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Contribution of small-scale migrant fishing to the emergence of the fishmeal industry in West Africa: Cases of Mauritania, Senegal and the Gambia

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The objective of this article is to present the contribution of migrant fishers to the supply of fishmeal factories in Senegal, The Gambia and Mauritania. The method consisted first of identifying migrant fishers and then quantifying the volumes of small pelagic fish they catch in the three countries studied. Then, an interview guide was submitted to more than 250 actors (migrant fishers and fishmongers) met in Banjul and Serrekunda in the Gambia, in Nouakchott and Nouadhibou in Mauritania, and in the fishing, centers located on the small Senegalese coast. These individual and collective interviews made it possible to estimate and determine the share of migrant fishers' catches allocated to the fishmeal industry. Overall, the four groups of migrant fishers (3 Senegalese and 1 Guinean) identified in Mauritania and The Gambia catch on average more than 305,000 tonnes of pelagic fish per year over the period 2015 - 2018. Analysis of the marketing of their catches shows that almost 63% of the 305,000 tonnes, i.e. 192,000 tonnes of pelagic fish, are destined to supply the fishmeal factories of the three countries studied, while only 113,000 tonnes are distributed on the national consumer markets (fresh and artisanal processed). Of the 192,000 tonnes destined for fishmeal factories, two-thirds are sent to Mauritanian factories, with Senegal and The Gambia sharing the remaining third. Thus, important collaborations have been established in recent years between migrant fishers and the fishmeal industries. Indeed, the fishmeal industries improve the operating accounts of migrant fishers by ensuring the sale of their catches at more remunerative prices than on the local market at the micro level. However, when analyzed on a large scale, fishmeal industries exert a real pressure on the nutritional security of West African countries, as pelagic fish are the main source of animal protein in Senegal and The Gambia and have been over exploited in recent years. In addition, they prevent access to artisanal processing of their raw material. All these elements raise the question of the urgency of regulating migrant fishers catches on a regional scale and drastically reducing the share allocated to fishmeal processing in favor of local consumption.

KEYWORDS

fisheries, industry, policy, market, processing

1 Introduction

West African coastal countries are facing the rapid emergence of fishmeal and fish oil industries (FaillerFerraro, 2021b; Dème, 2018). This emergence is linked to strong demand from external markets¹ (Asian and European) and the availability of raw material, particularly small pelagic fish supplied by migrant artisanal fishers and national and foreign industrial boats (Failler et al., 2015a; Dème et al., 2021a). The catches by migrant artisanal fishers targeting pelagics in the Gambia and Mauritania are around 305,000 tonnes per year on average over the period 2015 - 2018 (Failler et al., 2020; Dème et al., 2021b). The catches of migrant fishers help to provide raw material for fishmeal factories in West Africa. This collaboration is remunerated at more attractive prices than those of the local market² (Failler et al., 2015a; Dème et al., 2022a; Dème and Failler, 2022b). This large quantity of small pelagics fed into fishmeal factories by migrant fishers represents more than half of the fish processed annually into fishmeal in Senegal, The Gambia and Mauritania (Ba et al., 2017; Greenpeace, 2021). Despite the emergence of fishmeal factories and the significant growth in the quantities of small pelagic fish processed for the benefit of the European and Asian markets, no market regulation policy has been initiated by the States and the regional commissions. As a result, the net supply of small pelagic fish has declined significantly. In the long term, small pelagic stocks are threatened, as well as the survival of women processors in the sector (largely dependent on small pelagics) (Allison and Ellis, 2001). Recent work by CEEFAF FAO has shown that the pelagic fish stocks in the northwest area are at unsustainable levels, fully exploited or overexploited depending on the species. They even recommend banning the use of sardinella for fishmeal processing. In addition, West African migrant fishers make 20% of the catches in the EEZs of coastal countries without this being explicitly considered in national statistics (Failler et al., 2020). In recent years, regional research projects acting on an *ad hoc* basis have made it possible to monitor statistics on the volumes caught by migrant fishers. Thus, without a clear vision of the volumes caught each year by migrant channels, coastal states cannot effectively engage in a process to limit the supply of fishmeal and fish oil factories on the local market.

The objective of this article is to quantify, for the first time, the volumes of small pelagic fish landed by the Senegalese and Guinean migrant fishers in the fishmeal industries of Senegal, The Gambia and Mauritania. The results are based on fieldwork with national research institutions in the three countries and with migrant fishers and fishmongers in order to gather unpublished information. The method consisted firstly of identifying the various migrant small pelagic fisheries sectors in Mauritania and The Gambia. Then, interviews were conducted with migrant fishers and fishmongers to

obtain the average percentage of catches destined for fishmeal factories. This work was carried out for each of the four sectors identified. By applying the fish/meal conversion ratio (4 kg of fish for 1 kg of meal), the quantity of meal from the annual supply of migrant fishers was determined. Finally, the results of this study and the scientific literature were used to discuss the issue of the emergence of fishmeal industries in West Africa and the consequences for the sustainability of small pelagic stocks and the nutritional security of developing countries.

This work differs from the recent recounting exercises of the catches of the migrant fishers carried out in 2012 (Failler and Binet, 2012). They were limited to quantifying the volumes and values of the catches of the migrant fishers. This work goes beyond this quantification, on the one hand, by updating the data on migrant fishers, and on the other hand, by estimating with the migrant fishers and the fisheries administrations of the countries the share destined for fishmeal plants. By updating data that were previously unknown and not associated with the issue of the transformation of small pelagic and migratory fisheries into fishmeal, it contributes to a better understanding of the issues.

The article is structured in four parts. The first part presents a review of migrant fishers in West Africa targeting small pelagics. The second part presents the research methodology. The third part presents the importance of small pelagic species in the three countries. It also presents the catch volumes of migrant fishers and the marketing of the products. Finally, the fourth part discusses the emergence of fishmeal industries in West Africa and their collaboration with migrant fishers. It concludes with recommendations for a better management of migrant fisher's catches, which should be oriented primarily towards the local market for the food security of West African populations and the sustainability of pelagic fish stocks.

2 Migratory small pelagic fisheries in Senegal, The Gambia and Mauritania

2.1 Characterization of the migrant fishery

Migrant fishing is an integral part of the West African fisheries landscape (Failler et al., 2020; Sall et al., 2021). Its importance has increased since the 1980s with the motorisation of pirogues, the use of isothermal boxes, and the loading of ice for fish conservation (Failler, 2020; Dème et al., 2021c; Binet et al., 2012). These technological developments have enabled fishers to acquire more powerful engines, increase the size of canoes, extend their stay at sea and exploit new fishing grounds. More recently, this migration is motivated by the depletion of marine resources in traditional fishing areas, migrant fishers and the availability of the resource in the host countries and the potential of their markets, both local and international (Dème et al., 2021c). Approximately 5,000 fishers from many nationalities are involved in migration in the seven countries of the Sub-Regional Fisheries Commission (SRFC) (Failler et al., 2020). Four migration departure points have been identified in the West African maritime space: Senegal, Guinea, Sierra Leone and Ghana (Failler et al., 2020; Dème et al., 2021c). Countries such as The Gambia, Mauritania and Guinea Bissau are

1 The external market receives frozen whole fish (without valorization), fishmeal (unfit for human consumption). Artisanal processing also supplies the African market (Mali – Burkina – Ivory Coast).

2 The local market receives fresh and artisanal processed small pelagics for human consumption.

the main host countries for migrant fishers (Dème et al., 2021b; Pierre and Ferraro, 2021; Failler et al., 2013). Sierra Leone and Guinea are both departure and reception countries for migrant fishers (Soumah et al., 2021).

Despite their significant roles to fisheries in the West African sub-Region, the catches of these migrant fishers are absent from various national statistics. Indeed, landing data collections in the West African countries does not consider the origin of the catches (Binet et al., 2012; Dème et al., 2021c). In this regard, Binet et al. (2012) mention that any fish landed is assimilated to a fish caught in the national EEZ. Finally, the attempt to set up a reliable national data collection system is challenged by the catches of unreported migrant fishers. This justifies the preliminary work of identifying and estimating the catch volumes of migrant fishers in the countries studied.

2.2 Identification of migratory small pelagic fish chains supplying fishmeal factories in Senegal, Mauritania and The Gambia

Recent work has identified more than 27 migratory pathways in the SRFC area targeting demersal, pelagic, ray and shark species (Tarbya et al., 2011; Dia, 2012; Failler et al., 2015b; Failler, 2020; Ly and David, 2021). Given that pelagics remain the raw material of the processing industries, the study focused on the migratory chains of small pelagics. Four types of migrant fishers³ are identified in the country's studies. (Mauritania, Senegal and The Gambia). Thus, Mauritania has two Senegalese small pelagic fisheries: the one established in Nouadhibou for fishmeal production factories and the one located in Nouakchott within the framework of the RIM-Senegal fishing agreement⁴ (Dia, 2012; Dème et al., 2021a). While the first group of migrant fishers has settled permanently in Mauritania and works exclusively for fishmeal factories, the second group is only present for one fishing season and landing their product on the Mauritanian and Senegalese markets. In the Gambia, two nationalities fishers targeting small pelagics are identified: they are Guinean and Senegalese migrant fishers (Jobe Ousmane, 2012; Dème et al., 2021a; Dème et al., 2021b).

³ The migrant fishers identified differ in terms of the conditions of access to the resources, the use and the destination of the production. In this study, we focused exclusively on migrant fishers who collaborate with the fishmeal industries by supplying them with all or part of their production.

⁴ Under the terms of the Convention on Fishing and Aquaculture of 25 February 2001 signed between Mauritania and Senegal, 400 pirogues are allowed to work under a free license paid at 80,000 CFA francs per pirogue per quarter. This is a reciprocal agreement that does not include financial compensation from the Senegalese state, with an obligation to land 25% of products in Mauritania (reduced to 15% in 2008). The revision of this agreement in 2008 made it possible to integrate other areas such as cooperation in research and training.

3 Methodology

3.1 Study framework

Located on the North-West African Atlantic coast, Senegal, The Gambia and Mauritania share a maritime border (Figure 1). With Exclusive Economic Zones (EEZs) known to be rich in fish, fishing activity remains very important in all three countries (Tarbya et al., 2011; Dème, 2018; Dème et al., 2021a; Dème et al., 2021b). Small pelagic fish that constitute the raw material for fishmeal factories are particularly exploited by both artisanal and industrial fisheries (Failler et al., 2013; Failler, 2014b). Indeed, the physical and biological characteristics explain the strong presence of small pelagics in the countries studied (Cury et al., 2000; Ba et al., 2017). Small pelagic fish species mainly caught in the various study countries are flat and round sardinella (*Sardinella aurita* and *maderensis*), horse mackerel (*Trachurus trachurus*), mackerel (*Scomber japonicus*), Ethmalosa (*Ethmalosa fimbriata*), and anchovy (*Engraulis encrasicolus*) (Ould Sidi, 2005; Diankha et al., 2018). These species exhibit high migratory characteristics and therefore move among the studied countries (Figure 1). Migrant fishers from Senegal tend to follow the migration route of these small pelagic species (Failler et al., 2020).

This explains why, over the past ten years, fishmeal industries have been gradually established on the West African coast, particularly in Mauritania, Senegal and the Gambia. According to information provided by the fisheries administrations, Mauritania, which had less than 3 factories in 2008, now has 41 functional factories with licences. The bulk of the factories are concentrated in Nouadhibou, numbering 33 compared to only 8 in Nouakchott. The number of factories is much lower in The Gambia and Senegal. The Gambia has 3 factories established on the sea front in Sanyang, Gunjur and Kartong. As for Senegal, the 9 factories that are counted are distributed between the centre (Dakar) and the small coast, precisely in Yenne and Joal (Avadi et al., 2018) (Figure 1).

3.2 Data source and analysis

3.2.1 Data on migrant fishing and the supply of fishmeal plants

Statistics on landings in Senegal, The Gambia and Mauritania do not specify the origin of catches. Any fish landed is considered as fish caught in the national EEZ (Failler, 2014a; Failler, 2020). Thus, national landings do not provide information on the volumes of catches made by migrant fishers. Data on migrant fishers were obtained through extensive fieldwork in the three countries studied between 2019 and 2021 within the framework of the project "Management and Resilience of Small Pelagic Fisheries in West Africa (GREPPAO)". The process of quantifying small pelagics caught by migrant fishers is based on indirect resource assessment. It first consisted firstly of identifying and locating the various migrant fishers established in The Gambia and Mauritania and targeting small pelagics. After this first identification stage, the volumes and values of the migrant fishers were estimated, as well as the marketing process of

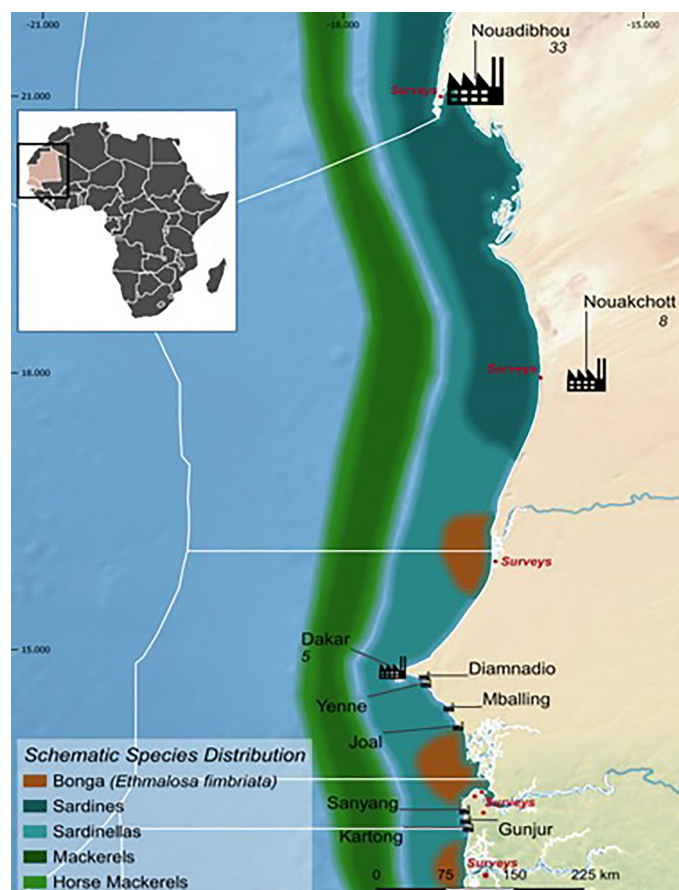


FIGURE 1

Distribution of small pelagics species and location of fishmeal factories in Senegal, Gambia and Mauritania⁵. (This distribution of small pelagics in Senegal, Mauritania and The Gambia has been done considering the opinion of the fishermen and the scientific literature). Source: Field surveys.

the products. The estimation was carried out with more than 155 migrant fishers interviewed between Senegal, The Gambia and Mauritania (Table 1). The idea was to have an estimate of the average catch per fishing unit and per trip. This average estimate multiplied with the average annual trips and the total number of fishing units⁶ made it possible to quantify the catches of small pelagics by migrant fishers. Thus, with 10 to 20 actors per research site, it was possible to establish the average estimate catches and trips (Table 1). Saturation was reached with almost the same orders of magnitude given by the migrant fishers. It should be noted that the fishery data here focus on the important small pelagic fish species that are industrially processed in the three countries studied, namely round sardinella (*Sardinella aurita*), flat sardinella (*Sardinella maderensis*) and *Ethmalosa* (*Ethmalosa fimbriata*).

To catch these species, Senegalese migrant fishers use gillnets and purse seines. As for the Guinean migrant fishers in Gambia,

⁵ The map is conceptualized based on information obtained on the distribution of small pelagic species in the three countries from the scientific literature. As there is no information on anchovy (*Engraulis encrasicolus*), its

⁶ It is the whole of the factors of production which allow the activity of fishing (fisher, canoe, engine and net).

they are more important during the cold season and are linked to the intensity of the upwelling at this period (Brahman et al., 2014).

Furthermore, the fishmeal factories do not break down the origin of the products they receive for processing (industrial boats or artisanal pirogues). Thus, discussions with more than 15 fishmeal industry managers were unable to establish an estimate of the quantities they receive from migrant fishers. This may also be related to the reluctance of the millers to share information on the quantities of fish processed into meal. Especially since in the three countries, protest movements against the fishmeal factory mills have been noted in recent years. Discussions were also held with 5 fisheries administrators to discuss the emergence of fishmeal factory in West Africa and its impact on the economy of the countries. On the basis of all this information, the supply of fish to fishmeal factories was estimated based on two mechanisms. First, various interviews with migrant fishers and fish traders in each of the countries studied were used to estimate the average percentage of purse seine catches destined for the fishmeal industries (some fishing units being bound by contractual agreements with the factories). Secondly, the proportion of landings from migrant fisheries purchased by the fishmongers and destined for the industries was also estimated. For this purpose, 80 fishmongers were interviewed. All these interviews were conducted both in Senegal and in the host countries of the

TABLE 1 Field survey process: research sites, number and profiles of actors interviewed, synthesis of the discussion.

	Actors meeting site	Number of actors (fishers and fish trader)	Actors profile	Discussion point
Senegal	Saint – Louis (Guet Ndar)	≥ 30	Wolof ⁷ and Lebou ⁸ migrant fishers practicing seasonal fishing in Mauritania.	Discussions focused on estimating the catch volumes of migrant fishers per fishing unit, as well as an estimate of the number of trips. On the basis of these estimates, the annual quantity of small pelagic fish caught was determined with the migrant fishers. In addition to this work on the estimation of catches, the interviews also focused on the marketing of the catches and the share destined for the meal industries. The issue of the challenges and impacts of supplying the fishmeal industries was also discussed with the migrant fishers. The micro-economic benefits were reviewed with the fishers
	Casamance	≥ 30	Diolas ⁹ migrant fishers from Casamance practicing seasonal fishing in Gambia	
Gambia	Grand Banjul	≥ 15	Diolas migrant fishers from Casamance	
	Serrekunda	≥ 15		
	Brikama	≥ 15	Soussou and Peuls migrant fishers from Guinea.	
Mauritania	Nouakchott	≥ 25	Wolof migrant fishers of Guet Ndar/ Lebou fisher of the small coast.	
	Port de Nouadhibou (EPBR)	≥ 25	Wolof migrant fishers of Guet Ndar/ Lebou fisher of the small coast.	

Senegalese migrant fishers. In Senegal, the migrant fishers and fishmongers were met in the fishing centres of Guet-Ndar (Saint-Louis, North of Senegal) and Casamance (South of Senegal). The migrant fishers we met put us in contact with fishmongers based in The Gambia who collaborate with the fishmeal factory. These

7 The Wolof's are a typical Senegambian ethnic group. They are the majority in Senegal where they represent almost half of the population and are the third place in Gambia with 15% of the inhabitants.

8 The Lébous are part of the Wolof community in Senegal. Traditionally fishers but also farmers, they are concentrated in the Cape Verde peninsula (Dakar) which they occupied when the first settlers arrived in the region.

9 The Diolas are a Senegalese ethnic group located mostly in the south of the country in Casamance.

fishmongers were met at various landing centres in The Gambia, including the market in Grand Banjul, Serrekunda and Brikama. In Mauritania, more than 80% of migrant fishers are based in Nouadhibou and work directly with the industry without intermediaries, so we met them at the artisanal fishing port of Nouadhibou (EPBR). The estimation of the catches and the supply of the factories was done through individual interviews and focus groups. The individual interviews and focus groups lasted on average more than two hours, with a total of 10 focus groups.

The individual and focus group interviews involved fishers and fishmongers. In all three countries, the work was often done in Wolof or French, except for the interviews with the Guinean community which were done in Soussou. The project focal point in Guinea conducted these interviews. Discussions with migrant fishers focused on their period of activity in the host countries' EEZs, the number of fishing trips (monthly estimate), the species targeted, the

fishing gear used, the quantities of fish caught (estimate per trip), the marketing of the catches, the share allocated to the fishmeal factories, the relations with the fishmeal factories (type of contract, selling price). The discussions with the fish traders concerned the estimation of the catches received from the migrant fishermen (per trip), the relations with the fish meal factories

3.2.2 Data analysis

The catches of the three species selected for the period 2015–2018 were used to obtain an annual average of the volumes caught by the migrant fishers. Thus, estimates of the quantities supplied annually to fishmeal factories were obtained from this average by supply segment (production and fishmonger's) and the average percentage obtained from surveys of migrant fishers and fishmongers. This calculation made it possible to estimate the quantities of fish that the migrant fishery allocates to processing plants. To get the quantity of fishmeal obtained from the supply of migrant fisheries, calculations were made based on the fish/fishmeal conversion ratio (it takes 4kg of fish for 1kg of fishmeal) (Avadi et al., 2018). This quantity subtracted from the total volume processed by the factories (obtained from the grey literature) provided the percentage contribution of migrant small pelagic fisheries to the supply of the fishmeal industry (Greenpeace, 2021; Greenpeace, 2019; Corten et al., 2017; Fréon et al., 2014). In addition, data collection from research institutions in the three countries provided a ten-year database (2009–2018) on national catches (artisanal and industrial fisheries), statistics on small pelagics and on foreign trade. These data allowed the calculation of net supply and per capita consumption of small pelagics for each country:

$$\begin{aligned} & - \text{Per capita theoretical availability of small pelagics} = \\ & (\text{Small pelagic production} + \text{Small pelagic imports} - \\ & \quad \text{Small pelagic exports}) / \text{population} \end{aligned}$$

4 Results

4.1 Small pelagic production in The Gambia, Senegal and Mauritania

Catches of small pelagics (*Sardinella aurita*, *maderensis* and *Ethmalosa fimbriata*) are becoming an increasingly large share of the total catch from 2009 to 2018¹⁰ in the three countries studied. In the Gambia, it represents an average of 39% of catches. The proportion is much higher in Mauritania and Senegal, where the share of small pelagics represents more than 71% of catches. The importance and evolution of the volumes of small pelagics caught differ from one country to another. The Gambia has the lowest catch volumes with an average of 22,300 tonnes of pelagics caught annually. The catch production of small pelagics was just below 18,000 tonnes in 2009, but increased to over 29,000 tonnes in 2017.

In Senegal, the catches fluctuate from year to year, with an average of 300,000 tonnes over the 2009 to 2018 period. The linear progression tends to be upwards. The lowest and highest production was recorded in 2010 and 2016 with 266,900 and 339,900 tonnes respectively. However, the curve of small pelagic catches has been rising without interruption from 2009 to 2016 in Mauritania. With a very high annual growth rate of 80% over the decade, the production of small pelagics has increased from 64,000 tonnes in 2009 to over 590,000 tonnes in 2018 (Figure 2).

Overall, catches of small pelagics are on the increase in all three countries, with increasing volumes of catches. In addition, in this area, 2 out of 3 fish caught are small pelagics.

4.2 Theoretical availability small pelagic species in Senegal, Mauritania and The Gambia

Small pelagics are the most consumed species in Senegal, Mauritania and the Gambia. In the Gambia and Senegal, the theoretical availability¹¹ of small pelagics fluctuates from year to year, with an overall downward trend. In Mauritania, the average theoretical per capita consumption is 9 kg for the 30,900 tonnes of supply on the local market. The lowest value of small pelagic theoretical consumption was recorded in 2009, at 6kg, and the highest in 2015 and 2016, at 10kg (Figure 3). It decreased in 2017 and 2018 from 8kg to 7kg respectively. In the Gambia, the fluctuation is much greater, with an average of 12kg and the lowest theoretical consumption recorded in 2013 at 10kg. It reached 16kg in 2017 due to a larger supply in previous years (35,600 tonnes). However, it dropped again to 11kg in 2018 (Figure 3). In Senegal, the theoretical consumption of small pelagic fish is continuously decreasing. Thus, it fell from 18kg in 2009 to 9kg in 2018. Thus, the market supply of small pelagics has decreased by 50% over a decade (Figure 3).

4.3 Production of migrant small pelagic fish and supply of fishmeal and fish oil plants

4.3.1 Production of migrant small pelagic fish in The Gambia and Mauritania

Senegalese seine nets¹² have been used almost all along the West African coast. By deploying the technology in Mauritania, there are

¹¹ (the theoretical or apparent availability of fish corresponds to the quantity of fish available on the market and accessible to local populations. In other words, the theoretical availability of fish in a country is its production plus its imports and minus its exports).

¹² A 'Senegalese' purse seine fishing unit consists of two pirogues, one small and one large. The small ones are generally between 12 and 14 metres in length with the seine on board, and the one with the crew is between 18 and 22 metres (Dia et al., 2012).

¹⁰ Small-scale and industrial fishing.

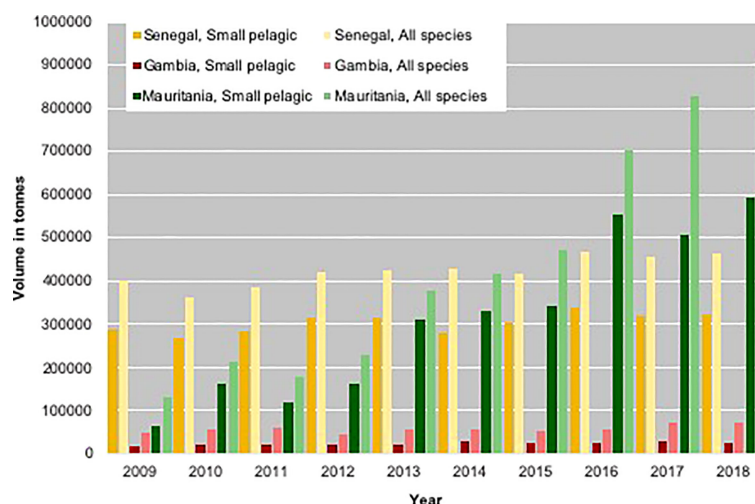


FIGURE 2

Total catches and share of small pelagics in Senegal, the Gambia and Mauritania. Source: GBOS, IMROP, CRODT. ¹This figure presents the total productions small pelagic (artisanal and industrial fisheries). Small pelagic in Senegal are exclusively exploited by artisanal fishing. While in The Gambia and Mauritania, they are exploited by the artisanal and industrial fishery.

now more than 200 purse seine units in Nouadhibou chartered by Mauritanian operators who own fishmeal factory production plants. They catch an average of 135,000 tonnes per year. The Senegalese small pelagic sector in Nouakchott established under the fisheries agreements between Senegal and Mauritania mobilises more purse seine units for larger catches. Indeed, the agreement authorises 400 purse seines to target mainly sardinella. The catches of the 400 purse seines are estimated on average at 150,000 tonnes according to surveys, i.e. three times the volumes fixed in the agreements, i.e. 50,000 tonnes. The Senegalese are also active in the Gambian EEZ (between 7 and 12 miles). With more than a hundred purse seines, they catch more than 13,600 tonnes of sardinella and bongas (*Ethmalosa fimbriata*). Finally, the Guineans also exploit small pelagics in the Gambia. More than 300 Guineans are registered and about 45 purse seines belonging to them allow them to catch nearly 7,000 tonnes annually. Overall, the purse seine units identified in The Gambia and Mauritania catch more than 305,000 tonnes of small pelagics annually.

4.3.2 Supply of fishmeal and fish oil plants divided by migrating small pelagic species

The flows of small pelagics to supply fishmeal factories are illustrated in the table above (Table 2). In terms of supply, Mauritanian factories receive more than two-thirds of the production of the migrant sectors. This is due to the large quantities caught by the Senegalese migrant small pelagic sector based in Nouadhibou, i.e. more than 135,000 tonnes destined exclusively for fishmeal factories. In addition, Senegalese migrant fishers operating in Mauritanian waters under the RIM-Senegal fishing agreement land more than 40% (i.e. 60,000 tonnes) of their catches in the fishmeal factories in Nouakchott. At the same time, these fishers only supply 10% (15,000 tonnes) to fishmeal factories in Senegal. About the Gambian migrant small pelagic sector provided by Senegalese migrant fishers, catches are distributed

both in Senegal and The Gambia. These products are distributed by Senegalese fish merchants on behalf of Senegalese factories or through contracts established directly with Gambian factories. Thus, of the 7,000 tonnes that Senegalese migrant fishers active in the Gambia catch on average each year, 40% (2,800 tonnes) are sent to Gambian factories and less than 20% (1,400 tonnes) to Senegalese factories. Finally, Guinean migrant fishers land more than 55% of these catches in Gambian factories, i.e. nearly 7,000 tonnes through Gambian fishmongers.

Overall, this figure (Figure 4) shows that of the 305,000 tonnes caught by the migrant small pelagic fisheries in The Gambia and Mauritania, more than 192,000 tonnes are used by the fishmeal industry and less than 113,000 tonnes end up on the local market or are shipped frozen to the external market.

5 Discussion and recommendations

The results showed that artisanal migrant fishers are an important supply mechanism for fishmeal factories along the Mauritanian, Gambian and Senegalese coasts. Fishers and fishmongers indicated many reasons for this finding. Firstly, the purchase prices of pelagic fish in the fishmeal factories are often 10 to 20 percent higher than the price offered on the local market by the fishmonger. In addition, fishmeal factories are less demanding on the quality and size of the species, which means that there is almost no discarding. Fish processed into meal are not subject to any particular sanitary control during their passage through the factory (Failler et al., 2015a). Furthermore, some of the shipowners we met claim to work exclusively for the fishmeal factories following the establishment of an annual work contract. These are all reasons why migrant fishers favour modern processing industries rather than the local market. Thus, it is deduced that the strong dynamic of collaboration existing between migrant fishers and

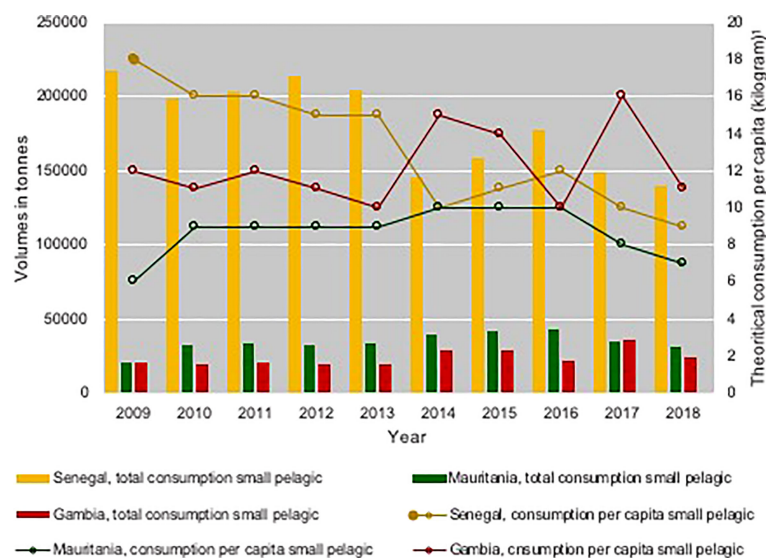


FIGURE 3

Theoretical Consumption of small pelagics in the Gambia, Mauritania and Senegal. Source: Data GBoS, CRODT, IMROP. ¹ Per capita theoretical availability of small pelagics = (Small pelagic production + Small pelagic imports - Small pelagic exports)/population.

TABLE 2 Estimation of annual catches of migratory small pelagic species in The Gambia and Mauritania over the period 2012 - 2018¹³.

Host countries of migrant fisher	Countries of departure of migrant fishers	Species	Number of purse seine units ¹	Estimated annual catch (tonnes)
Mauritania (Nouadhibou)	Senegal	Small pelagics	200 ²	135 000
Mauritania (Nouakchott)	Senegal		400 ³	150 000
Gambia	Senegal		100	13 600
Gambia	Guinea		45	7 000
		Total	745	305 600

Source: Field surveys.

¹Purse seine catches targeting mainly small pelagics can catch up to 30 tonnes per fishing trip.

²Information provided by the Mauritanian Institute of Oceanographic Research and Fisheries - IMROP

³The agreement between Mauritania and Senegal authorises more than 400 Senegalese pirogues to fish around 50,000 tonnes of sardinella. Field surveys show that three times that amount is fished with no monitoring noted. Most of the catches go to Mauritanian meal factories.

industrialists has favoured the emergence of fishmeal industries in West Africa.

The first fishmeal industry in West Africa was established in Mauritania in 2005 (Brahman et al., 2014). At first, the supply of the factories remained secondary compared to the supply of the consumer market. From the 2010's, the fishing industry in Mauritania became particularly complex and includes a large contingent of foreign operators. With the multiplication of Turkish, Chinese and, to a lesser extent, national and European investments, the fishmeal industry has started to drain increasing quantities of small pelagic fish into modern processing unfit for human consumption (Belhabib et al., 2015). Thus, in just one decade, Mauritania, through fishing agreements signed with

Senegal, in addition to the nationalisation of Senegalese boats, and agreements with Turkish industrial boats, has increased its production of small pelagics almost six-fold. This availability of raw material explains in part why rapid establishment of fishmeal factories in Mauritania was so quick. Thus, investments have increased at an average annual rate of almost 20%, from USD 90 million in 2013 to USD 349 million in 2018 (Imrop, 2019). Compared to Mauritania, Senegal and The Gambia are experiencing a timid development of fishmeal processing industries. Nevertheless, the activity is well established in both countries.

Overall, the option for Senegal, The Gambia and especially Mauritania to accompany foreign investment in fishmeal production is based on economic considerations by improving the contribution of the fisheries sector to the national economy (Bâ et al., 2017). Indeed, the fact that the production of small pelagics has been stimulated in the three countries studied, especially in Mauritania, has generated more jobs in the fisheries

¹³ The 2012-2013 data are from the work of Failler et al., 2020 on migrant fisher and their marketing. As for the 2015-2018 data, they were obtained in the field following the surveys.

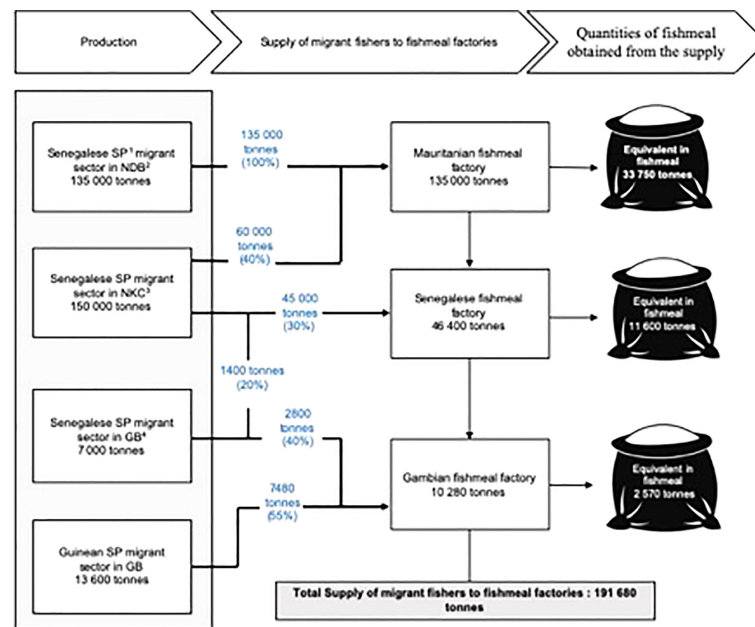


FIGURE 4

Estimated supply of small pelagics to fishmeal factories by migrant fishers over the period 2012 – 2018. Source: Field surveys. ¹SP, Small pelagic; ²NDB, Nouadhibou; ³NKC, Nouakchott; ⁴GB, Gambia.

sector, increased the trade surplus in fisheries products and resulted in a more substantial inflow of foreign currency. The Mauritanian Institute of Oceanographic and Fisheries Research - IMROP estimates the number of jobs generated by fishmeal factories at 1,200 (Imrop, 2019). In the Gambia and Senegal, more than 300 people are employed in the factories. This figure does not include the offshore jobs generated in the three countries, which are even higher but remain unintimated yet.

Over the decade 2009 - 2018, fishmeal accounted for about 15% of the total value of exported fishery products. In Senegal, the contribution of fishmeal exports is not significant, with an average of 3,000 tonnes of fishmeal exported each year, constituting only 2% of fishery product exports (dominated until now by frozen and fresh products). The economic benefits of fishmeal and fish oil factories in Mauritania, The Gambia and Senegal do not necessarily translate into social benefits for the population, as can be seen at present with the depletion of small pelagic fish and the consequences for food security in the three countries studied.

Small pelagic fisheries in Senegal, Gambia and Mauritania are reported to be overexploited (Curry et al., 2000; Chouvelon et al., 2015; Bâ et al., 2015). This situation combined with the unsuitable methods of processing of small pelagic fish poses a real threat to food security. In Senegal, individual consumption of small pelagics has been falling for a decade now to the point of being halved (18kg/pers/year in 2009 compared to 9kg/pers/year in 2018) (Dème et al., 2022a). This decrease in consumption is linked to the large quantities of small pelagics exported annually (clean or unfit for consumption). In Senegal, the quantities of fish exported are much higher than the quantities supplied on the local market. In The Gambia, the same problem arises with a local availability of fish that

is gradually decreasing (Acosta-Alba et al., 2022). This explains that there are large fluctuations in individual consumption of small pelagics. Individual consumption hides many disproportionalities between urban and rural populations. Indeed, field surveys reveal that logistical problems which includes poor cold infrastructure, precarious fish transport conditions and difficulties to access to certain areas are the contributing factor of reduction in fish consumption in rural areas (UNCTAD, 2014; Dème, 2018). This points to a serious supply deficit of small pelagics in The Gambia. Despite the bigger supply of small pelagics in recent years, because a large proportion of those catches are being processed for fishmeal, the country's national supply of fish for consumption purposes compromised, as are its exports of frozen products. Moreover, Mauritania is the main supplier of small pelagics to ECOWAS countries such as Côte d'Ivoire, Mali and Nigeria. Despite the bigger supply of small pelagics in recent years, its national supply is compromised, as are its exports of frozen products. Consequently, the processing of fishmeal and fish oil to feed aquaculture in Asia and Europe seriously compromises the food security of West African countries. The redeployment of fishing effort from the fishing units that supplied the consumer market to the fishmeal industries is a credible hypothesis of the consequences of the fishmeal industry on food security. Pelagic fish are strategic resources that are generally accessible at prices in line with the low incomes of African populations. This justifies the fact that in Senegal and The Gambia, pelagics provide an average of 65% of animal protein requirements (Tacon and Metian, 2018; Dème et al., 2019). This strategic importance should now lead West African countries to reflect on a mechanism for domiciling pelagic resources on a regional scale and to prioritise human consumption. To this

end, in-depth work must now be undertaken in the three countries studied in order to define a national policy on the net supply of fishery products in which the supply of fishmeal factories will be considered in the same way as fishing agreements, i.e. as a means of disposing of the surplus needed to meet the population's needs (Failler, 2015). This requires the integration of migratory fishing into the management of fisheries resources at the sub-regional level in order to control the quantities and the supply chains related to migrant fisheries

6 Conclusion

The Senegalese and Guinean migrant small pelagic fish sectors make a decisive contribution to the supply of fishmeal factories in Mauritania, Senegal and the Gambia. More than two thirds of their catches, i.e. 192,000 tonnes, are sent to Mauritanian, Senegalese and Gambian fishmeal factories and less than a third to their consumer market. Thus, like the sedentary small pelagic fisheries in the three countries studied, the migrant fishers are actively involved in the development of the fishmeal production sector in West Africa. For migrant artisanal fishers, the fishmeal factory market is more remunerative than the consumer market and less demanding in terms of product quality. For all these reasons, the consumer market for small pelagic fish is absorbing less and less pelagic fish to the benefit of industrial processing (unfit for consumption), which is constantly growing. The primary consequence of this is an overall drop in the consumption of small pelagic fish per person in the three countries studied. In addition, the supply of the artisanal processing segment has also been steadily declining over the decade 2009 - 2018.

Thus, if the positive impacts of fishmeal factories are the improvement of the operating accounts of the seiners, the creation of jobs and the contribution to the economy of the countries, the negative impacts are much more important. These negative impacts include the threat to the nutritional security of SRFC countries, given the important role of pelagic fish in their diet. In the artisanal processing segment, thousands of jobs are threatened, and the sustainable livelihoods of women processors are jeopardised due to the lack of raw materials. These threats must lead the SRFC countries to establish a regulatory framework for migrant fishers and public policies for the marketing of catches from this fishery.

Such policies should first be based on a good knowledge of the volumes of fish caught and landed in the different countries, complicated by the mobile aspect of migrant fishers. Then, they must commit to regulating the market so that only surplus production is supplied to the fish factories. In this way, migrant fisheries will no longer be at the disposal of foreign companies for non-food processing, but rather a central food security mechanism of the SRFC countries in addition to the national fisheries. The challenge is to satisfy an ever-increasing demand for fishery products in West African countries due to their high population growth.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

ED: Conceptualization, coordination of data collection, methodology, writing - review & editing. MD: Writing - original draft, data collection, methodology, formal analysis. BA: Writing - review & editing. PF: Writing - review & editing, funding acquisition. WB: Writing - review & editing. GT-G: Writing - review & editing. ID: Data collection in Senegal and The Gambia. AF: Data collection in Senegal and The Gambia. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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