The others, on the other hand, tend to minimize these effects without really being able to justify themselves.

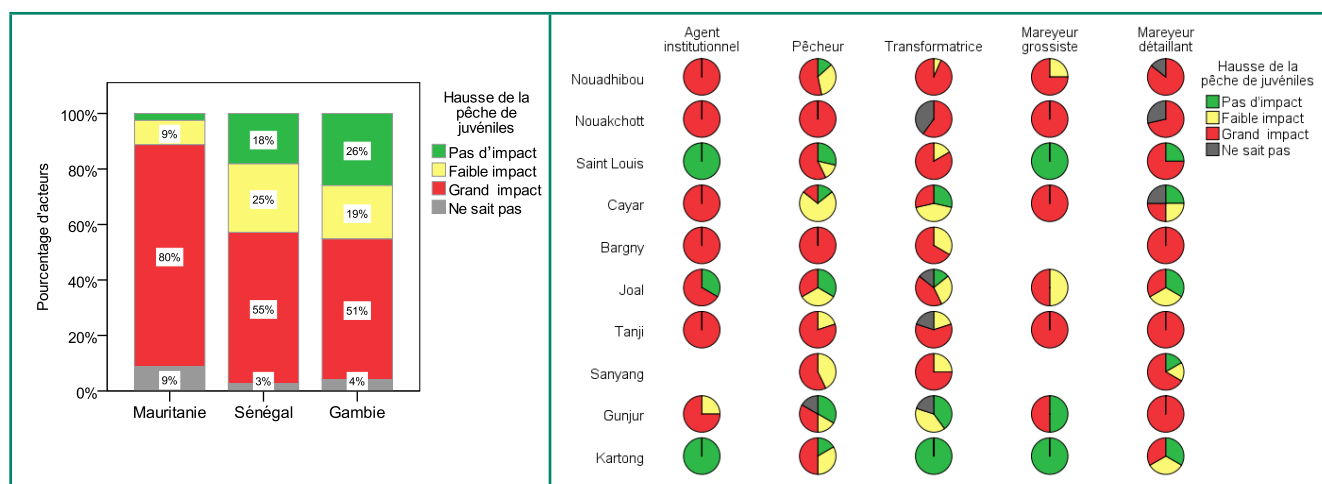
Photo 3. Overview of the fleet supplying Nouadhibou's factories



The role of the fishmeal and fish oil industry as a factor in the fishing of juvenile fish is often mentioned in the context of fisheries management. The surveys carried out in this study shed light on the diversity of perceptions of professional players on this aspect. Although opinions are relatively diverse, in each country, at least half of the professional actors questioned affirm that factories have a major impact on the increase in juvenile fish fishing (Figure 9). In Mauritania, where this industry is very important and where there are large nursery areas for small pelagics, including the PNBA, this proportion reaches 80%. Even if the plants do not explicitly ask for juveniles, most players consider that their great capacity to process everything, whatever the quality of the product, strongly encourages fishermen to collect everything, in the knowledge that small fish that cannot be eaten will always find a buyer.

It should be noted, however, that in Senegal and The Gambia, a significant proportion of the stakeholders interviewed maintain that the impact of the factories on the increase in juvenile fishing is low, or even non-existent. Such opinions are relatively important in sites such as Saint Louis, Cayar, Gunjur and especially Kartong. They are justified by the fact that stakeholders consider the exploitation of juveniles to be forbidden by law, and that local fisheries services and organizations in place ensure that this is the case at the time of landing. Moreover, for some stakeholders in Senegal and Gambia, the problem of the rise in juvenile fishing is more global and has other roots beyond the fishmeal and fish oil industry. Against a backdrop of overcapacity and scarcity of fishery resources, it is the result of widespread poor fishing practices, including the use of small-mesh nets and fishing in nursery areas.

Figure 9. Opinions of professional actors on the increase in juvenile fishing



Considering the responses from plant managers, most of them consider that the fishmeal and fish oil industry has no impact in terms of increased juvenile fishing. However, no specific justification for this was given. In addition, some stated that they were unaware of the industry's impact on the exploitation of juveniles.

As a major component of fish demand in recent years, the fishmeal and fish oil industry has raised many questions about its role in the depletion of fish stocks. In the case of round sardinella, which is a major target, many of the professionals surveyed claim that the factories are partly responsible for the increasingly catastrophic state of stocks (Figure 10). In Mauritania, in particular, this cause-and-effect link is best perceived, with 84% of stakeholders believing that factories have a major impact on the increasing scarcity of round sardinella. In the particular case of Nouadhibou, all the institutional agents as well as the processors and wholesalers are unanimous on this observation. Generally speaking, Mauritanian fishermen point out that it was with the advent of fishmeal and fish oil factories that the round sardinella was subjected to increasingly intense exploitation. They expressed the same opinion of other small pelagic species such as flat sardinella, sardine, ethmalose and even yellow mullet. In fact, the bulk of catches of these species, including fresh catches, are transported directly to the factories.

In Senegal and the Gambia, the extent of the impact of fishmeal and fish oil factories on the depletion of round sardinella and other small pelagic species is relatively less perceived. In fact, around a third of stakeholders consider this impact to be high, while the others consider it to be low or even non-existent. For most stakeholders at sites such as Joal and Gunjur, even if the factories have a share of the responsibility, it is above all other factors such as strong fishing pressure to satisfy national and sub-regional demand, as well as poor fishing practices, that have caused the depletion of small pelagics. In addition, overfishing by small-scale fishing and, above all, industrial fishing, which not only supplies factories but also other markets, has been strongly criticized.

Figure 10. Opinions of the professional actors on the increasing scarcity of round sardinella



Of the ten factory managers surveyed in the three countries, four acknowledge that fishmeal and fish oil production have a major impact on the scarcity of round sardinella. However, the others believe that this impact is low, or even non-existent. This perception, not really justified by the managers, is even more important for other small pelagic species such as flat sardinella, ethmalose and sardine.

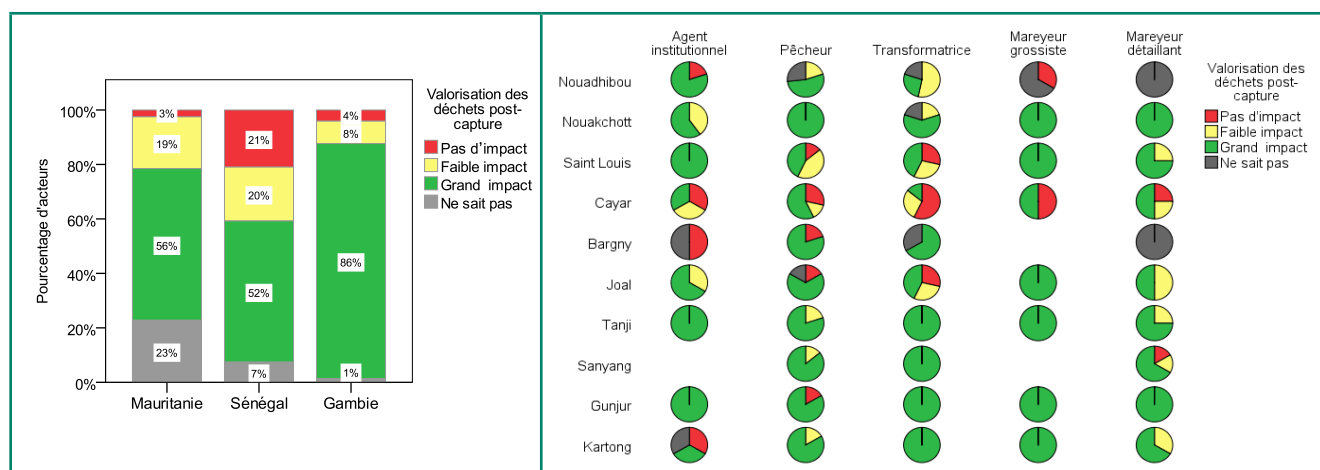
6.2 Perceptions of the impact on value-adding and marketing

Among the positive effects best appreciated by the vast majority of stakeholders, the ability of fishmeal and fish oil factories to reduce post-capture losses figures prominently. Faced with the lack of adequate means of preserving fresh fish products in some areas, many stakeholders believe that the factories are ideal outlets for a large proportion of catches that could be totally lost, especially during periods of overproduction in relation to demand.

For them, this advantage is due to the fact that the plants are capable of recovering and processing almost all the fish landed, whatever the quantity and quality. In Gambia, for example, where conservation capacities are fairly limited, 86% of the stakeholders surveyed maintain that factories have a major impact on the recovery of post-capture waste (Figure 11). In all four of the country's sites, some categories of stakeholders were even unanimous on the positive contribution made by the plants. In Mauritania and Senegal, slightly more than half the players consider that the plants have a major impact on the recovery of post-capture waste. However, in these two countries, a significant proportion of those questioned believe that this impact is weak, or even non-existent. This is especially true of many women processors based in locations such as Nouadhibou, Saint Louis, Cayar and Joal. Those who are more pessimistic on the subject claim that nowadays, resources are so scarce that, taking into account the needs of artisanal processing, there are no longer enough post-capture losses that could require valorization in the form of flour and oil.

In a similar vein to the assessment of post-capture waste recovery, the ability of fishmeal and fish oil plants to reduce the number of cases of fish going unsold is also seen as having a considerable positive impact. Indeed, for the vast majority of professional players surveyed, when local production is significantly higher than immediate demand, the plants are the only bulwark against poor sales of landed fish. They act as a sort of safety net, ensuring that fishermen can always find an outlet for their catches. However, a proportion of players based mainly in Senegal were quick to point out that fish is currently so scarce that even in the absence of factories, it is unlikely to find itself in a situation of poor sales. For them, given the superiority of demand over supply of fish products, the production of fishmeal and fish oil has little or no impact on the prevention of poor sales.

Figure 11. Opinions of professional actors on post-capture waste recovery

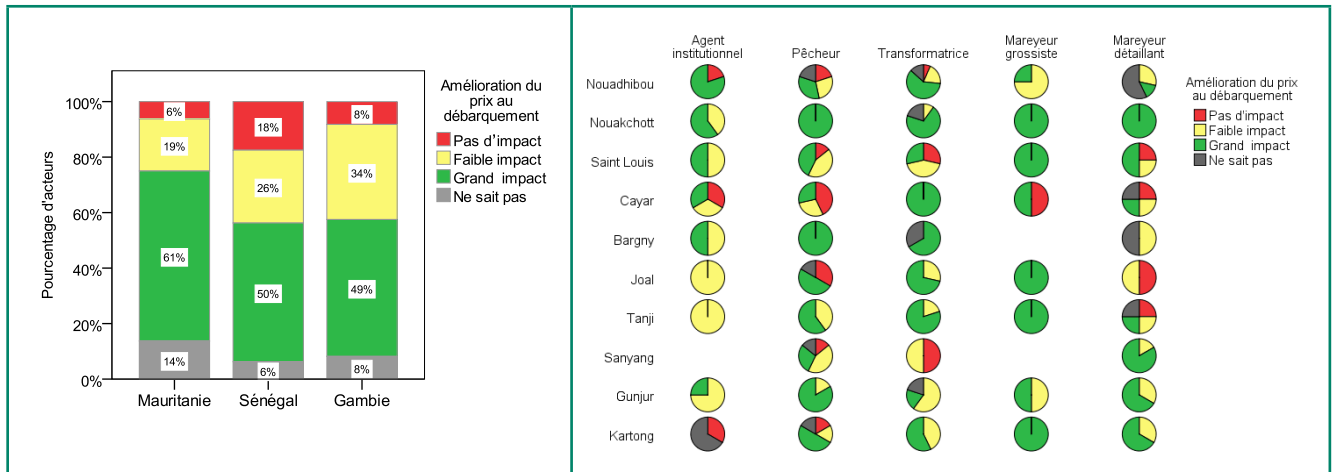


Looking at the ten factory managers interviewed, opinions are divided. Half of them maintain that the fishmeal and fish oil industry has a major impact in terms of recovering post-capture waste and preventing fish from going unsold. For them, this advantage is due to the fact that the plants can process anything that cannot be marketed due to a lack of takers in the fish trade, artisanal processing or local markets.

With regard to the role of factories in improving the landed price of fish, opinions are a little more divided. However, in all three countries, the majority of stakeholders surveyed believe that the production of fishmeal and fish oil has a major impact on raising landed prices (Figure 12). This opinion is more important in Mauritania, especially in Nouakchott, where all the fishermen and fishmongers interviewed were unanimous. Generally speaking, in all the sites visited, wholesale fish merchants are the players most aware of the important role played by factories in the rise in landed fish prices. The main explanation given by these players is that the production of fishmeal and fish oil contributes to widening the gap between supply and demand in a context of proven scarcity of fish resources. Furthermore, they consider that in many sites, when the volume of landings is low, factories offer much higher prices than wholesalers and processors in order to guarantee their supply of raw material. As a telling illustration, a fishmonger in Gunjur notes that before the factories were installed, a case of sardinella used to cost 1,500 dalasis, whereas it now costs 3,500 dalasis.

It should be noted that there is also a significant proportion of players who consider the contribution of factories to improving landed prices to be low, or even nil. This is particularly the case in Senegal and Gambia, where just over 40% of stakeholders hold this view. Indeed, these stakeholders, especially institutional agents, consider that it is the overall demand for fish combined with the scarcity of resources that has led to the considerable rise in prices, and not specifically the supply of fishmeal and fish oil plants. In addition, some players, including fishermen, point out that factories have strategies that sometimes even contribute to lower landed prices. In fact, at many sites, particularly in Mauritania and the Gambia, factories sign contracts with Senegalese purse seine canoes at the start of the season, subject to a pre-set price. Thus, even if market conditions become favorable, this low price will be maintained. What's more, when the volume of landings is relatively high at a site, the factories take advantage of this to offer derisory prices and buy large quantities, knowing that the fishermen will be obliged to sell to try and cover part of the costs of the trip. Moreover, in the Gambia and Mauritania sites, there are generally combined consequences. In fact, it's once the campaign is underway that the large Senegalese pirogues arrive, contributing, if conditions are favorable, to local overproduction and thus to a drastic drop in prices.

Figure 12. Opinions of professional actors on improving landed prices



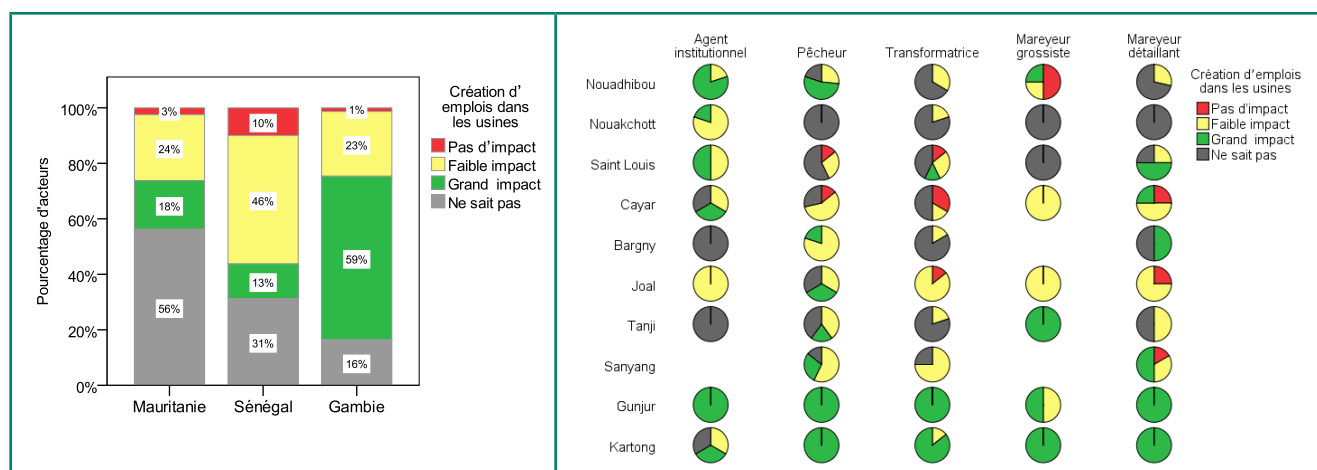
In the case of plant managers, five out of the ten interviewed consider that the fishmeal and fish oil industry helps to improve landed prices. In fact, for them, fishmeal and fish oil production increases demand while adding value to catches that could not be marketed and therefore simply discarded. Other managers, however, maintain that the impact on landed prices is low or non-existent.

6.3 Perceptions of impacts on employment and income

When it comes to job creation in the factories, the importance of the fishmeal and fish oil industry's contribution varies greatly from country to country and from site to site (Figure 13). Opinions are clearly more favorable in The Gambia (59%), especially in Gunjur and Kartong, where a large majority of stakeholders surveyed confirm a rather large impact. In this area, stakeholders also point out that, given the scarcity of local job opportunities, the factories are generally seen as an un hoped-for source of employment, especially for young people. However, due to the seasonal nature of the factories' activities, these are essentially non-permanent jobs, usually on a daily basis.

In Senegal and Mauritania, opinions on job creation are mixed, with a very high level of ignorance about impacts in sites such as Saint Louis, Bargny and Nouakchott (Figure 13). However, in the specific case of Senegal, almost half of the stakeholders maintain that the plants do have an impact in terms of job creation, but only a small one. This is particularly true in Cayar and Joal, where some stakeholders confirm that only a few young people have been recruited. However, most of them work as day laborers. In Mauritania, despite the large number of factories, some stakeholders maintain that in reality they create few jobs, which are generally precarious. In addition, at sites such as Sanyang (Gambia), it has been reported that a large proportion of employees are not recruited from the local population.

Figure 13. Opinions of professional actors on job creation factories

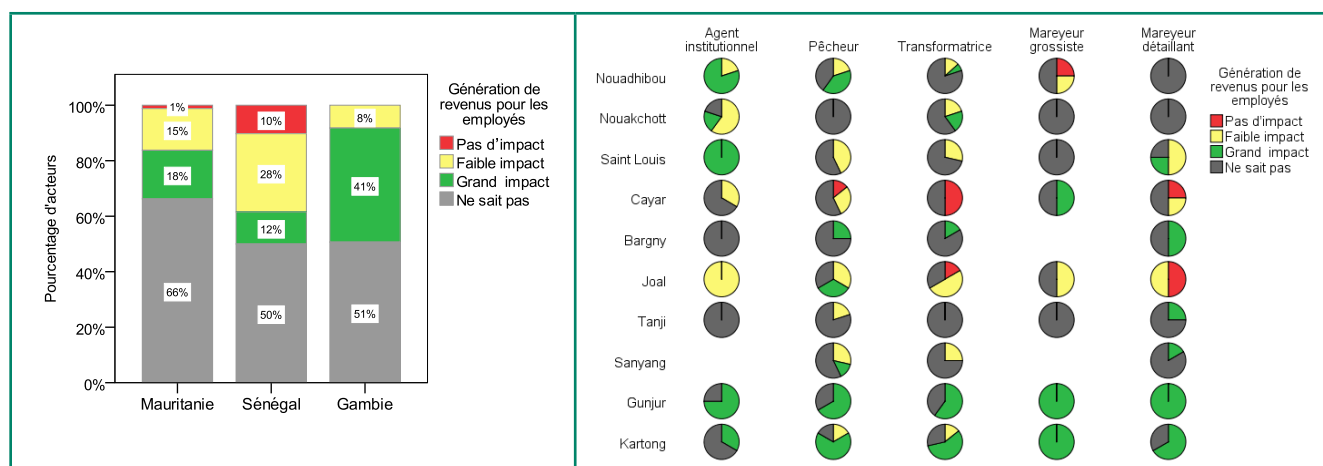


The ten plant managers interviewed were virtually unanimous on the importance of the fishmeal and fish oil industry for job creation. Indeed, nine of them believe that the plants create direct and indirect jobs. For them, the factories are job opportunities that help to combat unemployment, especially at local level.

When it comes to the importance of income for factory employees, the level of importance is generally ignored by most of the professional players interviewed (Figure 14). This is especially the case in Mauritania, where three quarters of stakeholders know nothing about the income of factory workers. In Gambia, on the other hand, opinions are much more favorable among all the stakeholders surveyed. In this country, a considerable proportion of people consider that the factories have a considerable impact on income generation. This opinion is widely shared at the Gunjur and Kartong sites, where the industry is seen as a good opportunity. In Senegal, more than a third of players believe that the impact is low or non-existent. Generally speaking, in all countries, the finger is pointed at the low level of employee remuneration. However, these payments can contribute to the satisfaction of basic needs, especially in a context where local sources of income are scarce.

When it comes to the tax revenues generated by governments in the form of taxes, the vast majority know nothing about their importance. In all three countries, at least three quarters of players are completely unaware of this aspect. However, some believe that, given the tax regimes applicable to all companies, factories probably pay considerable amounts, given the scale of their production, which is mainly exported. At local level, factories that charter pirogues and/or boats also pay royalties to the authorities in charge of managing fishing docks. Fishing licenses for these pirogues and boats are also a source of revenue for government coffers, especially in Mauritania.

Figure 14. Opinions of professional actors on income generation for employees



The vast majority of plant managers surveyed consider that the fishmeal and fish oil industry makes a considerable contribution to revenue generation. This is particularly the case for the income earned by workers, as well as for the taxes paid to the States. Of the ten managers, eight believe that the industry has a major impact on both these aspects.

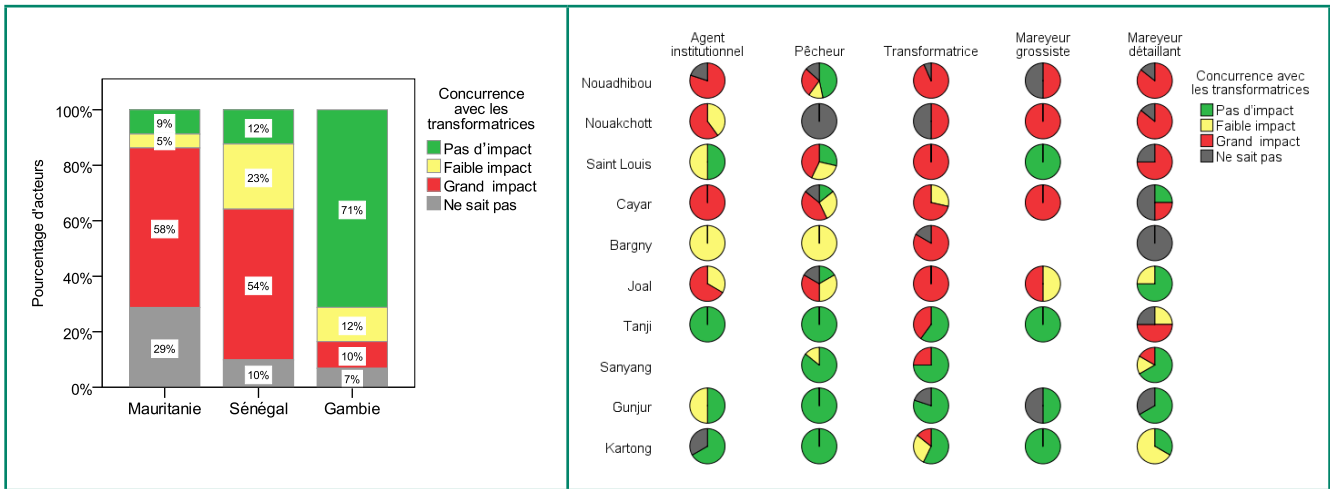
6.4 Perceptions of the impact of post-capture links on actors

Along the fish harvesting value chain, the post-capture links play a very important role, in terms of employment, income and supply to domestic and foreign markets. In terms of the players involved, processors and wholesalers are most likely to be exposed to the consequences of fishmeal and fish oil factories. Due to the nature of their activities, they are potentially subject to direct co-occurrence on access to landed fish. Field surveys show that on this point, opinions in Gambia clearly differ from those in the other two countries (Figure 15). In this country, around three quarters of the stakeholders questioned overwhelmingly affirmed that factories have no impact in terms of competition with processors and fishmongers. This opinion is widely shared in all four sites, where most players maintain that the presence of the factories even facilitates the supply of fishmongers and processors. Indeed, in many of these sites, the arrival of the Senegalese seine pirogues chartered by the factories is always seen as a godsend in terms of providing sufficient fish for all players in the value chain. In fact, at the time of the surveys, when the fishing season was not yet open, many processors and fishmongers were almost out of business, eagerly awaiting the arrival of the factory canoes. On the other hand, at almost all these sites, most of those interviewed claimed to have tacit agreements with the factories on the principle of first supplying local players before the factories, especially when catch levels were low. What's more, given the low conservation capacity of fresh fish at local level, when landings are low, the factories focus on fish that has deteriorated or is about to deteriorate.

In contrast to the Gambia, Senegal and Mauritania are characterized by predominantly negative opinions concerning factory competition with processors (Figure 15), but also with fish merchants. In both countries, more than half the stakeholders surveyed felt that the impact of competition from factories was great, and a serious threat to the livelihoods of the post-capture link. At major sites such as Nouadhibou, Nouakchott, Saint Louis, Cayar and Joal, the processors and fishmongers interviewed were virtually unanimous on this negative impact of fishmeal and fish oil production. In the particular case of Mauritania, almost all the fresh fish landed by pirogues and charter boats goes straight to the factories, without any effective strategy for supplying local players as a priority. In Senegal, given the scarcity

of fish in relation to demand, stakeholders claim that some factories do not hesitate to offer higher prices to obtain supplies of small pelagics. Some even hire fishmongers to fetch the fish for them. However, some factories, as in Joal, refrain from buying when landings are low.

Figure 15. Opinions of professional actors on competition with processors



None of the plant managers interviewed felt that the industry competes significantly with processors and wholesalers. For them, the industry has little or no impact in terms of competition with post-capture players. They see the plants as targeting production that the market cannot absorb, in addition to waste.

Photo 4. Overview of the empty stalls of small pelagic artisanal processors in Joal



7 - PERCEPTIONS OF IMPACT ON THE LOCAL ENVIRONMENT

7.1 Perceptions of water pollution impacts

With its ability to process large quantities of catches, including those of inferior quality or already deteriorated, the fishmeal and fish oil industry is generally seen as a means of reducing discards of potentially unmarketable fish. Despite the diversity of perceptions depending on the country and site, field surveys show that a good proportion of stakeholders are in tune with the vital importance of this role (Figure 16). In the Gambia, where conservation facilities are lacking and the local market's capacity to absorb fish is low, almost all the stakeholders interviewed felt that the factories had a major impact on reducing the amount of fish discarded at sea. In Senegal, although 57% of stakeholders have a positive opinion in this respect, more than a third of them believe that this impact is low or even non-existent. This sentiment is relatively prevalent among stakeholders at sites such as Cayar and Joal. Indeed, they insist that fish has been in such short supply for so many years that there are hardly any fish left to discard, especially as demand is increasingly strong and means of fresh preservation and transport have been significantly improved. Mauritania stands out above all for the high proportion of stakeholders (49%) unable to give an opinion on the role of factories in reducing discards at sea. This ignorance is widespread among Nouakchott's fishermen and processors, as well as among Nouadhibou's retail fishmongers. Nevertheless, it should be noted that a third of Mauritanian players claim that this impact is nonetheless considerable.

Figure 16. Opinions of professional actors on reducing fish discards at sea

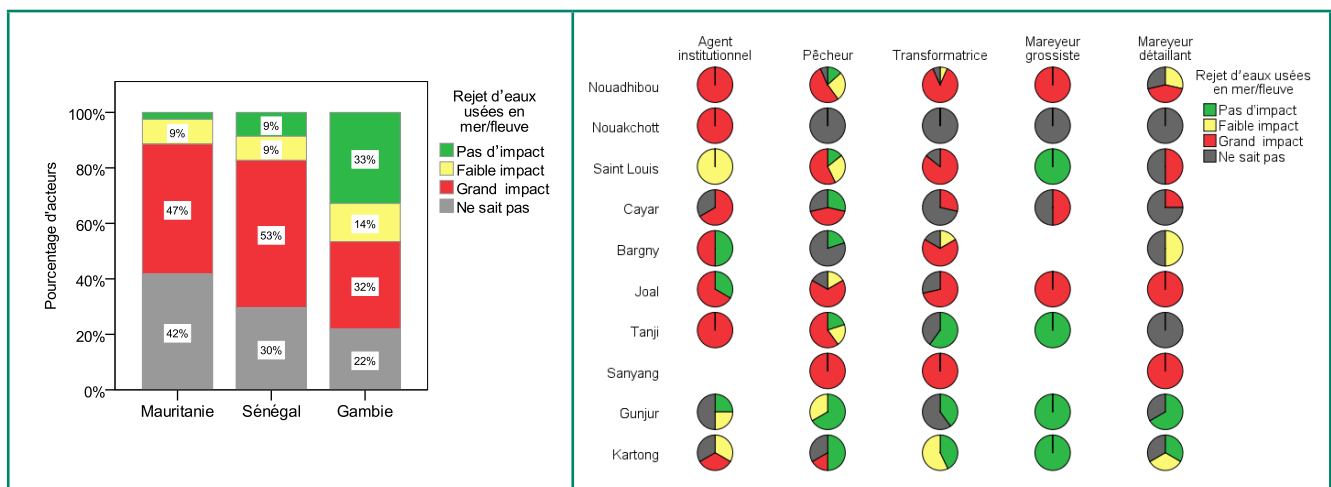


In the case of the plant managers we surveyed, most felt that the fishmeal and fish oil industry had a major impact on reducing discards at sea. For them, the plants are an opportunity to add value to catches that would otherwise be discarded for lack of a buyer or quality. Wastewater containing potentially harmful solid or dissolved substances, including fats, is one of the liquid wastes generated by the fishmeal and fish oil industries. Once generated, such waste is liable to spill into the natural environment and pollute water if appropriate precautions are not taken. These wastewater discharges are more likely to impact aquatic environments (sea, river and lake) given their proximity to the areas where fishmeal and fish oil plants are installed. A significant proportion of the stakeholders surveyed in the three

countries expressed negative opinions about this aquatic pollution (Figure 17). Indeed, even in the Gambia, a third of stakeholders claimed that the discharge of wastewater into the sea/river has a major impact in terms of environmental pollution. This is particularly the case at Sanyang, where all the stakeholders interviewed unanimously deplored the fact that wastewater is discharged into the sea via a pipe coming directly from the plant installed next to the beach. On the other hand, at the Gunjur and Kartong sites, most people said that although this problem existed at the outset, the factories had subsequently taken measures by storing raw wastewater in tanks to extract fertilizers and/or treat it before discharging it into the sea.

It is in Mauritania and Senegal where we find a greater proportion of stakeholders who consider the impact of wastewater pollution on aquatic environments to be considerable. In the case of Mauritania, while the existence of this pollution is ignored by stakeholders due to the remoteness of the plants, its impact is considered significant by the majority of people surveyed in Nouadhibou. Although they mentioned an Indian factory that recovers detritus and turns it into fertilizer, they particularly emphasized the very high level of pollution in the bay, which is the outlet for most of the factories' discharges. A similar observation was made by just over half the stakeholders in Senegal, and especially in Joal, where there was near-unanimous agreement on the significant impact of marine pollution by wastewater from the existing plant. In the particular case of Cayar, the local population pointed the finger at the discharges often made into Lake Mbawane via a cistern.

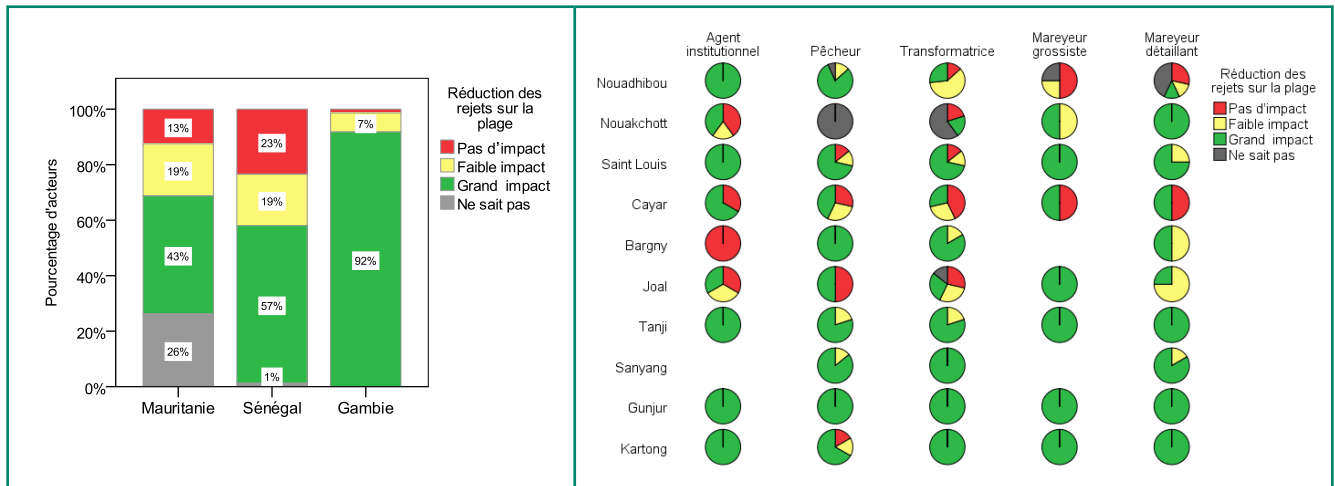
Figure 17. Opinions of professional actors on wastewater discharges into the sea/river



7.2 Perception of soil pollution impacts

With regard to the reduction of fish discards on the beach, the diversity of opinions is quite similar to that observed previously for discards at sea. This is especially the case in Senegal and Gambia, where opinions in favor of a significant impact are in the majority (Figure 18). It should also be noted that in Mauritania, even though a quarter of stakeholders are unable to give an opinion on this question, almost half of them (43%) believe that the factories have made a considerable contribution to reducing the amount of fish that used to rot on the beach for lack of outlets. Fishermen in Nouadhibou and retail fishmongers in Nouakchott are almost unanimous on this positive contribution to the quality of the local environment. However, in all three countries, a significant proportion of stakeholders consider this impact to be weak or non-existent. A majority of processors based in Nouadhibou, Cayar and Joal support this view. For them, even without the factories, there are no longer enough landings to cause major beach discharges, especially as artisanal processing is finding it increasingly difficult to find raw material.

Figure 18. Opinions of professional actors on reducing fish discharges on the beach



When it comes to the extent of soil pollution caused by wastewater, the opinions of stakeholders interviewed in the field are relatively mixed (Figure 19). In the Gambia, opinions are clearly more positive, with 63% of stakeholders believing that wastewater discharge has no impact in terms of soil pollution. In fact, they claim that wastewater generally does not spread outside the plant. At the Gunjur and Kartong sites, stakeholders even mentioned the existence of tanks where this waste is stored, treated and even transformed into fertilizer. On the other hand, in Mauritania and Senegal, a large proportion of the stakeholders surveyed (at least 40%) consider that wastewater discharge has a major impact in terms of soil pollution. A good illustration of this impact was given by several stakeholders in Cayar, where they reported that fields had become sterile in the area where waste from the plant was discharged. In Mauritania, while stakeholders in Nouakchott had no idea of the impact because the plants were so far from residential areas, the majority of those in Nouadhibou confirmed considerable soil pollution in the vicinity of the plants. For some, this nuisance is even reflected in the deterioration of the local landscape.

Figure 19. Opinions of professional actors on wastewater discharge to land



7.3 perception of air pollution impacts

The emission of smoke, generally dense and toxic, is the main air pollution problem often attributed to the fishmeal and fish oil industry. Field surveys therefore provided an opportunity to seek the opinion of local professionals on the extent of this impact. Overall, the responses obtained showed a strong impact, with more contrasting assessments in Gambia (Figure 20). Despite the negative opinions of a sizeable proportion of stakeholders (27%) based mainly in Sanyang, almost half of respondents in Gambia (44%) felt that smoke emissions had no impact on their immediate environment. In reality, such emissions do occur, but in Kartong and Gunjur, they take place relatively far from residential areas, so the smoke is less noticeable. In the case of Nouakchott, since the factories are so far away, stakeholders know almost nothing about their air pollution. On the other hand, due to the high density of fishmeal and fish oil factories nearby, it is in Nouadhibou that almost all the stakeholders surveyed consider smoke emissions to have a major impact on air pollution. This situation is relatively similar at sites in Senegal, such as Saint Louis, Cayar and Joal, but with a lesser impact due to the much smaller number of factories.

Incidentally, it should be noted that the emission of toxic dust resulting from the fish meal production process is also found in Nouadhibou, where its impact is overwhelmingly judged to be considerable. On the other hand, this high level of air pollution is less perceptible in all the other sites visited.

Figure 20. Opinions of professional actors on toxic smoke emissions



Photo 5. Overview of the smoke emitted by a fish meal and oil factory in Nouadhibou



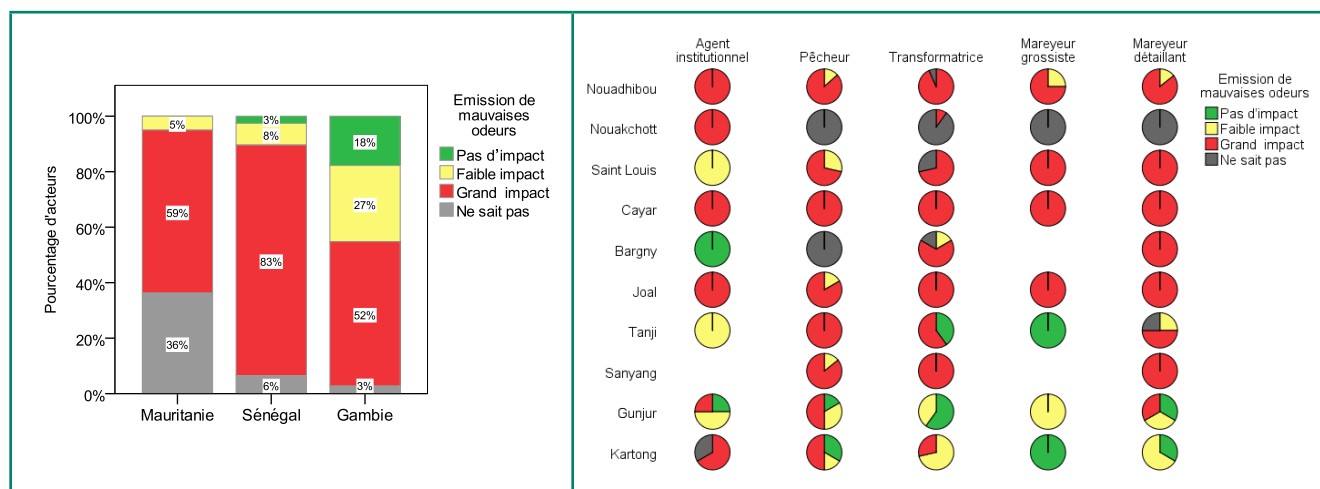
8 - PERCEPTIONS OF IMPACTS ON COMMUNITY WELL-BEING

8.1 Perception on the impact of noise and odour pollution

Of all the nuisances caused by the fishmeal and fish oil industry, the emission of unpleasant odors is the one most feared by the local population. It is without doubt the main source of disruption to the well-being of communities in general, and surrounding populations in particular. This reality is corroborated by field surveys revealing the considerable impact of bad smells emitted by factories (Figure 21). Indeed, in Mauritania and Senegal, with the exception of Nouakchott and Bargny which have no nearby plants, the stakeholders interviewed were virtually unanimous on the major harmful impact of foul odors. Only in Gambia do a little more than a quarter of stakeholders consider the impact to be real, but relatively low and therefore bearable. In most cases, the people we met at the sites maintain that when the plants are in operation, breathing is very difficult in the surrounding area. Although wind direction also plays an important role, they claim that the strong, persistent odors can be felt everywhere, including inside bedrooms and living rooms. The most striking illustration of this nuisance is the fact that in Cayar, for example, stakeholders even mentioned households that could no longer stand the situation and ended up moving out of their homes to escape the nuisance.

As far as noise pollution from the fishmeal and fish oil industry is concerned, the problem is less worrying overall. In fact, the vast majority of those involved in the industry claim that loud noise has no impact on their well-being. The few who did report a significant impact were those who frequented the interior of the plants or areas in their immediate vicinity, particularly in Nouadhibou. For them, the noise of the machines in operation can sometimes be disturbing.

Figure 21. Opinions of professional actors on odor emissions



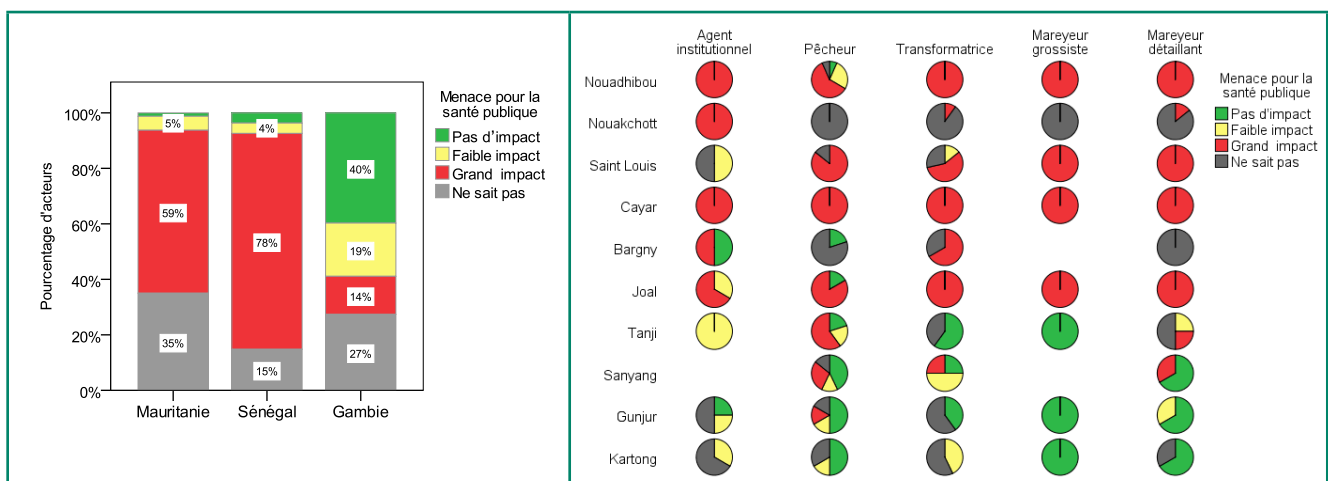
As for the ten plant managers interviewed in the three countries, the majority felt that the emission of toxic smoke was a major problem. They consider smoke to have little impact. Some even think it has no impact at all. Similar views were also noted with regard to the emission of unpleasant odors and dust from the plants.

8.2 Perceptions of the impact on the threat to public health

In relation to the possible consequences of various forms of pollution and nuisance, the fishmeal and fish oil industry represents a potential threat to the public health of local communities. Based on the field surveys carried out, the health risks associated with the activity of the factories are globally considered real and considerable by the professional actors interviewed (Figure 22). This feeling, which reflects real concerns, was expressed by 59% of stakeholders in Mauritania and 78% in Senegal. In the case of Mauritania, there is near-unanimity in Nouadhibou on the fact that factories represent a major threat to public health. This trend is also quite similar for sites such as Saint Louis, Joal and above all Cayar, where all those surveyed rated the health impact as high. The Gambia stands out for the contrasting opinions of the stakeholders, with 40% of them perceiving no impact at all. This positive assessment is very much in evidence at the Gunjur and Kartong sites, in contrast to Sanyang, where the health risks are relatively more worrying.

Among the facts justifying negative opinions on the health threat, stakeholders very often mention the increase in respiratory illnesses such as asthma, which they attribute to the fumes and bad smells emitted by fishmeal and fish oil factories. Some even report more frequent cases of choking and coughing, especially among children and the elderly. Examples of gastric and dermatological illnesses due to soil and water pollution in direct contact with the population are also mentioned.

Figure 22. Opinions of professional actors on the threat to public health



8.3 Perceptions of the impacts on the occurrence of local conflicts

Given the many divergent interests of communities, and the positive and negative consequences that are experienced differently, the fishmeal and fish oil industry is a potential source of social instability. This is due in particular to the conflicts it is capable of generating through the exploitation of resources, but also to protests from local populations. With regard to the impact of plant activities on the increase in conflicts between fishermen, the opinions given by the stakeholders surveyed vary widely from country to country and from site to site (Figure 23). In Mauritania, more than half the stakeholders were unaware of the extent of this impact, while 20% considered it to be considerable. In Senegal, and especially in the Gambia, most of those questioned said that the presence of the factories had no impact on the increase in conflicts between fishermen.

It's worth noting the particular case of Cayar, where a high proportion of stakeholders, including the fishermen themselves, feel that there has been a considerable impact. For many of them, in a context of dwindling resources, the installation of the plant has further

divided the fishermen into two camps. On this site, which attracts waves of permanent or seasonal migrant fishermen, the fishermen who support the plant and even help to supply it with raw materials generally fish with gillnets or purse seines (Photo 7). However, these two types of gear have long been a source of tension with local fishermen who used to fish by line. At certain Gambian sites, such as Gunjur and especially Sanyang, conflicts are generally linked to the fact that the factories in place give priority to contracting with Senegalese fishermen. Feeling aggrieved, some local fishermen harbor a sense of frustration that remains a latent source of conflict. Although less exacerbated, this reality is also present in Nouadhibou, and could become increasingly conflictual in the future as small pelagics become increasingly scarce.

Figure 23. Opinions of professional actors on the increase in conflicts between fishermen

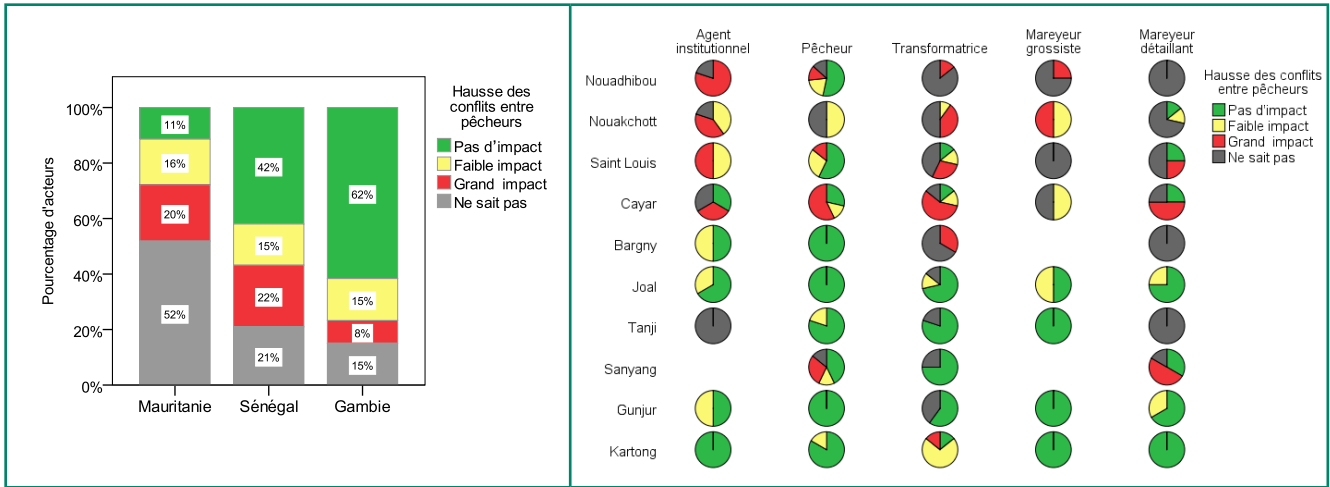


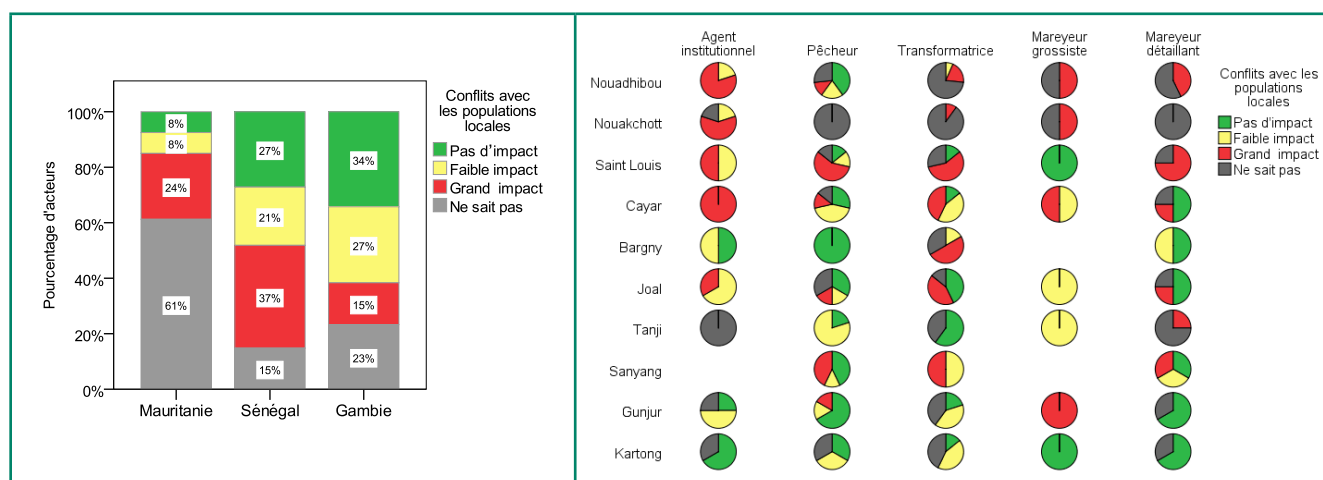
Photo 6. Fisherman repairing a monofilament gillnet



In addition to fishermen, the fishmeal and fish oil industry is also likely to lead to more conflict among local populations. Such conflicts are also a threat to social stability, and therefore to the collective well-being of communities. In addition to conflicts linked to direct protests by local populations against the perceived harmful effects of the factories, there are also those that are intrinsic to the internal divisions that the industry has created within the communities living together. Based on field surveys, the importance of both types of conflict is more negatively perceived in Senegal, where 37% consider their impact to be considerable (Figure 24). This assessment is more prevalent in Saint Louis, Cayar and, to a lesser extent, Joal.

In the particular case of Cayar, there have been more than a few violent protests against the plant, with some cases currently before the courts. In addition, many actors mention latent internal conflicts within a population divided into two camps by the plant and the local authorities who favored its installation. In Joal, too, popular protests have taken place in the past to denounce the unpleasant odors and the risk of disease. The situation has now calmed down, but remains topical. This is also the case at sites in Gambia, with the exception of Tanji, where there have been protests against the existing plants. In the particular case of Sanyang, the plant had agreed a memorandum of understanding with the local population, but then refused to sign it. This led to strong protests by local youth in 2017, and the issue is still with us today. In Nouadhibou, the actors mentioned protests from the surrounding populations, but this has not yet led to serious conflictual tensions.

Figure 24. Opinions of professional actors on the increase in conflicts between fishermen



8.4 Perceptions of impacts on improving basic infrastructures

As a major emitter of waste, the development of the fishmeal and fish oil industry could be an opportunity to put in place infrastructure capable of contributing to the improvement of the local sanitation system. These could, for example, include sewage piping systems and waste treatment facilities that could also benefit the local environment. Unfortunately, surveys carried out in the field reveal that such a contribution is not really observed by the stakeholders (Figure 25). In fact, a large majority of stakeholders (up to 68% in Mauritania) are totally unaware of the existence of any impact of the plants on improving the local sanitation system. For those who were able to give an opinion, this impact is rather weak or non-existent. This is the case for almost half the players in Senegal, and especially in the Cayar site. In some cases, stakeholders even blame the plants for destroying existing sanitation efforts.

Figure 25. Opinions of professional actors on improving the sanitation system

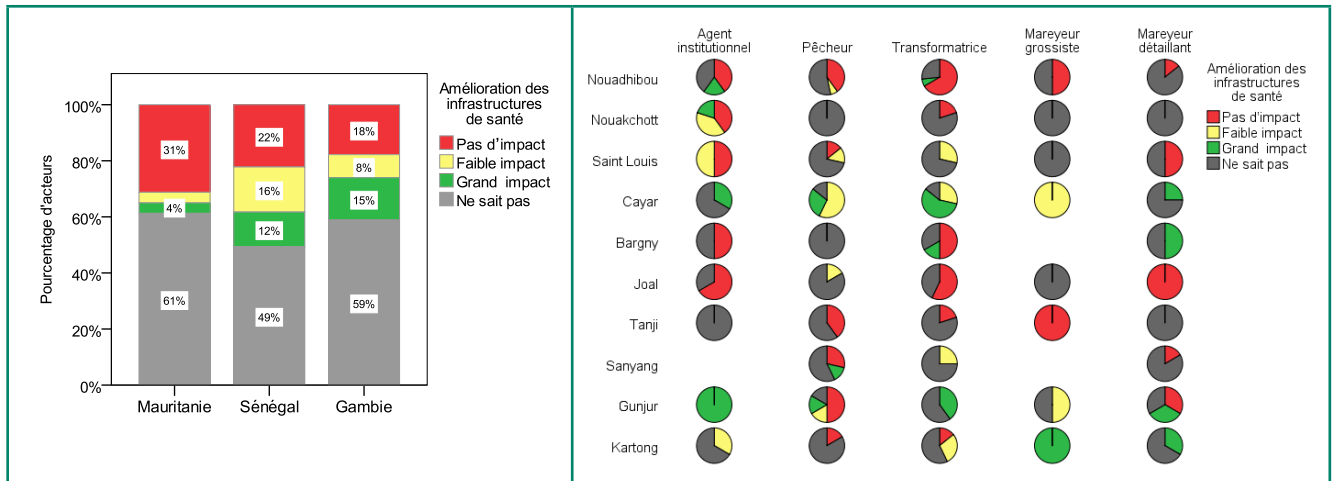


Basic infrastructure is essential for meeting the priority needs that underpin the well-being of local communities. This is why, in the new paradigm for managing economic activities, companies are increasingly committed to supporting and contributing to infrastructure improvements. This is particularly true in the context of corporate social responsibility. In view of the potential adverse effects on public health, the fishmeal and fish oil industry could well become involved in this area. However, in terms of health, the surveys carried out show that this commitment has not yet materialized in any significant way in the field (Figure 26). Indeed, in all three countries, most of the professional players interviewed were unaware of any factory support for improving health infrastructures in their locality. Most of them claim to have seen nothing to this effect, and to have been informed of no concrete action.

The few players who were able to express an opinion consider that, if not zero, the impact of the factories on improvement is low and therefore negligible. At a few sites, such as Cayar, Gunjur and Kartong, opinions in favor of a significant impact refer to a few initiatives that do not generally concern infrastructure. The most noteworthy of these was the construction of four to five wards at the Cayar health center. In Nouadhibou, the construction and equipping of a health post was mentioned, while in Gunjur, some actors mentioned the renovation of the hospital by the factory. Other actions mainly concern one-off financial or material support for health facilities or local authorities in charge of this field. In Cayar, Gunjur and Joal, for example, the plant made payments of unspecified amounts, while in Sanyang it provided the health post with beds, fans and air conditioners.

In terms of other basic infrastructures, the surveys revealed the contribution made by the factories in the fields of education and transport. However, here too, the importance of the fishmeal and fish oil industry's support for their improvement remains almost totally imperceptible to local players. Initiatives in these two areas are rarely mentioned. In the case of transport, most players even believe that the vehicles used to supply the factories and evacuate their production contribute to the deterioration of local roads, without any compensation being provided.

Figure 26. Opinions of professional actors on improving healthcare infrastructures



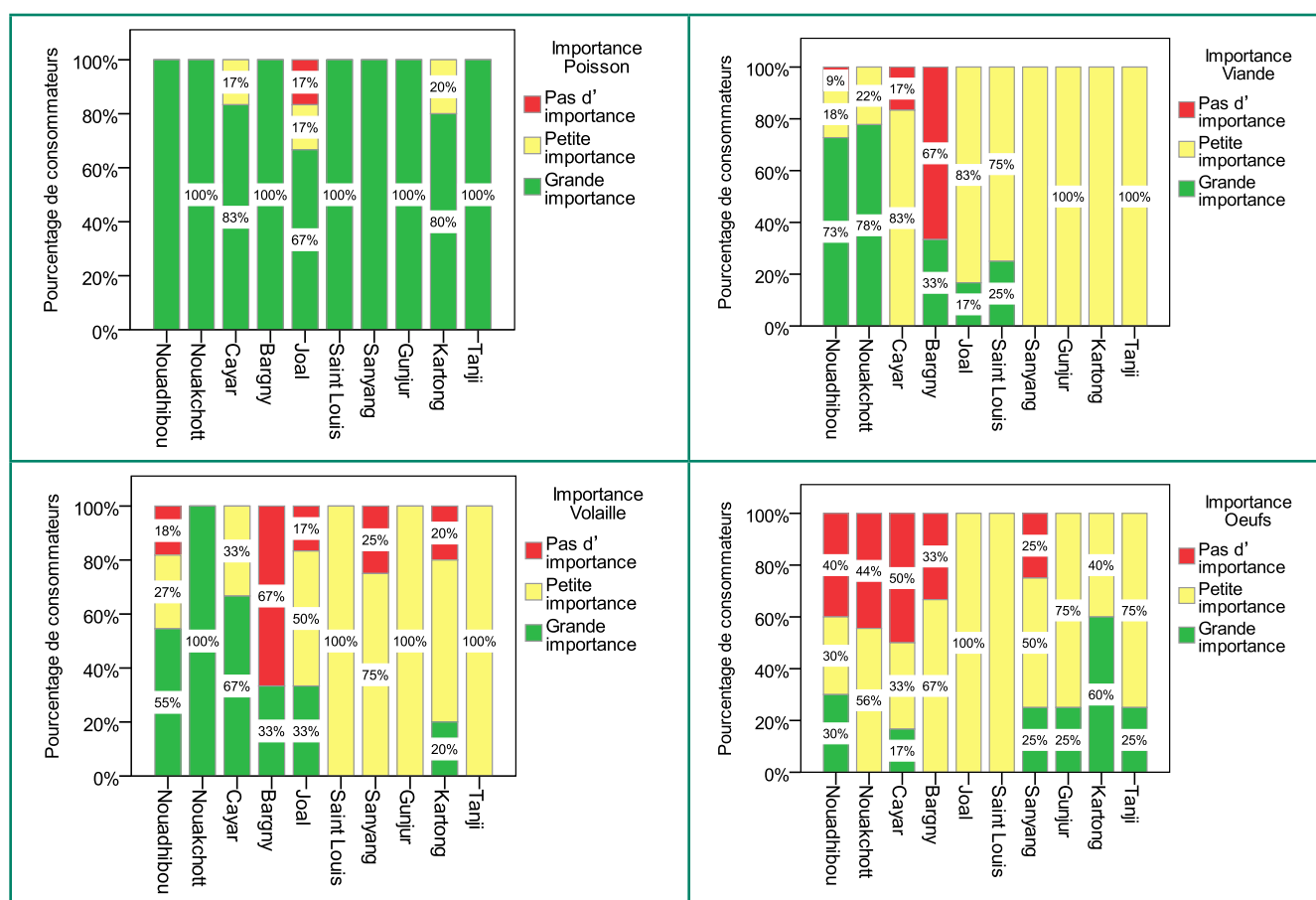
The plant managers interviewed had very different views on the contribution of the fish-meal and fish oil industry to improving basic local infrastructure. However, unless they are unaware of the industry's real contribution in these areas, most managers believe that the impact is low.

9 - PERCEPTIONS OF IMPACTS ON FISH CONSUMPTION

9.1 Importance of animal protein sources for consumers

The field surveys provided an opportunity to ask consumers about the importance of different sources of animal protein in their households. Fish is by far the most important source (Figure 27). In most of the survey sites in the various countries, all the consumers questioned considered it to be of great (%) importance. In rare cases, such as Kayar, Joal and Kartong, a few consumers (17%) consider fish to be important, but to a lesser extent. Meat is generally of little importance in household consumption. For reasons linked to culinary habits and accessibility, meat is particularly important as a source in the two Mauritanian sites. In Nouakchott and Nouadhibou, for example, around three in ten of those questioned were of this opinion. In the particular case of Senegal, Bargny is an urban site in the immediate vicinity of the capital, where a third of consumers consider meat to be of great importance. In the case of poultry, its role is especially significant for consumers in the capital Nouakchott (100%) and, to a lesser extent, in major urban sites such as Nouadhibou (55%) and Cayar (67%). Eggs are generally considered to be of little or no importance by most consumers surveyed.

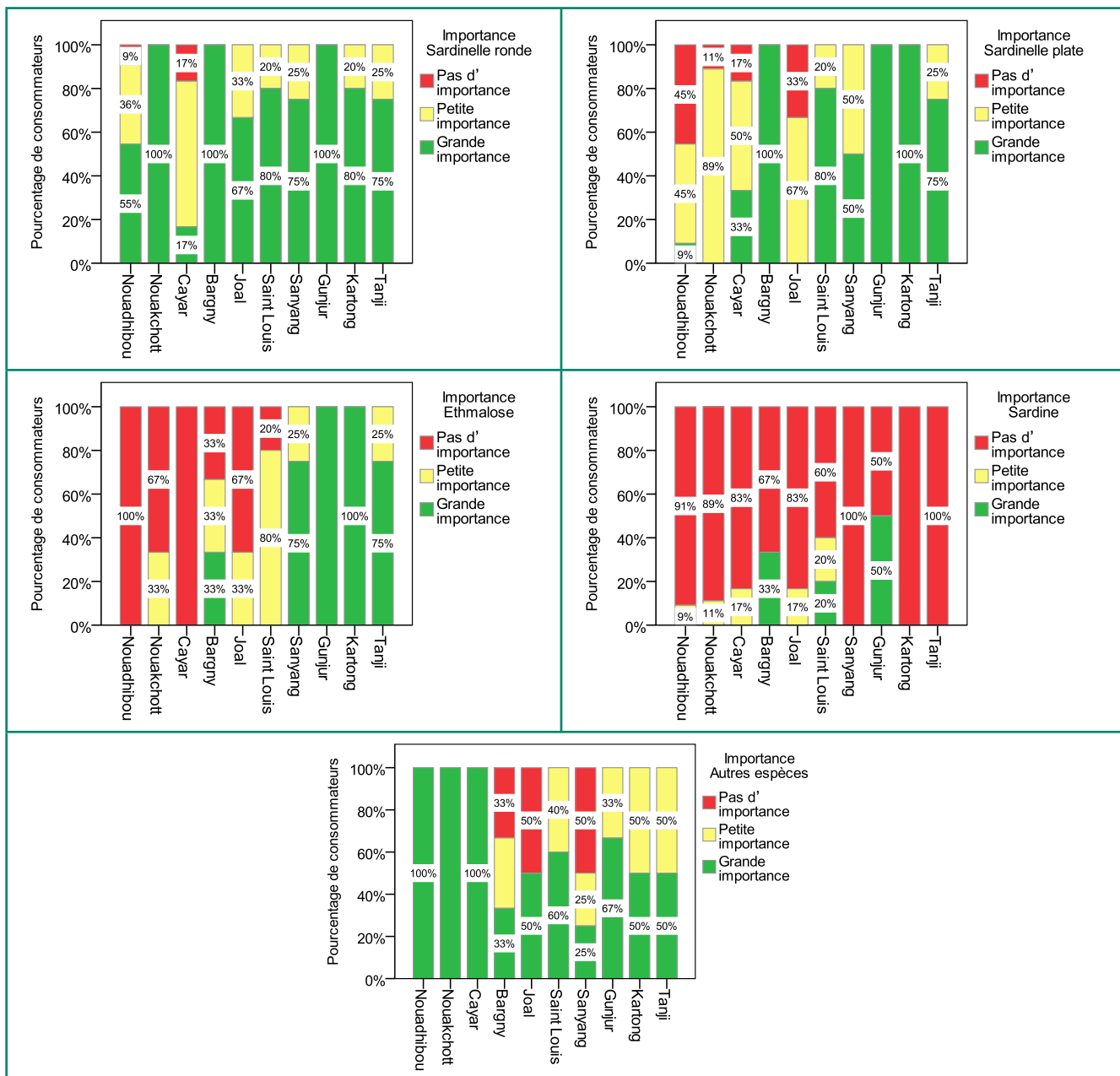
Figure 27. Consumers' opinions on the importance of protein sources



Looking at the main species of small pelagic fish individually, sardinella is by far the most preferred by consumers (Figure 28). Indeed, at most of the sites visited, at least three quarters of the consumers surveyed considered this species to be of great importance. The

only site where more than half of those surveyed considered sardinella to be of low importance was Cayar. In fact, this is a site where, in the past, the importance of demersal line fishing, combined with the presence of a marine trench conducive to the abundance of demersal fish, means that local populations are still less attached to small pelagics for their consumption. As far as flat sardinella and ethmalose are concerned, they are particularly important for consumers in the Gambia. The sardine is the small pelagic species that is essentially considered unimportant in almost all sites in the three countries. As for the other pelagic or demersal species, they are highly preferred by all consumers surveyed in Mauritania, but also in the Cayar site. In most of the other sites, with the exception of Saint Louis, at least 50% of those surveyed considered them to be of little or no importance in their consumption.

Figure 28. Consumers' opinions on the importance of the main species

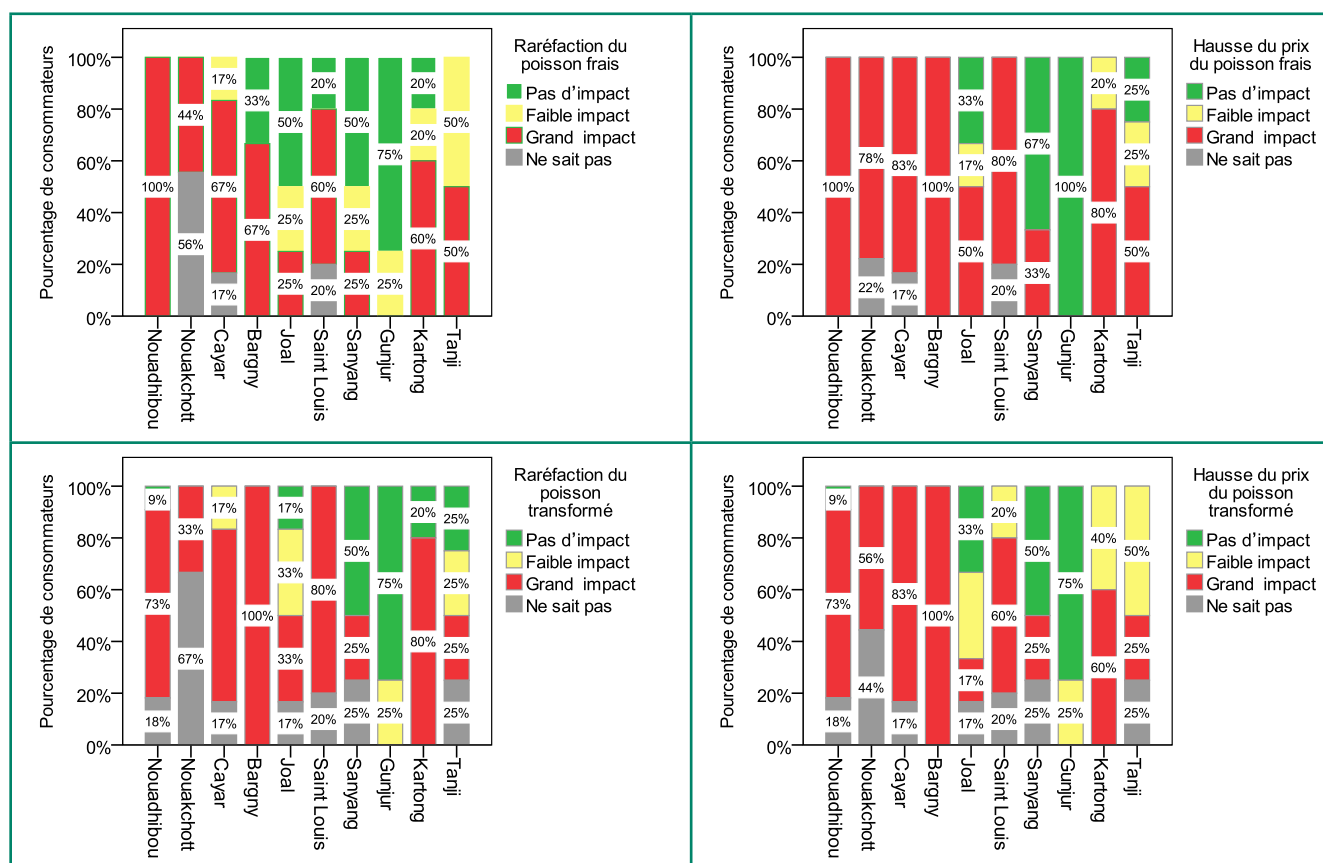


9.2 Factory impacts on fish availability and accessibility

In terms of the impact of the fishmeal and fish oil industry on the accessibility of fish, the opinions of the consumers surveyed are quite mixed (Figure 29). Generally speaking, the high cost of fish is feared more than its unavailability. Indeed, even a large proportion of consumers who think that the impact on scarcity is low or even non-existent affirm that the factories have contributed to the rise in fish prices. These consumers consider that fish is still available, but not for everyone. It should also be noted that, because of the strong dependence on fresh fish, its scarcity on the market and its high price are more worrying than fish.

As regards both the unavailability and the high cost of fish, we also note that the impacts are less felt in two Gambian sites, Sanyang and Gunjur, where at least 60% of consumers surveyed stated that the impacts were nil or low. It should be remembered that in the Gambian sites, the supply of fish to the factories by chartered purse seines is generally an opportunity to improve the supply of fish for the local population. This is particularly the case in Mauritania, but also in sites further north in Senegal (Saint Louis, Cayar and Bargny).

Figure 29. Consumers' opinions on the impact of factories on fish accessibility



9.3 Impact on consumers' adaptive strategies

Consumers' ability to adapt to the impacts of the fishmeal and fish oil industry depends first and foremost on their fish-buying habits. As regards the main place of purchase (Table 2), consumers generally prefer the landing site (on average 38.6%) and the fish market (on average 35.1%). For many of them, these are the places where they can find more fish at a better price, especially when fish is in short supply. However, it should be noted that the fish market is especially important for consumers in Nouakchott, Nouadhibou and, to a lesser extent, Bargny, where diversity of purchasing locations is a reality.

The local market, which offers the advantage of being able to buy other food products at the same time, is also of considerable importance (on average 22.8%). It is even preferred by at least half the consumers questioned in Saint Louis, Cayar and Sanyang. On the other hand, the stalls of retail fish traders who sell at neighbourhood level and other places such as supermarkets are usually avoided by consumers, who consider that due to scarcity, these places are no longer able to supply enough fish at a good price. The current situation with regard to choice of purchase location is therefore likely to worsen if factories continue to have a further negative impact on fish resources. Consumers who have the means to do so will increasingly turn to landing sites and fish markets, distance permitting, while those who are far from these places will face ever-increasing fish shortages and prices.

Table 2. Distribution of consumers by site and main fish purchase location

Site	Local Market	Fish Market	Landing site	Neighborhood retailer	Other places	Total
Nouadhibou	9,1%	63,6%	27,3%	0,0%	0,0%	100,0%
Nouakchott	11,1%	77,8%	0,0%	0,0%	11,1%	100,0%
Cayar	50,0%	16,7%	33,3%	0,0%	0,0%	100,0%
Bargny	33,3%	33,3%	0,0%	33,3%	0,0%	100,0%
Joal	16,7%	16,7%	66,7%	0,0%	0,0%	100,0%
Saint Louis	60,0%	20,0%	20,0%	0,0%	0,0%	100,0%
Sanyang	50,0%	25,0%	25,0%	0,0%	0,0%	100,0%
Gunjur	0,0%	0,0%	100,0%	0,0%	0,0%	100,0%
Kartong	20,0%	20,0%	60,0%	0,0%	0,0%	100,0%
Tanji	0,0%	0,0%	100,0%	0,0%	0,0%	100,0%
Average	22,8%	35,1%	38,6%	1,8%	1,8%	100,0%

Frequency of purchase is generally an important factor in cushioning shocks, especially short-term ones, in the consumer market. This is especially the case for fish, which is increasingly characterized by irregular supply, resulting in momentary and unpredictable unavailability and high prices, even during seasons once considered periods of abundance. The more a consumer is able to buy in sufficient quantities to space out his or her purchase frequencies as long as possible, the less vulnerable he or she is to market shocks. Surveys show that most consumers interviewed (on average 33.6%) usually opt to buy fish on a daily basis (Table 3). For them, this predominant option is actually due to low purchasing power and the absence of means of preservation at home. Households in this situation are therefore more exposed to the impact of fishmeal and fish oil factories on fishery resources.

With regard to other levels of purchasing frequency, it can be noted that a quarter of consumers usually buy every week. This is especially the case in Nouadhibou (63.6%), Nouakchott (44.4%) and, to a lesser extent, in Sanyang and Tanji. On the other hand, consumers who buy fish monthly are much rarer (14.0%) and are mainly concentrated in Nouakchott and a little in Cayar. For other households, especially in Saint Louis and Joal, an opportunistic strategy is favored. This involves buying fish irregularly when it is more accessible and/or financial means permit. For more affluent households, the monthly purchasing strategy is likely to develop further if the factories continue to contribute to the scarcity of fish, while poor consumers are more likely to opt for opportunistic and therefore irregular supplies.

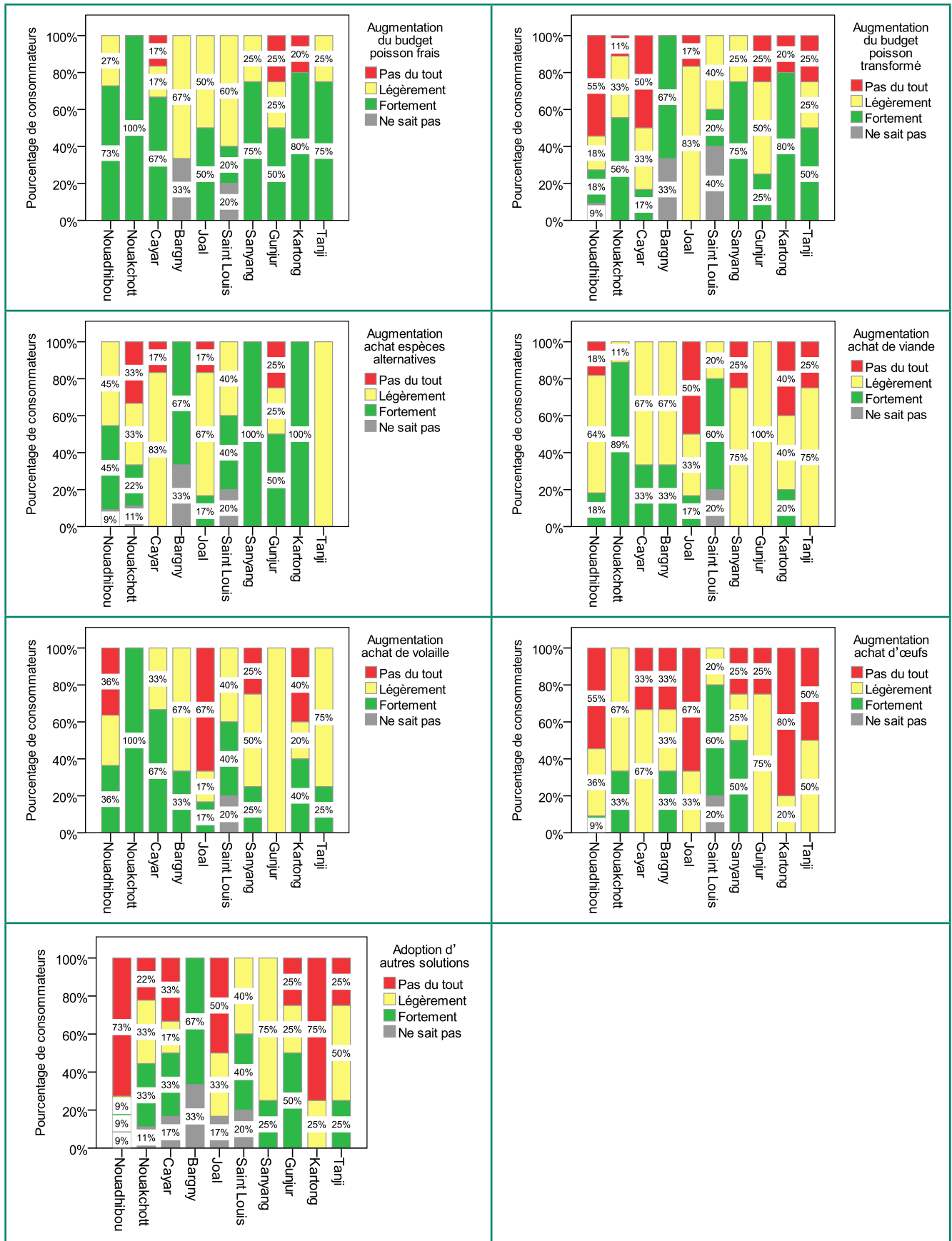
Table 3. Distribution of consumers by site and frequency of fish purchases

Site	Daily	Weekly	Monthly	Irregular	Other frequency	Total
Nouadhibou	9,1%	63,6%	9,1%	9,1%	9,1%	100,0%
Nouakchott	0,0%	44,4%	55,6%	0,0%	0,0%	100,0%
Cayar	50,0%	16,7%	33,3%	0,0%	0,0%	100,0%
Bargny	100,0%	0,0%	0,0%	0,0%	0,0%	100,0%
Joal	33,3%	0,0%	0,0%	50,0%	16,7%	100,0%
Saint Louis	20,0%	0,0%	0,0%	80,0%	0,0%	100,0%
Sanyang	75,0%	25,0%	0,0%	0,0%	0,0%	100,0%
Gunjur	75,0%	0,0%	0,0%	25,0%	0,0%	100,0%
Kartong	60,0%	0,0%	0,0%	0,0%	40,0%	100,0%
Tanji	75,0%	25,0%	0,0%	0,0%	0,0%	100,0%
Average	38,6%	24,6%	14,0%	15,8%	7,0%	100,0%

Faced with the scarcity of fish, whether or not linked to the fishmeal and fish oil industry, the adoption of alternative solutions is undoubtedly inevitable for consumers. In this respect, the opinions of the consumers surveyed are very mixed (Figure 30). However, it is clear that increasing the budget to be able to continue buying and consuming fresh fish is the most widely considered option. Indeed, in most sites, at least half of the consumers questioned are willing to significantly increase their financial means to continue to satisfy their household's need for fresh fish. This is the case in Nouakchott (100%), Cayar (67%) and Kartong (80%). A large proportion of consumers (at least 50%), particularly those based in Saint Louis, Bargny and Joal in Senegal, are also planning to increase their fresh fish budget, albeit slightly. Indeed, most of the people surveyed in Senegal claim that they have long since made considerable budget increases to cope with the structural scarcity and high cost of fresh fish. They claim that they are obliged to continue making efforts in this direction, since this product is essential for their households.

As far as other alternative solutions are concerned, the options considered vary widely from site to site. In the case of increasing the budget for the purchase of processed fish, this is strongly considered in most Gambian sites, but also in Bargny (67%) and, to a lesser extent, in Nouakchott (56%). On the other hand, this option is rejected by a large proportion of consumers in Nouadhibou and Cayar. The use of alternative species not usually consumed is also a highly considered strategy in The Gambia, with unanimous support in Sanyang and Kartong. On the other hand, increasing the purchase of meat and poultry is only significantly considered in major urban centers such as Nouakchott, Saint Louis and Cayar. On the other hand, most households foresee only a slight increase in egg purchases, if any at all. As far as the adoption of other alternatives is concerned, most consumers surveyed do not consider it as an option in their adaptive strategies (73% in Nouadhibou and 75% in Kartong). On the other hand, it is considered a strong possibility by at least 50% of the consumers surveyed in Bargny and Gunjur. Such alternatives include changes in culinary habits, such as greater use of cowpeas (beans) as a source of protein, and a greater orientation towards other less protein-rich dishes such as millet, maize or rice porridge.

Figure 30. Consumers' opinions on alternative solutions to fish scarcity



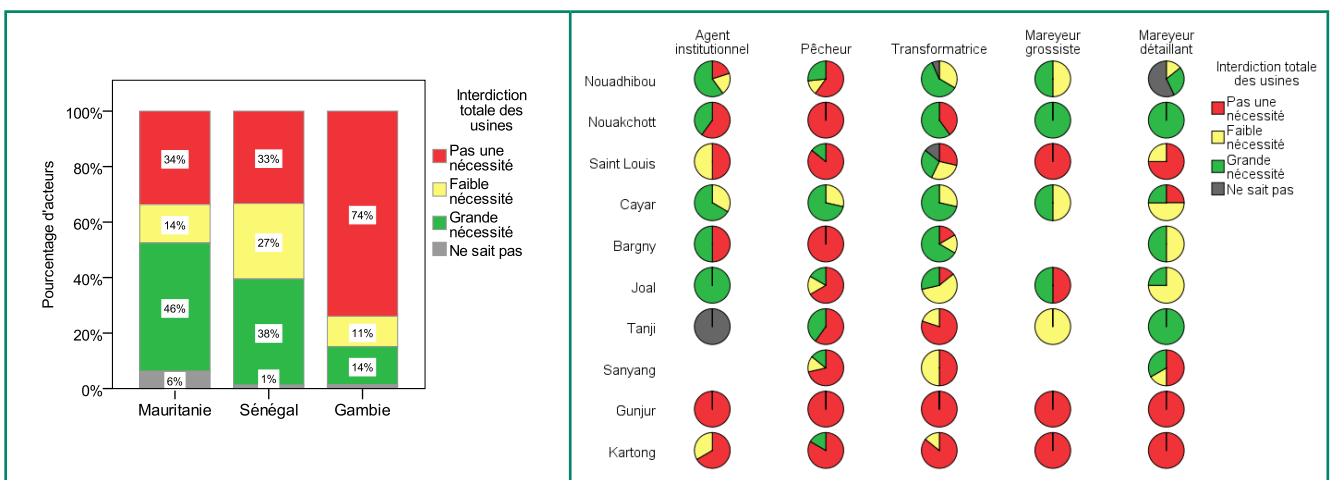
10 – PERCEPTIONS OF STAKEHOLDERS ON THE MEASURES TO BE IMPLEMENTED

10.1 Perceptions on the limitation of factory capacity

A total ban on fishmeal and fish oil factories is one of the measures sometimes mooted to put an end to the negative impacts of the fishmeal and fish oil industry. This is a radical measure consisting of a complete ban on this industry in the countries of the sub-region, including the closure of factories that already exist. Surveys carried out in the field provided an opportunity to ask industry players for their views on the extent of the need to implement this extreme form of limiting the operational capacity of factories. The results show contrasting opinions in Mauritania and Senegal (Figure 31). In Mauritania, although almost half of all stakeholders believe that this radical measure is a great necessity, a third of respondents, including all Nouakchott fishermen, hold the opposite view. This opposition was also noted in Senegal, with a more nuanced intermediate position defended by 27% of those surveyed, including a diversity of stakeholders in Cayar. For them, even if eliminating factories altogether could be a solution, it's not really a top priority. On the other hand, there's a very special situation in the Gambia, where around three quarters of stakeholders say there's no need to ban factories altogether. In fact, Gunjur and Kartong are virtually unanimous in rejecting this option.

Generally speaking, those who suggest a total ban on factories justify their reasoning on the seriousness of their negative effects on resources, the environment, community livelihoods and well-being. On the other hand, those who reject this measure consider that factories create jobs in a local context generally marked by a lack of job opportunities. In addition, they point out that, in the event of overproduction, factories are the only outlet, as storage and transport capacities are sometimes poorly developed locally.

Figure 31. Opinions of professional actors on a total ban on factories



Failing a total ban on fishmeal and fish oil factories, another less radical option for limiting the industry's capacity is also conceivable. This involves freezing the number of plants at a given level. This means that no new plants can be authorized in addition to those already in place. Compared with a total ban, this measure is generally more acceptable to a greater

proportion of industry players (Figure 32). Indeed, in Mauritania and Senegal, respectively 68% and 58% of respondents felt that the freeze was a major necessity, while less than a quarter strongly disagreed. Such disagreements were expressed, for example, by all the fishermen in Nouakchott and a variety of stakeholders in Cayar. In the Gambia, although around half of all stakeholders are opposed to the freeze, a significant proportion consider it to be a great necessity. This is notably the case for most of the fishermen in Kartong and the processors in Sanyang.

In general, those who are reluctant to support the freeze point to its importance in terms of jobs and outlets in the event of exceptionally high catches. On the other hand, those who see the measure as a weak or strong necessity emphasize the need to halt industry expansion, which could worsen the situation. They see the freeze as a way of maintaining current jobs while controlling negative impacts such as pollution and competition with post-capture activities and consumption.

Figure 32. Opinions of professional actors on freezing the number of factories



Considering the opinions of the ten plant managers interviewed, there was almost unanimous disagreement with a total ban on the fishmeal and fish oil industry. For them, this is not a necessity, as this industry is an important part of the fishing industry. On the other hand, six managers think that freezing the number of plants is a necessity.

10.2 Perceptions on the restriction of factory activities

The supply of fish as a raw material is a major step in the operationalization of the fishmeal and fish oil industry. The importance of this supply flow, as well as the sources and quality of the fish supplied, determines production levels and socio-economic impacts. So, given the importance of fresh fish for post-capture activities and consumption, one possible solution to some of the effects of the fishmeal and fish oil industry would be to ban its use. This would mean restricting the raw material to processing waste and by-products. In a similar vein, another possible restriction on the raw material used by factories would be to prohibit the use of the species most widely consumed in each country. With regard to these two measures, the professional players surveyed expressed relatively similar opinions, which varied from country to country and from site to site (Figure 33). Indeed, in the case of the ban on the use of fresh fish, for example, almost three quarters of those questioned in Mauritania considered it a great necessity. However, Nouakchott fishermen were unanimous in

their rejection of this measure. In Senegal, although more than 52% of stakeholders agree with this absolute necessity, a significant proportion (54%) see little or no need for such a ban. In Gambia, on the other hand, a large majority (60%) disagreed with the need for such a measure. The few negative opinions were recorded in the da Tanji site, mainly among retail fishmongers.

The tendencies noted for the ban on the use of fish are relatively the same as those relating to the prohibition of the most consumed species. Those in favor of these two measures to restrict the industry's raw material consider that they would best limit the harmful consequences of competition with post-capture activities and consumption. On the other hand, those who disagreed feared that they would eventually lead to the closure of factories, resulting in the loss of direct and indirect jobs, as well as the other benefits associated with this industry at local and national level.

Figure 33. Opinions of professional actors on the ban of fresh fish



To reduce the ecological and socio-economic footprint of the fishmeal and fish oil industry, limiting the volume of production could be a suitable restrictive measure. This would involve setting each plant a production quota for fishmeal and/or fish oil that must not be exceeded per year. With regard to the opinions of the professional players surveyed on this measure, we note more favorable opinions in Mauritania, in contrast to Gambia, where the rejection of this measure is clearly dominant (Figure 34). It should be noted that a large proportion of fishermen in Nouadhibou and especially Nouakchott are opposed to the measure. In Senegal, opinions are more divided, although 42% of stakeholders consider limiting production to be a major necessity. The others consider it to be of little or no necessity.

Generally speaking, those in favor of the measure see it as a way of preserving the industry while mitigating its negative impacts. On the other hand, those who disagreed argued that once a plant has been authorized, its production should no longer be restricted. In their view, given the heavy investment involved, plants need to produce as much as possible to meet investment and operating costs, in order to create jobs and generate income.

Figure 34. Opinions of professional actors on limiting factories output



Almost all the fishmeal and fish oil produced in the countries of the sub-region is exported. Thus, the external market is the real driver for the development of this industry in this zone. Once exported, this production is transformed into animal feed, used in particular to feed aquaculture fish and livestock. A ban on the export of this product could therefore have a dual objective, namely to limit production and hence its effects, and to ensure that the meal and oil are used in the domestic aquaculture and livestock sectors. In relation to this measure, the opinions of the stakeholders surveyed were relatively mixed (Figure 35). In addition to the 43% of Mauritanian stakeholders who are unable to comment on this issue, a large proportion of people in Senegal and The Gambia see little need for such a measure. Even if a third of Senegalese players consider it indispensable, the rate of disagreement is considerable in all three countries.

The level of ignorance and reluctance towards banning the export of fishmeal and fish oil can be explained by the fact that most of the players surveyed admitted not knowing what fishmeal and fish oil are used for. In addition, they felt that if the countries of the sub-region were unable to buy and use fishmeal and fish oil properly, it would be out of the question to prohibit its export. For those who agree, they believe this would help limit the industry's footprint. Moreover, domestic use of the production would enable the development of aquaculture and livestock farming, which face a serious problem of availability and accessibility of good-quality protein feed.

Figure 35. Opinions of professional actors on the flour/oil export ban

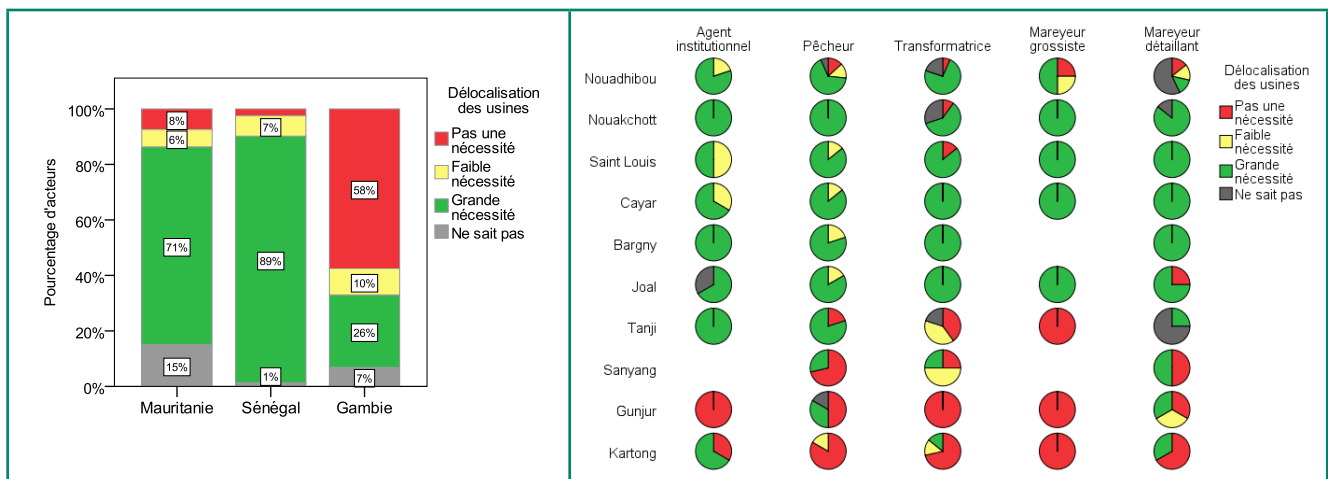


The ten plant managers interviewed had very different views on the restrictive measures. However, the majority of managers consider the ban on fresh fish or the most widely consumed species, as well as the limitation of production volume, to be a futile necessity, if at all necessary. For their part, they almost unanimously reject the ban on exporting the fishmeal and fish oil produced.

10.3 Perceptions on the regulation of factory activities

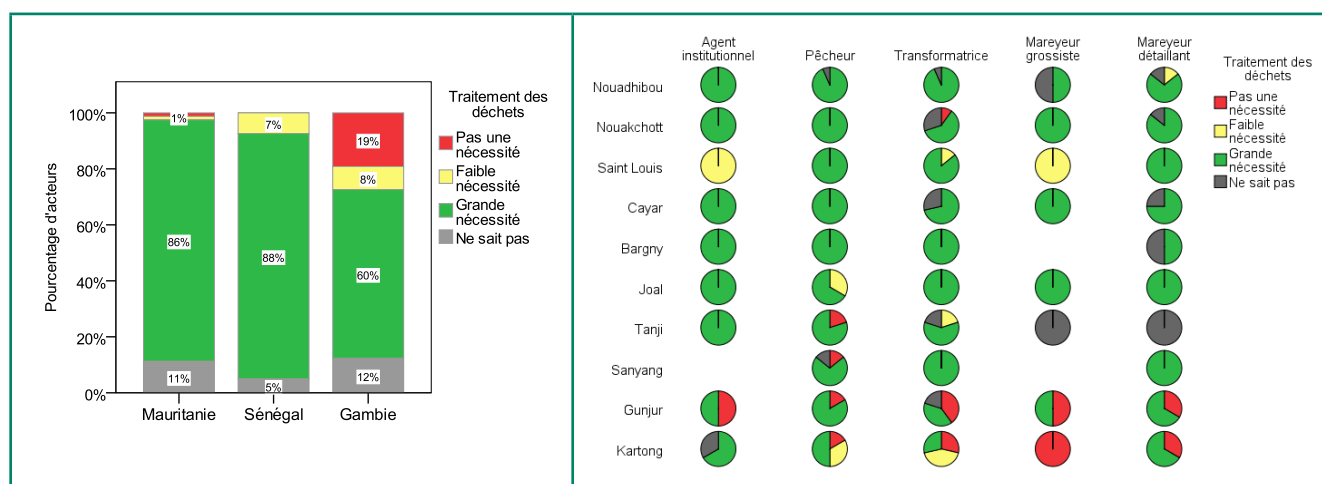
As mentioned above, the fishmeal and fish oil industries generally have significant adverse effects on the immediate environment and, above all, on the well-being of local communities. When they are located close to residential areas, they pose a particular threat to people's health. This being the case at most sites, relocation is the regulatory measure most often cited to put an end to the unwanted impacts on surrounding homes. During the field surveys, the professional players interviewed were generally in favor of implementing this measure (Figure 36). The situation in the Gambia is rather unusual, with 84% of respondents not deeming relocation necessary. Indeed, for sites such as Kartong and Gunjur, most stakeholders believe that the current distance between plants and homes is acceptable. As a result, they consider that relocation would pose problems of accessibility for plant employees, especially in a local context marked by a lack of means of transport. In the case of Senegal and Mauritania, the vast majority of professionals surveyed were in favor of relocating factories. For them, the threats to the living environment and health clearly justify the need to move factories away from residential areas.

Figure 36. Opinions of professionals actors on the relocation of factories



The treatment of plant waste is an important factor in limiting environmental pollution and its effects on local populations. In terms of this regulatory measure, there is a high level of support among professional players for the need to implement it (Figure 37). In Mauritania and Senegal, there is almost unanimous agreement on this point. In Gambia, however, a significant proportion of people disagreed with this option. Based mainly in Kartong and Gunjur, they consider that the existing plants have already taken appropriate measures to avoid pollution, and that there is no particular need for waste treatment.

Figure 37. Opinions of professional actors on factory waste treatment



The regulation of plant activities necessarily involves regular, effective monitoring to identify shortcomings and threats. However, there are undeniable shortcomings in this area, leading to a lack of information on how factories operate and their real impact. This is also reflected in the authorities' difficulty in verifying compliance with the specifications and commitments made when the plants were set up. As a result, more effort needs to be put into strengthening plant monitoring. Based on the surveys carried out in the field, there is near-unanimity on the need to implement this measure in all three countries (Figure 38). Indeed, stakeholders believe that there is a real laxity in the fishmeal and fish oil industry. They therefore feel that more rigorous monitoring would enable them to better identify shortcomings within the factories, and thus to better supervise their activities so as to significantly reduce negative impacts. Such a strategy would also provide a better incentive for the industry to ensure compliance with regulations.

Figure 38. Opinions of professional actors on tighter factory control



The ten plant managers who were surveyed generally agree with the implementation of measures to regulate the activities of the fishmeal and fish oil industry in order to mitigate its negative impacts. Indeed, five managers consider that relocating factories away from residential areas is a major necessity, while only one considers it unnecessary. With regard to waste treatment and tighter control, seven and eight managers respectively say that these are measures of great necessity.

11 - CONCLUSION AND RECOMMENDATIONS

11.1 Conclusion

The expansion of the fishmeal and fish oil industry in West Africa in general, and in the three countries of Mauritania, Senegal and the Gambia in particular, is a major challenge that deserves greater attention. Against a backdrop of dwindling fisheries resources, the question of how to manage this industry is increasingly mobilizing a variety of direct and indirect stakeholders to mitigate its adverse effects on the environment, resources and communities. This study, commissioned by RAMP AO, therefore represents a significant contribution in terms of knowledge production, to be used to better understand the various dimensions of fishmeal and fish oil production. It also provides a wide range of information capable of better guiding advocacy actions, as well as informing decision-making on this highly sensitive issue.

Based on a combination of quantitative and qualitative approaches, the results of this study highlight the complexity and, above all, the heterogeneity of the characteristics and consequences of the fishmeal and fish oil industry. It also shows the wide diversity of interests and perceptions of the various stakeholders with regard to impacts and potential measures to be taken. The raw material is essentially small pelagic fish caught by chartered artisanal and/or industrial fleets, especially in Mauritania and the Gambia. What's more, unlike Senegal and especially the Gambia, the scale of fishmeal and fish oil production and its economic spin-offs are far greater in Mauritania, which has become one of the world's ten biggest exporters. Although there is a diversity of destinations, fishmeal goes mainly to China, Vietnam and Turkey, while France, Spain and Denmark are among the major importers of fish oil.

Even if the creation of a few direct and indirect jobs generates income, in all three countries there are effects that threaten the environment, the exploitation of resources and the well-being of local communities. Such negative impacts are linked to pollution (smoke, wastewater, bad smells, etc.), pressure on resources (overfishing and exploitation of juveniles), threats to health (odor nuisance, respiratory and dermatological illnesses) and competition for access to fish for players such as fishmongers, processors and consumers. However, when it comes to all these impacts, it is not uncommon to find differing perceptions of the extent of potential or actual consequences. For example, in certain areas of The Gambia where employment opportunities and fish conservation facilities are lacking, factories that also contribute to improving fish availability through chartered pirogues are sometimes viewed positively by many local stakeholders. All these realities at national and local levels are also reflected in the divergence of opinions on adaptive solutions, but also on the measures to be taken to mitigate the negative impacts of the factories.

11.2 Recommendations

With the aim of eradicating or mitigating the negative impacts of the fishmeal and fish oil industry in Mauritania, Senegal and The Gambia, the following five major recommendations have been put forward to decision-makers and their partners:

1. Regulate the capacity and activities of the fishmeal and fish oil industry;
2. Reduce post-capture losses usually transported to factories;
3. Create more employment opportunities for local communities;

4. Strengthen the policy of preserving and/or restoring small pelagic stocks;
5. Raise awareness among stakeholders.

To help guide the operationalization of the recommendations, the main actions to be taken and the potential implementers are presented in the table below (Table 4).

To help guide the operationalization of the recommendations, the main actions to be taken and the potential implementers are presented in the table below (Table 4).

Table 4. Key recommendations and guidelines for implementation

Recommendations	Actions to be implemented	Managers
Regulate the capacity and activities of the fishmeal and fish oil industry	<ul style="list-style-type: none"> Refrain from setting up any new fishmeal and fish oil plants Conduct an environmental audit to assess the level of compliance of all plants Relocate plants at least 5 km from residential areas Prohibit the use of fresh fish for the most consumed or overexploited species Equip factories with anti-odor filters and liquid and solid waste treatment equipment. Take preventive measures to protect factory workers against health risks Promote local investment in factories through corporate social responsibility (CSR). 	<ul style="list-style-type: none"> States States States, Manufacturers States Manufacturers Manufacturers States, Manufacturers
Reduce post-capture losses usually transported to factories	<ul style="list-style-type: none"> Install cold storage facilities at sites with high fish production and/or marketing. Better support artisanal processing to improve production capacity and quality Strengthen transport means and infrastructures to facilitate the sale of fish on national and sub-regional markets. 	<ul style="list-style-type: none"> States, Partners States, Partners States, Partners
Creating more job opportunities for local communities	<ul style="list-style-type: none"> Give priority to direct and indirect labor throughout the plant value chain. Direct factory production towards the development of national aquaculture and livestock sectors. Better develop local sectors of activity other than fishing (agriculture, livestock farming, trade, etc.) Strengthen local human capacities through education and vocational training 	<ul style="list-style-type: none"> Manufacturers States, Manufacturers States, Partners States, Partners,
Strengthen the policy of preserving and/or restoring small pelagic stocks	<ul style="list-style-type: none"> Reinforce surveillance and improve penalties for bad fishing practices Ensure compliance with regulatory mesh sizes and protection of nursery areas Introduce full and simultaneous biological rest on a sub-regional scale Reduce artisanal and especially industrial fishing pressure on a sub-regional scale. 	<ul style="list-style-type: none"> States, Local actors States, Local actors States, Local actors States, Local actors
Raising awareness among stakeholders	<ul style="list-style-type: none"> Strengthen communication on the major risks and impacts of the fishmeal and fish oil industry Draw attention to the state of stocks and the risk of collapse of small pelagic stocks. Raise awareness of the importance of fish in food security at national and sub-regional level. 	<ul style="list-style-type: none"> States, Research, Partners, Local actors, Media, etc.

References

- Avadí, A., Dème, M., Mbaye, A. et Ndenn, J. 2020. Fisheries value chain analysis in the Gambia. Report for the European Union, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375–804). 134 p. et annexes.
- Cashion, T., Le Manach, F., Zeller, D. et Pauly, D. 2017. Most fish destined for fishmeal production are food-grade fish. *Fish and Fisheries*, 18: 837–844.
- Corten, A., Braham, C-B. et Sadegh, A.S. 2017. The development of a fishmeal industry in Mauritania and its impact on the regional stocks of sardinella and other small pelagics in Northwest Africa. *Fisheries Research*, 186: 328–336.
- Einarsson M. I. et al., 2019. Nordic Centre of Excellence Network in Fishmeal and Fish oil. Report Matis 6-19 Mai 2019 ISSN 1670-7192 DOI: 10.5281/zenodo.3243334.
- FAO. 2001. Développement de l'aquaculture 1. Bonne pratique de fabrication des aliments aquacoles. FAO Directives techniques pour une pêche responsable n° 5, Suppl. 1. Rome. 58 p. (également consultable sur: www.fao.org/3/y1453f/y1453f.pdf).
- FAO. 2020a. La situation mondiale des pêches et de l'aquaculture 2020. La durabilité en action. Rome, 224 p. (également consultable sur: www.fao.org/3/ca9229fr/ca9229fr.pdf).
- FAO. 2020b. Report of the Working Group on the Assessment of Small Pelagic Fish Off Northwest Africa. Casablanca, Maroc, 8–13 juillet 2019. Comité des pêches pour l'Atlantique Centre-Est (COPACE). FAO Rapport sur les pêches et l'aquaculture n° 1309, Rome. 335 p. <https://doi.org/10.4060/ca9562b>.
- Fréon, P., Sueiro, J.C., Iriarte, F., Evar, O.F.M., Landa, Y., Mittaine, J.F. et Bouchon, M. 2014. Harvesting for food versus feed: a review of Peruvian fisheries in a global context. *Reviews in Fish Biology and Fisheries*, 2014. doi 10.1007/s11160-013-9336-4.
- Green, K. 2016. Fishmeal and fish oil facts and figures. *Seafish*, Décembre 2016. 33 p.
- Hecht, T. et Jones, C.L.W. 2009. Use of wild fish and other aquatic organisms as feed in aquaculture – a review of practices and implications in Africa and the Near East. In M.R. Hasan et M. Halwart (sous la dir. de). *Fish as feed inputs for aquaculture: practices, sustainability and implications*. FAO Document technique des pêches et de l'aquaculture n° 518, p. 130–157. Rome, FAO.
- Hua, K., Cobcroft, J.M., Cole, A., Condon, K., Jerry, D.R., Mangott, A., Praeger, C., Vucko, M.J., Zeng, C., Zenger, K. et Strugnell, J.M. 2019. The future of aquatic protein: implications for protein sources in aquaculture diets. *One Earth*, 1: 316–329.
- Mullon, C., Mittaine, J-F., Thébaud, O., Péron, G., Merino, G. et Barange, M. 2009. Modeling the global fishmeal and fish oil markets. *Natural Resource Modeling*, 22(4): 564–609.
- New, M.B. et Wijkström, U.N. 2002. Use of fishmeal and fish oil in aquafeed: further thoughts on the fishmeal trap. FAO Circulaire des pêches n° 975. Rome, FAO. 61 p.
- Péron, G., Mittaine, J.F. et Le Gallic, B. 2010. Where do fishmeal and fish oil products come from? An analysis of the conversion ratios in the global fishmeal industry. *Marine Policy*, 34(2010): 815–820.
- Tacon, A.G.J. et Metian, M. 2008. Global overview on the use of fish meal and fish oil in industrially compounded aquafeed: trends and future prospects. *Aquaculture*, 285: 146–158.
- Tarbiya, M.L.O. et Mouhamadou, F.O. 2011. Étude diagnostique de la filière de la farine et de l'huile de poisson en Mauritanie et au niveau international. IMROP, CSRP. 32 p.
- Thiao D. and Bunting S.W. 2022. Socio-economic and biological impacts of the fish-based feed industry for sub-Saharan Africa. FAO Fisheries and Aquaculture Circular No. 1236. Rome, FAO, Worldfish and University of Greenwich, Natural Resources Institute. <https://doi.org/10.4060/cb7990en>

Appendix 1 : Questionnaire 1 - Basic country sector data

Countries : Mauritania Senegal Gambia

Fill in the data below (last 5 years), indicating the data sources supplied.

Data to be filled in	2018	2019	2020	2021	2022	Data source
Number of active canoes						
Number of active ships						
Number of artisanal fishermen						
Total volume of landings AF						
Total value of landings AF						
Total volume of landings IF						
Total value of landings IF						
Volume of round sardinella landings						
Value of round sardinella landings						
Volume of flat sardinella landings						
Value of flat sardinella landings						
Volume of ethmalose landings						
Value of ethmalose landings						
Volume of sardine landings						
Value of sardine landings						
Number of wholesale fishmongers						
Number of retail fishmongers						
Number of processors						
Industrial processing volume						
Industrial processing value						
Artisanal processing volume						
Artisanal processing value						
Volume of exports						
Value of exports						
National consumption volume						
Per capita consumption						
Number of active flour/oil factories						
Number of inactive flour/oil factories						
Volume of fishmeal produced						
Volume of fish oil produced						

Note: AF = Artisanal fishing / IF = Industrial fishing

Give any potentially useful comments on these data

Appendix 2 : Questionnaire 2 – Interviews with factory directors/managers

1. Informations d'identification

Q101	Countries : Mauritania <input type="checkbox"/> Senegal <input type="checkbox"/> Gambia <input type="checkbox"/>
Q102	Factory name:
Q103	Factory location:
Q104	Year factory established:
Q105	Production capacity (volume of fish that can be processed per year:
Q106	Name of Manager:
Q107	Manager's contact details:
Q108	Legal form of factory : Sole proprietorship <input type="checkbox"/> Limited company <input type="checkbox"/> Cooperative <input type="checkbox"/> Limited liability company <input type="checkbox"/> other form other form <input type="checkbox"/>
Q109	Specify other legal form :

2. Démarche de mise en place et de contrôle de votre usine

Q201	Was an environmental and social study carried out prior to setting up the plant ? Pas du tout <input type="checkbox"/> Not at all <input type="checkbox"/> Partially <input type="checkbox"/> Don't know <input type="checkbox"/>
Q202	Justify :
Q203	If the study was carried out, was it made public? Not at all <input type="checkbox"/> Partially <input type="checkbox"/> Completely <input type="checkbox"/> Don't know <input type="checkbox"/>
Q204	Justify :
Q205	If restitution was made, were the communities' concerns taken into account? Not at all <input type="checkbox"/> Partially <input type="checkbox"/> Completely <input type="checkbox"/> Don't know <input type="checkbox"/>
Q206	Justify :
Q207	If the study was carried out, was a conformity check carried out after the factory was installed? Not at all <input type="checkbox"/> Partially <input type="checkbox"/> Completely <input type="checkbox"/> Don't know <input type="checkbox"/>
Q208	Justify :
Q209	Do the relevant departments monitor the factory's operation and activities? Not at all <input type="checkbox"/> Sometimes <input type="checkbox"/> Regularly <input type="checkbox"/> Don't know <input type="checkbox"/>
Q210	Justifiez :
Q211	Has the factory been subject to any sanctions during its existence? Never <input type="checkbox"/> Rarely <input type="checkbox"/> Regularly <input type="checkbox"/> Don't know <input type="checkbox"/>
Q212	Justify :
Q213	Does the factory organize consultations with local communities? Never <input type="checkbox"/> Rarely <input type="checkbox"/> Regularly <input type="checkbox"/> Don't know <input type="checkbox"/>

Q214	Justify :
Q215	Does the factory have mechanisms for resolving conflicts with communities? Not at all <input type="checkbox"/> Partially <input type="checkbox"/> Completely <input type="checkbox"/> Don't know <input type="checkbox"/>
Q216	Justify :

3. Production and marketing information

Q301	Where and how do you source your raw materials (fish) ?
Q302	What are the main species of fish you receive ?
Q303	What are the best production periods of the year, and why ?
Q304	What are the main destination countries for your flour ?
Q305	What are the main destination countries for your oil ?
Q306	Who buys your flour, and for what purpose ?
Q307	Who buys your oil, and for what purpose ?
Q308	What are the stages and procedures involved in selling your products ?

4. Potential risks for factory employees

What are the main risks for your employees?

Q401	Injuries: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q402	Justify :
Q403	Dust inhalation: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q404	Justify :
Q405	Smoke inhalation: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q406	Justify :
Q407	Absorption of toxic waste: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q408	Justify :
Q409	Exposure to high temperature: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q410	Justify :

Q411	Excessive working hours: No risk <input type="checkbox"/> Low risk <input type="checkbox"/> High risk <input type="checkbox"/> Don't know <input type="checkbox"/>
Q412	Justify :
Q413	How do you manage these main work-related risks?
Q414	Do your employees have health insurance? Yes <input type="checkbox"/> No <input type="checkbox"/>

5. Impact of the factory on the exploitation of fishery resources.

What do you think of your factory's contribution to the positive and negative impacts below?

Impacts positifs	
Q501	Recovery of post-capture waste: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q502	Justify :
Q503	Reduction in cases of poor fish sales: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q504	Justify :
Q505	Improvement in landed price of fish: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q506	Justify :
Q507	Job creation in factories: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q508	Justify :
Q509	Income generation of factory employees : No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q510	Justify :
Q511	Local and/or national tax payment: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q512	Justify :
Negative impacts	
Q513	Increase in fishing effort: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q514	Justify :
Q515	Increase in fishing of juvenile fish: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q516	Justify :
Q517	Scarcity of round sardinella: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q518	Justify :
Q519	Scarcity of flat sardinella: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q520	Justify :

Q521	Scarcity of ethmalose: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q522	Justify :
Q523	Scarcity of sardines: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q524	Justify :
Q525	Scarcity of other species : No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q526	Justify :

6. Impacts of the factory on the state of the environment

What do you think of your factory's contribution to the positive and negative impacts below?

Positive impacts	
Q601	Reduction in fish discards: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q602	Justify :
Q603	Reduced discharge of unsold fish on the beach: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q604	Justify :
Q605	Improvement of local sewage system: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q606	Justify :
Positive impacts	
Q607	Emission of toxic smoke: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q608	Justify :
Q609	Emission of toxic dust: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q610	Justify :
Q611	Emission of bad odor: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>

Q612	Justify :
Q613	Emission of loud noise: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q614	Justify :
Q615	Discharge of wastewater on the ground: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q616	Justify :
Q617	Discharge of wastewater in the sea/river: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q618	Justify :

7. Impacts of the factory on community well-being

What do you think of your factory's contribution to the positive and negative impacts below?

	Positive impacts
Q701	Support for the improvement of Health infrastructures: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q702	Justify :
Q703	Support for improving education infrastructures: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q704	Justify :
Q705	Support for improving transport infrastructures: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q706	Justify :
Q707	Better availability and/or quality of feed for aquaculture: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q708	Justify :
Q709	Availability/quality of feed for livestock: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q710	Justify :

Positive impacts	
Q711	Increase in conflicts between fishermen : No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q712	Justify :
Q713	Competition with fish processors : No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q714	Justify :
Q715	Competition with fishmongers: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q716	Justify :
Q717	Competition with fish consumers: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q718	Justify :
Q719	Conflicts with local populations: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q720	Justify :
Q721	Threat to public health: No impact <input type="checkbox"/> Low impact <input type="checkbox"/> High impact <input type="checkbox"/> Don't know <input type="checkbox"/>
Q722	Justify :

8. Measures to be taken to eradicate/reduce negative impacts

What do you think about the need to take the following measures?

Q801	Total ban on factories: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q802	Justifiez :
Q803	Freeze on current number of factories: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q804	Justifiez :
Q805	Ban on the use of fresh fish: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q806	Justifiez :
Q807	Ban on the use of the species most commonly consumed in the country: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q808	Justifiez :
Q809	Limitation of factory production volume: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q810	Justifiez :
Q811	Ban on exports of fishmeal and/or fish oil: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q812	Justifiez :
Q813	Relocation of factories away from residential areas: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q814	Justifiez :
Q815	Treatment of factory waste: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q816	Justifiez :
Q817	Reinforcement of factory control: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q818	Justifiez :
Q819	Application of the regulation: Not a necessity <input type="checkbox"/> Low necessity <input type="checkbox"/> High necessity <input type="checkbox"/> Don't know <input type="checkbox"/>
Q820	Justifiez :

Q821	What do you think about the possibility of using other protein sources other than fish ?
Q822	What recommendations would you like to make to decision-makers regarding fish-meal and fish oil production in the country ?

9. Basic factory data

	Indicators	2017	2018	2019	2020	2021	2022	2023
Q901	Number of permanent employees							
Q902	Number of non-permanent employees							
Q903	Number of domestic employees							
Q904	Number of foreign employees							
Q905	Number of artisanal canoes fishing for the factory							
Q906	Number of artisanal ships fishing for the factory							
Q907	Volume of fish processed (tons)							
Q908	Volume of flour produced (tons)							
Q909	Value of flour produced (.....)							
Q910	Volume of oil produced (tons)							
Q911	Value of oil produced (.....)							
Q912	Cost of fish purchased (.....)							
Q913	Amount of wages paid (.....)							
Q914	Amount of taxes paid (.....)							
Q915	Net profit generated (.....)							

Appendix 3: Questionnaire 3 – Survey of professional actors

1. Stakeholder profile

Q101	Questionnaire number :	
Q102	Date (format DD/MM/YY) :	
Q103	Countries : 1. Mauritania <input type="checkbox"/> 2. Senegal <input type="checkbox"/> 3. Gambia <input type="checkbox"/>	
Q104	Survey site : 11. Nouadhibou <input type="checkbox"/> 12. Nouakchott <input type="checkbox"/> 21. Saint Louis <input type="checkbox"/> 22. Cayar <input type="checkbox"/> 23. Bargny <input type="checkbox"/> 24. Joal <input type="checkbox"/> 31. Tanji <input type="checkbox"/> 32. bSanyang <input type="checkbox"/> 33. Gunjur <input type="checkbox"/> 34. Kartong <input type="checkbox"/>	
Q105	Actor's name (optional) :	
Q106	Actor's contact (optional) :	
Q107	Actor type : 1. Institutional agent <input type="checkbox"/> 2. Transformer <input type="checkbox"/> 3. Transformer <input type="checkbox"/> 4. Wholesale fishmonger <input type="checkbox"/> 5. Retailer fishmonger <input type="checkbox"/> 6. Other type <input type="checkbox"/>	
Q108	<i>If institutional agent, Name of institution :</i>	
Q109	Agent's function :	
Q110	<i>If fisherman, main fishing gear :</i> 1. Purse seine <input type="checkbox"/> 2. gillnet <input type="checkbox"/> 3. Passive net <input type="checkbox"/> 4. Other gear <input type="checkbox"/>	
Q111	Specify other fishing gear :	
Q112	<i>If processor, main product :</i> 1. Smoked fish <input type="checkbox"/> 2. Salted-dried fish <input type="checkbox"/> 3. Fermented fish <input type="checkbox"/> 4. Other products <input type="checkbox"/>	
Q113	Specify other products :	
Q114	<i>If wholesaler or retailer, main species marketed:</i> 1. Round sardinella <input type="checkbox"/> 2. Flat sardinella <input type="checkbox"/> 3. Ethmalose <input type="checkbox"/> 4. Sardine <input type="checkbox"/> 5. Other species <input type="checkbox"/>	
Q115	Specify other species :	
Q116	<i>If other type of actor, what is his/her activity :</i>	

2. Factory set-up and control policy

What do you think of the quality of the policy for setting up and controlling factories?

Q201	Environmental and social studies carried out prior to factory installation : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q202	Justify :	
Q203	Restitution publique des études environnementales et sociales : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q204	Justify :	
Q205	Prise en considération des préoccupations des communautés locales : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	

Q206	Justify :	
Q207	Contrôle de conformité et suivi des impacts des usines : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q208	Justify :	
Q209	Sanction des usines non conformes/réglementaires : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q210	Justify :	
Q211	Organisation de concertations avec les communautés locales : 1. Never done <input type="checkbox"/> 2. Sometimes done <input type="checkbox"/> 3. Always done <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q212	Justify :	

3. Impacts of factories on resource exploitation

What do you think of the following positive and negative impacts of the factories ?

	Positive impacts	
Q301	Recovery of post-capture waste: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q302	Justify :	
Q303	Reduction in cases of poor fish sales: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q304	Justify :	
Q305	Improvement in landed price of fish: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q306	Justify :	
Q307	Job creation in factories: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q308	Justify :	
Q309	Income generation for factory employees: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q310	Justify :	
Q311	Local and/or national tax payments: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	

Q312	Justify :	
Negative impacts		
Q313	Increase in fishing effort: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q314	Justify :	
Q315	Increase in fishing of juvenile fish: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q316	Justify :	
Q317	Scarcety of round sardinella: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q318	Justify :	
Q319	Scarcety of flat sardinella: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q320	Justify :	
Q321	Scarcety of ethmalose: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q322	Justify :	
Q323	Scarcety of sardines: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q324	Justify :	
Q325	Scarcety of other species : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q326	Justify :	

4. Impacts of factories on the environment

What do you think of the following positive and negative impacts of the factories?

Positive impacts		
Q401	Reduction of fish discards at sea: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q402	Justify :	

Q403	Réduction des rejets de poisson sur la plage : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q404	Justify :	
Q405	Amélioration du système d'assainissement local : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q406	Justify :	
Negative impacts		
Q407	Emission de fumée toxique : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q408	Justify :	
Q409	Emission de poussière toxique : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q410	Justify :	
Q411	Emission de mauvaises odeurs : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q412	Justify :	
Q413	Emission de bruit fort : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q414	Justify :	
Q415	Rejet d'eaux usées sur le sol : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q416	Justify :	
Q417	Rejet d'eaux usées dans la mer/fleuve : 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q418	Justify :	

5. Impacts of factories on community well-being

What do you think of the following positive and negative impacts of the factories ?

	Positive impacts	
Q501	Support for improved health infrastructures: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q502	Justify :	

Q503	Support for improving education infrastructures: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q504	Justify :	
Q505	Support for improving transport infrastructures: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q506	Justify :	
Q507	Availability/quality of feed for aquaculture: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q508	Justify :	
Q509	Availability/quality of feed for livestock: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q510	Justify :	
Negative impacts		
Q511	Increase in conflicts between fishermen: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q512	Justify :	
Q513	Competition with processors: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q514	Justifiez :	
Q515	Competition with fishmongers: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q516	Justify :	
Q517	Competition with consumers: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q518	Justify :	
Q519	CConflicts with local populations: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q520	Justify :	
Q521	Threat to public health: 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q522	Justify :	

6. Measures to be taken to eradicate/reduce negative impacts

What do you think about the need to take the following measures ?

Q601	Total ban on factories: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
------	---	--

Q602	Justify :	
Q603	Freeze on current number of factories: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q604	Justify :	
Q605	Ban on the use of fresh fish: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q606	Justify :	
Q607	Ban on the use of the most commonly consumed species: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q608	Justify :	
Q609	Limitation of factory production: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q610	Justify :	
Q611	Ban on four/oil export: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q612	Justify :	
Q613	Relocation of factories away from residential areas: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q614	Justify :	
Q615	Treatment of factory waste: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q616	Justify :	
Q617	Reinforcement of factory control: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q618	Justify :	
Q619	Enforcement of regulation: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q620	Justify :	
Q621	What do you think about the possibility of using other protein sources other than fish ?	
Q622	What recommendations would you like to make to decision-makers regarding fishmeal and fish oil production in the country ?	

Appendix 4: Questionnaire 4 – Survey of fish consumers

1. Consumer profile

Q101	Questionnaire number:	
Q102	Date (format Dd/MM/YY):	
Q103	Countries : 1. Mauritania <input type="checkbox"/> 2. Senegal <input type="checkbox"/> 3. Gambia <input type="checkbox"/>	
Q104	Survey site : 11. Nouadhibou <input type="checkbox"/> 12. Nouakchott <input type="checkbox"/> 21. Cayar <input type="checkbox"/> 22. Bargny <input type="checkbox"/> 23. Joal <input type="checkbox"/> 24. Saint Louis <input type="checkbox"/> 31. Sanyang <input type="checkbox"/> 32. Gunjur <input type="checkbox"/> 33. Kartong <input type="checkbox"/> 34. Tanji <input type="checkbox"/>	
Q105	Name of consumer (optional):	
Q106	Number of people over 5 years old in your household :	
	Importance of animal protein sources for the household :	
Q107	Fish : 1. No importance <input type="checkbox"/> 2. Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q108	Meat : 1. No importance <input type="checkbox"/> 2. Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q109	Poultry : 1. No importance <input type="checkbox"/> 2. Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q110	Eggs : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q111	Where do you usually buy fish ? 1. Local market <input type="checkbox"/> 2. Fish market <input type="checkbox"/> 3. Landing site <input type="checkbox"/> 4. Neighborhood retailers <input type="checkbox"/> 5. Other places <input type="checkbox"/>	
Q112	Specify other places :	
Q113	How often do you buy fish ? 1. Daily <input type="checkbox"/> 2. Weekly <input type="checkbox"/> 3. Monthly <input type="checkbox"/> 4. Irregular <input type="checkbox"/> 5. Other frequency <input type="checkbox"/>	
Q114	Specify other frequency :	
Q115	This year, approximately how much do you spend on fish per month ?	
	Importance of the products below in your purchases :	
Q116	Fresh fish : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q117	Smoked fish : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q118	Salted-dried fish : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q119	Fermented fish : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q120	Other products : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q121	Specify other products :	
	Importance of the origin of the fresh fish you buy :	
Q122	Sea-caught : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q123	River caught : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q124	Aquaculture : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	

Q125	Others : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q126	Specify others :	
Importance of the species below in your purchases :		
Q127	Round sardinella : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q128	Flat sardinella : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q129	Ethmalose : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q130	Sardine : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q131	Other species : 1. No importance <input type="checkbox"/> 2 Little importance <input type="checkbox"/> 3. Great importance <input type="checkbox"/>	
Q132	Specify other species :	

2. Potential impacts of fishmeal factories on fish consumption

Q201	Do you hear about fishmeal factories and their impacts? 1. Never <input type="checkbox"/> 2. Sometimes <input type="checkbox"/> 3. Often <input type="checkbox"/>	
What could be the impact of these factories in terms of:		
Q202	Scarcety of fresh fish? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q203	Justify :	
Q204	Increase in the price of fresh fish? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q205	Justify :	
Q206	Scarcety of processed fish? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q207	Justify :	
Q208	Increase in the price of processed fish? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q209	Justify :	
On which species might they have the greatest impact :		
Q210	Round sardinella? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q211	Justify :	
Q212	Flat sardinella? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	

Q213	Justify :	
Q214	Ethmalose? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q215	Justify :	
Q216	Sardine? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q217	Justify :	
Q218	Other species? 1. No impact <input type="checkbox"/> 2. Low impact <input type="checkbox"/> 3. High impact <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q219	Specify other species :	
Q220	Justify :	
To satisfy your household, what adaptive solutions could you adopt:		
Q221	Increase my budget for fresh fish? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q222	Justify :	
Q223	Increase my budget for processed fish? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q224	Justify :	
Q225	Increase the purchase of available/affordable alternative species? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q226	Justify :	
Q227	Increase meat purchase? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q228	Justify :	
Q229	Increase poultry purchase? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q230	Justify :	
Q231	Increase egg purchase? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q232	Justify :	

Q233	Adopt other solutions? 1. Not all <input type="checkbox"/> 2. Slightly <input type="checkbox"/> 3. Strongly <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q234	Specify these other solutions:	
Q235	Justify :	

3. Measures to be taken to eradicate/reduce negative impacts

What do you think about the need to take the following measures ?

Q301	Total ban on factories: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q302	Justify :	
Q303	Freeze on current number of factories: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q304	Justify :	
Q305	Ban on the use of fresh fish: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q306	Justify :	
Q307	Ban on the use of the most commonly consumed species: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q308	Justify :	
Q309	Limitation of factory production: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q310	Justify :	
Q311	Ban on flour/oil exports: 1. Not a necessity <input type="checkbox"/> 2. Low necessity <input type="checkbox"/> 3. High necessity <input type="checkbox"/> 9. Don't know <input type="checkbox"/>	
Q312	Justify :	
Q313	What recommendations would you like to make to decision-makers to improve the availability and accessibility of quality fish in the country ?	

