



Growth Without Guardrails:

The UN's aquaculture policy is undermining food security

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This report was researched and written by the Changing Markets Foundation.

www.changingmarkets.org

Design: Pietro Bruni - www.toshi.ltd



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Women fish processors in Mbao, Senegal, Credits: Famara Dieng/ILO

Executive summary

The Food and Agriculture Organization of the United Nations (FAO) was founded after the Second World War with a clear mandate: to raise levels of nutrition, improve access to food, conserve natural resources and help free humanity from hunger. It is promoting major expansion of aquaculture as a means of advancing food security, nutrition and climate action—but without establishing adequate safeguards to ensure that this growth supports those objectives. The FAO climate roadmap calls for at least 75% growth in global ‘sustainable aquaculture’ production by 2040 compared with 2020. Because FAO’s policies shape what governments, development banks, donors and businesses accept as sustainable, its target will influence aquatic food systems, food security, fishing livelihoods and the health of marine ecosystems for decades to come.

This report finds that FAO is promoting aquaculture growth without guardrails. Its roadmap and subsequent Guidelines for Sustainable Aquaculture (GSA) fail to distinguish between fundamentally different production systems or constrain the expansion of feed-intensive and

environmentally damaging forms of aquaculture. Crucial protections addressing nutrition and competition between aquafeed and human food were also removed from the guidelines. Without reform, FAO's expansion agenda risks contradicting its founding mission by increasing pressure on wild fisheries, diverting nutritious fish away from people and exacerbating food insecurity, especially for the most vulnerable in Africa and Asia, who rely on small fish as an important source of nutrition.

Aquaculture is the world's fastest-growing food-production sector. It now produces more than half of the aquatic animals (fish, crustaceans, molluscs including cephalopods) consumed worldwide and is expected to drive most future growth in production. In 2024, the global trade value of farmed and wild-caught finfish, algae, crustaceans and molluscs reached \$183.1 billion. This was only about 1% below the combined \$185.3 billion trade in beef, pork and chicken. In fact, aquatic foods represent a significant portion of the global food economy - approaching both global poultry and meat production in tonnes per year.

But aquaculture is not a single production model. It ranges from non-fed and low-trophic systems, such as mussels, oysters and seaweed, which require few external inputs and can provide ecological benefits, to intensive farming of salmon, sea bass, sea bream and shrimp, which relies on manufactured feed containing wild-caught fish, soy and other agricultural commodities. These systems have fundamentally different implications for food security, climate, biodiversity and resource use. Although FAO acknowledges this diversity, its push for growth does not translate these differences into clear priorities governing which production systems should expand.

While FAO says aquaculture expansion should be 'sustainable', neither its roadmap nor the GSA explains which species and production systems should deliver the additional production, how much feed and wild fish that growth could require or which forms of aquaculture should not expand.

To map the potential consequences, Changing Markets worked with world-class fisheries scientists at the Institute for the Ocean and Fisheries at the University of British Columbia to model different pathways to FAO's 2040 target. The results show that the outcome depends on which species expand and how they are fed. If recent trends continue, aquaculture's demand for wild fish would rise by 85-88%, reaching the equivalent of 29-38% of the entire global wild catch recorded in 2020. If growth is concentrated in feed-intensive species, demand could more than double, requiring the equivalent of nearly half the world's annual wild catch. By contrast, reducing the amount of fishmeal and fish oil used in feed, while directing more growth towards species that require little or no wild fish, could allow aquaculture production to grow while reducing aquaculture's demand for whole wild fish by up to 16-17% below 2020 levels.

Aquaculture's hunger for fishmeal and fish oil has already grown dramatically. FAO data shows that its share of global fishmeal use rose from around 10% in 1980 to around 90% in 2024, while its share of fish-oil use increased from roughly 1% to 63%. Claims that the sector has grown without requiring more marine ingredients therefore obscure a fundamental shift: aquaculture has become the overwhelmingly dominant consumer of a finite supply, and under current growth patterns its absolute demand for wild fish is set to continue rising.

This pattern is already visible among major salmon producers: an assessment by FAIRR in 2025 of the world's seven largest publicly listed salmon producers showed that five of the seven companies examined increased their absolute use of fishmeal or fish oil made from whole fish between 2020 and 2024- some by as much as 39%.

Financial analysts advising the industry are explicit about the resulting scarcity. Rabobank warns that rising aquaculture demand is colliding with 'stagnant marine ingredient availability', with fishmeal shortages potentially emerging as early as 2028 and fish-oil scarcity intensifying throughout the decade. The modelling commissioned for this report examines the underlying demand pressure: it shows how continued growth in feed-intensive species could sharply increase aquaculture's requirement for wild fish, while a more diversified pathway could reduce it.

Of fish destined for other uses, primarily fishmeal and fish oil (FMFO), 90% has been classified as suitable for human consumption. These smaller pelagic fish are rich in protein, essential fats and micronutrients. Feeding wild fish to farmed aquatic animals can result in less fish coming out than is taken from the ocean. Recent research estimated that, depending on how the calculation is made, producing 1kg of fed farmed output could involve the death of as much as 1.78kg of wild fish. A 2024 study of Norwegian salmon production found eating wild feed fish directly yielded more food value than the salmon for six of nine key nutrients: salmon fillets retained only 18% of their calcium, 25% of their iodine and less than 75% of their iron, omega-3, vitamin B12 and vitamin A. Converting fish to FMFO and using these to feed farmed animals can convert nutritious and affordable food into a smaller quantity of generally higher-priced seafood, while losing nutrients in the process.

The consequences are already visible. In Senegal, an important West African FMFO production hub, feed factories compete for the same small pelagic fish that support

local diets, artisanal fisheries and women-led processing livelihoods. Women are central to these local value chains: they buy fish landed by artisanal fishers, then smoke, dry, process and trade it through local and regional markets, making nutritious fish affordable and accessible far beyond the coast. When factories outbid them for increasingly scarce fish, the effects extend beyond lost income: they weaken local food distribution and household food security. Per capita consumption of small pelagic fish in Senegal halved between 2009 and 2018, while growing volumes of wild fish were diverted into fishmeal and fish oil. Although FMFO production was not the only cause, it greatly intensified competition for dwindling supplies of affordable fish. More farmed seafood produced for distant and wealthier markets cannot compensate communities for losing local access to nutritious fish.

Across West Africa, Changing Markets and Greenpeace Africa previously estimated that more than half a million tonnes of fish capable of feeding over 33 million people annually were instead being reduced into fishmeal and fish oil, largely for farmed fish and livestock production in Europe and Asia.

Although voluntary, FAO's Guidelines for Sustainable Aquaculture, published in 2025, represent the first global policy instrument dedicated entirely to aquaculture governance. This report tests whether the GSA are consistent with wider food-security and human-rights frameworks and FAO's own mandate. The UN Special Rapporteur on the Right to Food, Michael Fakhri, urged states to exercise "great caution" where industrial aquaculture intensifies ecological pressure or undermines local food systems. UN Special Rapporteur on Climate Change Elisa Morgera has similarly warned that using nutritionally valuable fish for industrial feed raises "serious human rights concerns" about declining access to food. Yet the GSA promotes growth without acknowledging that people's access to nutritious fish must come before industrial demand for fish feed.

Through a forensic analysis of FAO guidance, successive GSA drafts and discussions surrounding a 2023 workshop on fishmeal and fish oil co-organised by the FAO and the fish feed industry, this report shows that the absence of guardrails was not simply an oversight. Earlier drafts of the GSA contained safeguards addressing the nutritional effects and food security implications of aquaculture trade and competition between aquafeed ingredients and human food. These protections disappeared from the final guidelines without any explanation. In their place, the GSA emphasises efficiency, innovation, mitigation and feed optimisation - approaches that permit continued expansion and closely mirror narratives advanced by the FMFO and aquaculture industries. Our analysis reveals a clear policy drift towards a framework more compatible with the aquaculture industry precisely as stronger protections disappeared.

Norway's role runs through this shift in framing. As the world's leading salmon producer, it supported the formative work on the GSA and a Norwegian fisheries official chaired the expert consultation that shaped their development. Norwegian government funding also supported 2022 FAO research exposing the conflict between FMFO production and human food needs in West Africa and a subsequent workshop convened to address it. Yet the later process moved away from the food-first limits recommended by the Norway-funded FAO study and towards a compromise framework that combined protections for direct human consumption with an accepted role for a continued "responsible" FMFO industry. Norway therefore helped shape the guidelines' growth-oriented context as well as a parallel process through which a documented food-security conflict was reframed as something to be managed within continued FMFO production. Low-trophic and non-fed aquatic foods can contribute to nutrition with far lower resource demands, yet the GSA places these fundamentally different production models within the same broad growth framework.

Further growth in feed demand would fall on already stressed and increasingly climate-vulnerable fisheries. More than a third of assessed marine fish stocks are fished at biologically unsustainable levels. Recent El Niño disruption in Peru - a major global supplier of fish feed - demonstrates how quickly climate shocks can translate into global feed scarcity. Global anchovy production was reported to have fallen by as much as 40% year on year in 2026, while anchovy prices rose by 80% to an all-time high. Expanding feed-intensive aquaculture while remaining dependent on finite wild fish resources increases risks not only for marine ecosystems and food security but the industry itself.

If FAO is to remain aligned with its founding mandate, future aquaculture policy must move beyond broad expansion targets and efficiency metrics. It should place food security, human rights and ecological limits at the centre of decision-making. FAO should ensure that any targets for aquaculture growth focus on non-fed and low-trophic aquatic foods. Locally sourced fish should be prioritised for direct human consumption, with investment towards appropriate processing, storage and distribution that keep nutritious fish accessible and affordable where it is important to local diets, while supporting women processors and traders. FAO should also set a clear direction towards reducing and ultimately eliminating edible wild fish from aquafeeds. Finally, FAO should also promote plant-based foods and proteins as lower-impact pathways to better nutrition, adapted to local needs and contexts.

Without such reforms, the modelling warns of the negative consequences that the expansion of extractive aquaculture could bring: intensifying pressure on vulnerable wild-fish stocks, diverting nutritious and affordable fish from people and small-scale fishing communities and leaving fundamental questions of access, equity and resource allocation sidelined.

Glossary

Aquatic animals: Fish, crustaceans and molluscs, including cephalopods. The term excludes seaweed and other algae. This distinction matters because some FAO aquaculture totals include algae while others refer only to aquatic animals.

By-products and trimmings: Heads, frames, skins, offcuts and other materials remaining after fish processing. These materials can be converted into fishmeal and fish oil. Classification as a by-product does not by itself establish that the source fishery or processing system is sustainable.

Capture fisheries: The harvesting of free-ranging aquatic animals from oceans, coastal areas and inland waters, as distinct from aquaculture.

Carnivorous aquaculture: The farming of species that naturally consume other animals, including salmon, trout, sea bass and sea bream. These species are supplied with manufactured feed and have historically depended heavily on fishmeal and fish oil. Although modern feeds also contain crops, animal by-products and other ingredients, carnivorous species remain among aquaculture's most significant users of marine ingredients.

Fed aquaculture: Aquaculture in which farmed animals are supplied with externally produced feed. It includes species with very different diets and impacts, from carp and tilapia to salmon, shrimp and marine finfish. Fed aquaculture is therefore a broad category and is not synonymous with carnivorous aquaculture.

Feed-intensive aquaculture: Aquaculture systems that depend substantially on externally supplied manufactured feed and feed ingredients. In this report, the term principally concerns salmon, shrimp, marine finfish and other farmed species whose expansion could increase absolute demand for fishmeal and fish oil. The category is broader than carnivorous aquaculture because some omnivorous species, including shrimp, can also be feed-intensive.

Fish in: fish out ratio (FIFO): An estimate of the quantity of wild fish used through fishmeal and fish oil to produce a given quantity of farmed aquatic animals. Results vary depending on feed-conversion and marine-ingredient inclusion rates, reduction yields, treatment of by-products and how fishmeal and fish oil produced from the same fish are counted.

Fishmeal and fish oil (FMFO): Protein- and oil-rich ingredients produced from whole fish or fish-processing by-products. They are used primarily in animal feed—particularly aquaculture feed—as well as in livestock feed, pet food and fish-oil supplements.

Low-trophic aquaculture: The farming of organisms situated low in the aquatic food web, including seaweed, mussels, oysters and other bivalves. These organisms generally require fewer external resources than fed finfish and crustaceans and may provide ecosystem services such as nutrient removal or habitat creation. ‘Low-trophic’ describes an organism’s position in the food web, while ‘unfed’ describes whether it receives manufactured feed; the terms overlap but are not identical.

Marine ingredients: Ingredients derived from marine organisms and used in feed or other products. In this report, the term primarily refers to fishmeal and fish oil produced from whole wild fish or fish-processing by-products.

Reduction fisheries: Fisheries in which some or all of the catch is processed—or ‘reduced’—into fishmeal and fish oil rather than sold directly as food. Many reduction species also have actual or potential direct human-food markets.

Small pelagic fish: Small fish living mainly in the open water column, including sardines, sardinella, anchovies, herring and bonga. They are important as affordable human food and as prey within marine food webs but are also widely used to produce fishmeal and fish oil.

Unfed or non-fed aquaculture: Aquaculture in which farmed organisms obtain their nutrition from the surrounding environment rather than receiving manufactured feed. Examples include mussels, oysters and other filter-feeding bivalves, as well as seaweed. This report uses ‘unfed aquaculture’ as the preferred term.

Whole fish or whole wild fish: Wild-caught fish used directly to produce fishmeal and fish oil, in contrast to FMFO produced from material left after fish have first been processed for human consumption.

Whole wild fish equivalent (WWFE): An estimate of the live weight of whole wild fish required to supply a given quantity of fishmeal and fish oil. It enables absolute marine-resource demand to be assessed alongside efficiency ratios. It is a calculated equivalent, not necessarily the exact quantity caught for a particular product.



Fish aisle selling salmon at a London supermarket

1. FAO's aquaculture growth agenda: a target without guardrails

1.1 When more production became the answer to hunger

The founding mandate of the Food and Agriculture Organization of the United Nations (FAO) is not neutral about the purpose of food systems. Created in 1945, in the shadow of the food crises that followed the Second World War, FAO was founded on the principle that food systems exist first and foremost to nourish people. Its constitution commits the organisation to raising levels of nutrition and standards of living, improving the production and distribution of food and agricultural products, bettering the condition of rural populations and conservation of natural resources.¹ The constitution expressly includes fisheries and marine products within this mandate.

Aquaculture is the world's fastest-growing food-production sector. More than half - 59% - of the seafood consumed globally by volume now come from

aquaculture rather than catching free-ranging, wild aquatic fish, or 'capture fisheries', and FAO projects that the sector will drive most future growth in aquatic food production.² However, this growth has not been evenly distributed across production systems. Over recent decades, fed aquaculture has expanded far more rapidly than unfed systems, accounting for roughly three-quarters of global aquaculture animal production in 2024. As a result, questions about feed ingredients, marine resource use and competition between food and feed have become increasingly central to debates about the sustainability of aquaculture expansion.

Aquaculture simply means the farming of aquatic organisms, including fish, crustaceans, molluscs and other animals and algae like seaweed. However, not all aquaculture is alike: some systems, such as mussels, oysters and seaweed, require little or no external feed to grow, while others - like fish including salmon, sea bass, sea bream, shrimp and tuna - rely on manufactured feeds that can contain fishmeal, fish oil, soy and other agricultural inputs.

FAO's Blue Transformation agenda and climate roadmap, Achieving SDG 2 without breaching the 1.5°C threshold: A global roadmap, envision major growth in global aquaculture production, including a target of at least 75% growth by 2040. In Africa, FAO has argued that aquaculture output must rise substantially simply to maintain current per capita consumption of aquatic foods as populations grow.³

FAO's public messaging around its 2024 Guidelines for Sustainable Aquaculture (GSA), the first global policy instrument on aquaculture, includes aquaculture as part of its hunger and nutrition mandate. The organisation describes aquaculture as vital for food security and nutrition and presents the GSA as contributing to better production, better nutrition, a better environment and a better life.⁴

This vision did not emerge with the GSA. In the influential 2015 paper Feeding 9 Billion by 2050 - Putting Fish Back on the Menu, Manuel Barange (then Director of Science at the UK-based Plymouth Marine Laboratory), senior FAO aquaculture official Rohana P. Subasinghe and their co-authors identified aquaculture as having the greatest potential to meet growing demand for aquatic foods.⁵ Barange joined FAO the following year and subsequently became its leading fisheries and aquaculture official - and the most prominent public advocate of its aquaculture-growth agenda.

This growth agenda is reinforced by an increasingly reassuring public narrative about the availability of wild fish. In a 2026 FAO interview, Barange answered the question "Are we running out of fish?" with "the short answer is no". He pointed to estimates that total fish biomass is approximately 12 times human biomass, described global capture volumes as broadly constant since the late 1980s and characterised fish as a renewable "gift from God that keeps on coming". Although he acknowledged that oceans have limits and that sustainability cannot be taken for granted, his framing reduces questions of stock health, ecological limits and competing claims on fish to a reassuring global picture of abundance.⁶

In the same interview, Barange suggested that negative fisheries stories are amplified because the media prefer 'inflammatory negative stories' and because people with 'their own agendas' selectively use supporting information.

Stable global catches do not, however, mean that fleets are catching the same quantity from the same healthy stocks with the same amount of effort. One global assessment found that the fishing fleet more than doubled between 1950 and 2015 - from 1.7 million to 3.7 million vessels - while catch per unit of effort fell by more than 80%. Put simply, more than twice as many vessels were chasing fish while

bringing back dramatically less for the amount of time and fishing gear involved.⁷ Another study found that global fishing power increased approximately tenfold from the 1950s, while the catch obtained for an equivalent unit of fishing power roughly halved.⁸

Global fishing catch reconstructions estimated that actual marine catches were approximately 50% higher than reported to FAO and, after peaking in 1996, declined by an average of 1.22 million tonnes annually - more than three times the decline visible in official data.⁹ The stable global catches narrative therefore refers only to reported landings; it does not show that fish populations are stable or that fisheries can sustain additional pressure.

FAO's broader conviction that aquaculture expansion is necessary to feed the world would later become central to the FAO's Blue Transformation agenda and its road-map for achieving food security within planetary boundaries, including a target of increasing sustainable aquaculture production by 75% by 2040.

But aggregate growth targets obscure a more important question: what kind of aquaculture is expanding, what resources does it depend on, and who benefits from the resulting fish production?

Aquaculture has not replaced capture fisheries so much as become increasingly intertwined with them through the demand for feed. While fishmeal and fish oil (FMFO) inclusion rates have declined in some farmed species, total demand for marine ingredients has remained high - and the pressure will keep growing as production volumes expand. In 2024, more than 18 million tonnes of aquatic animals - one-fifth of the global wild catch - were reduced into fishmeal and fish oil, accounting for the vast majority of fisheries and aquaculture production used for

non-food purposes.¹⁰ That means one in every five tonnes of fish caught from the wild is turned into FMFO - most of which is used to feed other fish. An earlier global study, based on marine fisheries landings from 1950 to 2010, found that around 20 million tonnes of fish a year was destined for uses other than direct human consumption, of which approximately 18 million tonnes went into fishmeal and fish oil. It found that 90% of the fish diverted to non-food uses were species suitable for human consumption.¹¹

1.2 What wild-fish dependent aquaculture takes from oceans and people

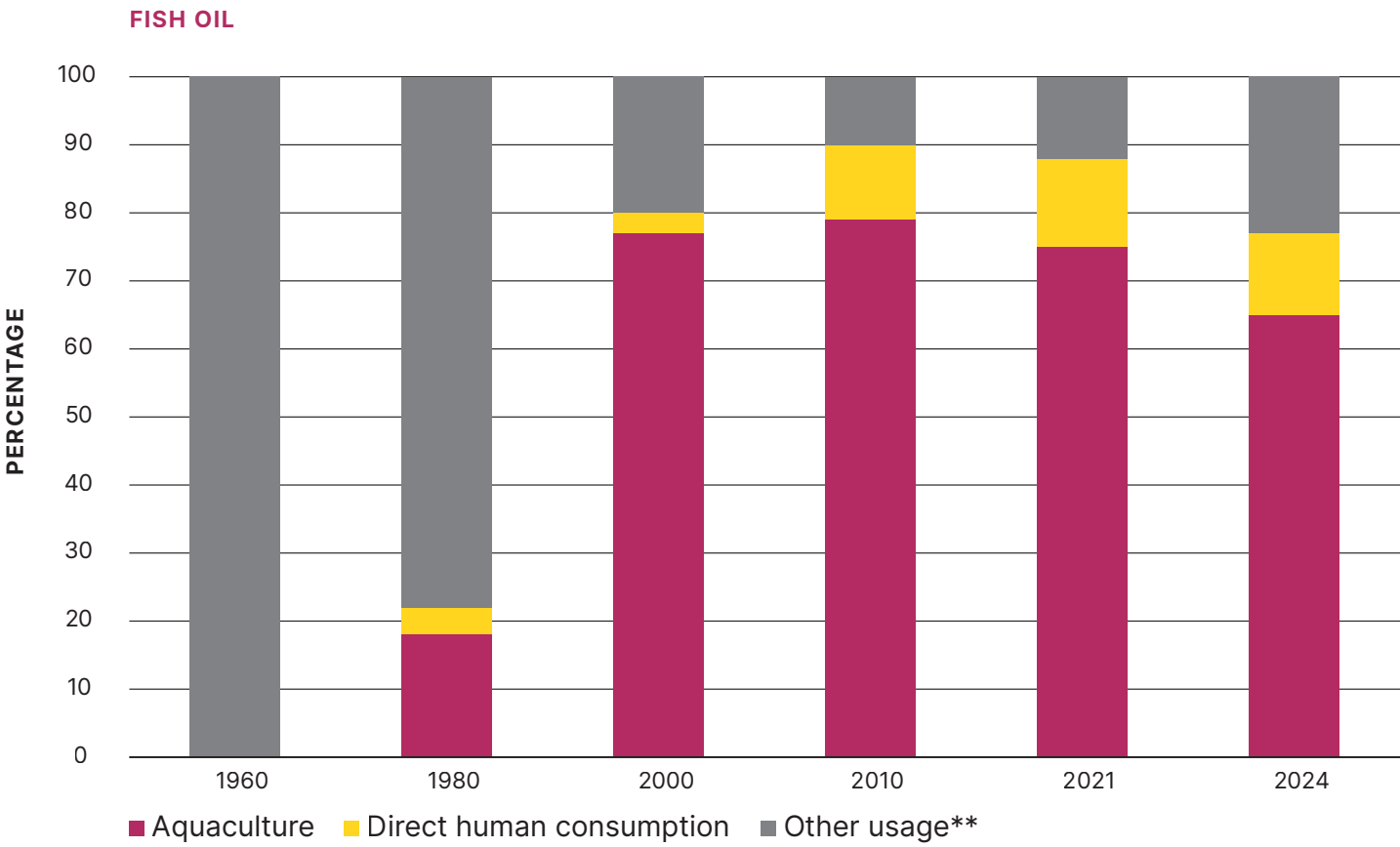
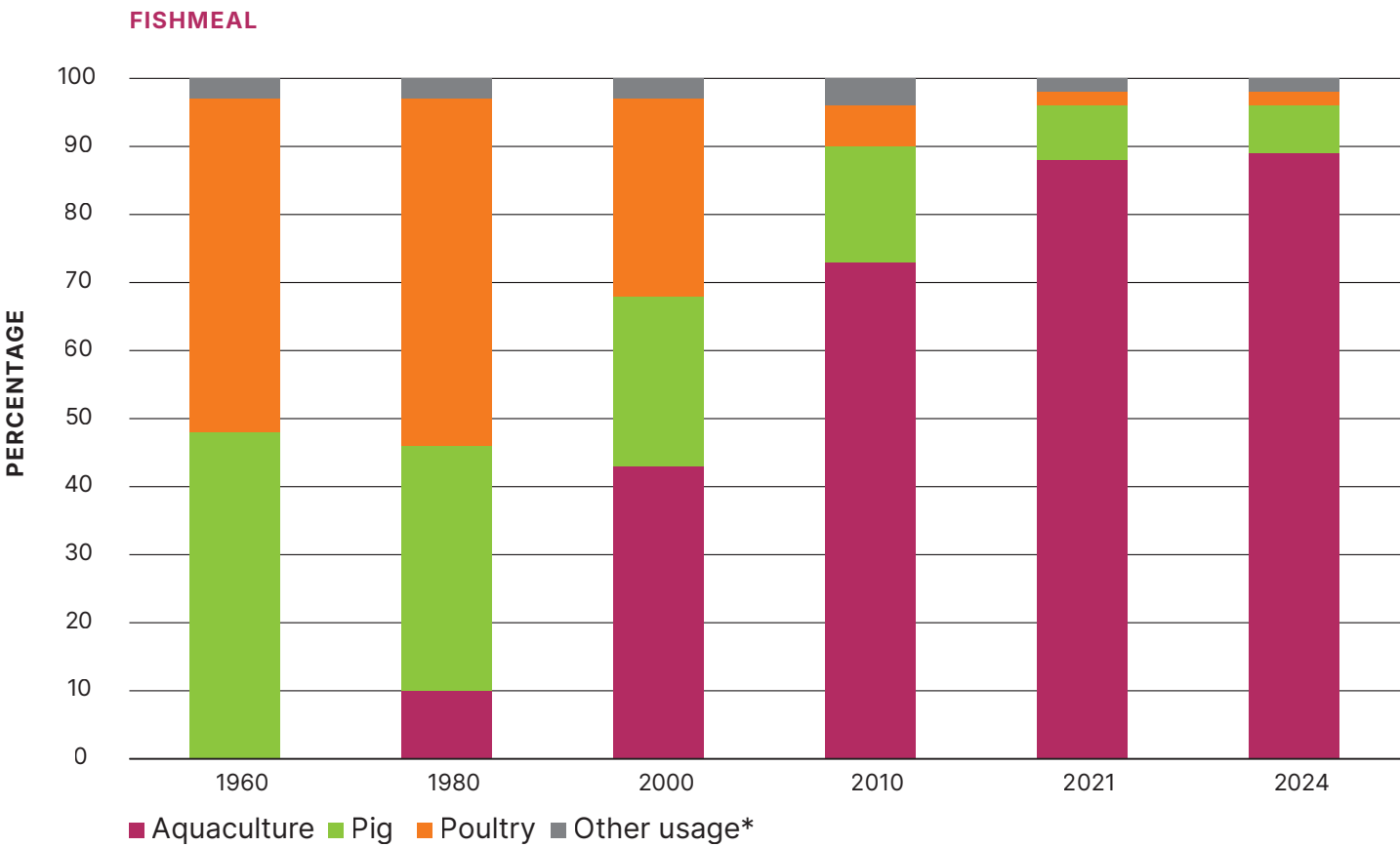
A growth target without sustainability criteria that distinguish unfed from non-fed aquaculture, herbivorous from carnivorous species, or domestic food systems from export-oriented supply chains poses serious risks. Increasing aquatic animal production without guardrails is likely to increase feed demand, pollution, disease risk, pressure on wild fish and competition for ingredients that could be used more directly in human food systems.¹²

The projected expansion of feed-intensive aquaculture is not merely a hypothetical consequence of FAO growth targets. Across the sector, major industry actors are actively investing in campaigns designed to increase consumption of feed intensive species including farmed salmon and shrimp and expand their share of global protein markets. The resulting changes in consumer demand are not accidental or spontaneous: companies, industry bodies and producing countries have deliberately sought to create and normalise them. Rather than supplying unmet nutritional needs, industry growth strategies increasingly focus on transforming

products that were once considered occasional items into everyday foods. Campaigns promoting salmon in convenience foods, pizzas and everyday family meals are designed to stimulate additional demand. The Norwegian seafood industry is targeting increased salmon consumption in markets such as Spain, Portugal, Italy and the United Kingdom, identifying commercial opportunities created by declining wild fish supplies, rising seafood prices and changing consumer preferences. At the same time, the Global Shrimp Council has been established with the explicit objective of increasing global shrimp consumption and promoting shrimp as an everyday protein choice. The marketing strategies of the global carnivorous aquaculture industry are therefore focused less on addressing nutritional deficiencies or improving food access, and more on increasing consumption. If growth is solely driven by market forces and countries that aggressively seek to expand consumption of feed-intensive species, then policy safeguards around species composition become even more important.

A central test for any aquaculture growth strategy is whether it reduces pressure on wild fisheries in absolute terms rather than only improving relative feed metrics. Over the past four decades, aquaculture has become the dominant consumer of marine ingredients. According to FAO’s own data, aquaculture’s use of global fishmeal production increased from only around 10% in 1980 to around 90% in 2024, while its share of fish oil use rose from roughly 1% to 63% over the same period.¹³

Yet this shift receives little attention in FAO’s discussion of marine ingredients. Instead, FAO’s biennial fisheries and aquaculture report SOFIA 2026 emphasises that ‘aquaculture growth has not increased pressure on reduction fisheries at global level’ because total fishmeal and fish oil production has remained relatively stable despite the expansion of fed aquaculture.



NOTES: * Mainly pet food. ** Pet food, biofuel, cooking oil.
SOURCE: IFFO estimates.

Figure 1: Utilisation of fishmeal and fish oil in selected years. Source: FAO SOFIA 2026

While factually correct in terms of overall fishmeal and fish oil production volumes, this framing obscures a major change in how those marine ingredients are used. Aquaculture is no longer one user of marine ingredients among many; FAO’s graph shows that its share has grown significantly and that it has become their dominant destination.

As a result of the way this is reported, wider discourse around aquaculture has also largely failed to acknowledge the continuing impact of the fed aquaculture industry on wild capture fisheries.

Even financial analysts advising the industry are more explicit than FAO about the scarcity of FMFO and the risks this creates for the industry itself. Rabobank warned in 2025 that rising aquaculture demand was colliding with ‘stagnant ma-

rine ingredient availability’. It projected that fishmeal shortages could emerge as early as 2028, while fish-oil scarcity would intensify throughout the decade.¹⁴ The same production plateau that FAO presents as evidence of successful decoupling is therefore identified by Rabobank as a binding constraint on further growth.

FAO’s climate roadmap presents a milestone of at least 75% growth in sustainable aquaculture production by 2040, but the publicly available document does not explain the assumptions underpinning this figure, and fails to specify which fish should grow or implications for wild fish use.

Available evidence suggests that recent aquaculture growth has been moving in the wrong direction. A separate 2026 global assessment of aquaculture production between 1950 and 2023 found that, since the 1980s, growth has increasingly con-

TRENDS IN GLOBAL PRODUCTION OF AQUATIC ANIMALS BY AQUACULTURE (FED AND NON-FED) AND AMOUNT OF CAPTURE FISHERIES REDUCED INTO FISHMEAL AND FISH OIL, 1980–2024

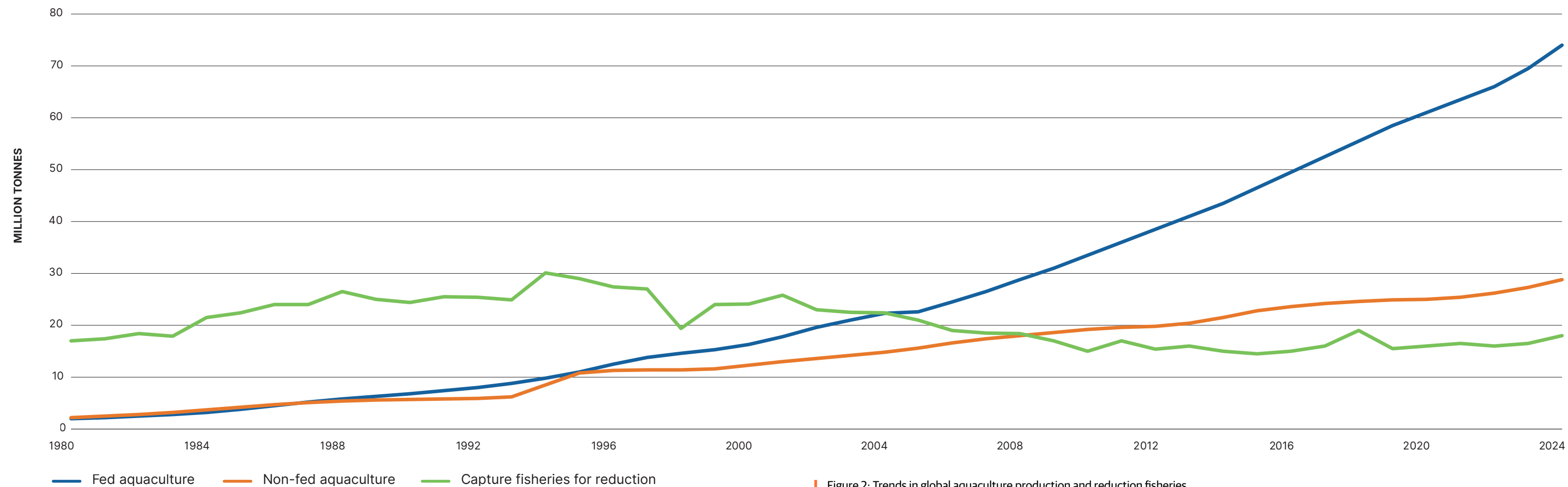


Figure 2: Trends in global aquaculture production and reduction fisheries.
Source: SOFIA 2026: <https://openknowledge.fao.org/server/api/core/bitstreams/7cb2534a-9886-418b-aa43-0ee679842b4f/content>

centrated in a smaller number of intensively farmed finfish, including salmon, trout and sea bass.¹⁵ These species depend on externally supplied feed that continues to include fishmeal and fish oil derived from wild-caught fish and have lower potential to advance food security, climate and biodiversity objectives than unfed species such as bivalves. Recent trends therefore provide no basis for assuming that future expansion will naturally follow a lower-impact pathway.

Deeply concerned about the potential impacts such unqualified growth targets could have on food security and the environment, Changing Markets decided to commission a modelling exercise. We worked with world-leading researchers at the University of British Columbia to examine what FAO's target to expand aquaculture (of aquatic animals, which excludes algae) could mean for whole wild fish demand under different assumptions about feed efficiency, fishmeal and fish oil inclusion, by-product substitution and species mix.¹⁶ The results paint a troubling picture.

The 75% aquaculture growth target can produce radically different pressures on wild fisheries depending on which species expand and how they are fed. FAO's aggregate target therefore tells policymakers almost nothing about whether the resulting growth would be environmentally or socially sustainable.

In 2020, aquaculture's demand for fishmeal and fish oil derived from whole fish was equivalent to an estimated 14.1-18.7 million tonnes of wild fish - around 16-21% of the entire global capture-fisheries production recorded that year. This is the baseline from which the modelling assesses the consequences of FAO's proposed expansion.

If recent production and feeding trends continue, annual demand would rise to the equivalent of 26.6-34.6 million tonnes of wild fish by 2040. This represents an increase of 85-88% and would be equivalent to 29-38% of everything caught

from the wild worldwide in 2020. Put another way, aquaculture could require the equivalent of approximately 73,000-95,000 tonnes of wild fish every day simply to feed farmed fish and other aquatic animals.¹⁷

An expansion concentrated more heavily in feed-intensive species - including salmon, shrimp, marine finfish and other crustaceans - would be still more damaging. Whole-wild-fish demand would rise to 30.7-41.4 million tonnes annually: 34-46% of the entire 2020 global wild catch, or approximately 84,000-113,000 tonnes every day. This would more than double aquaculture's 2020 demand, increasing it by approximately 117-121%. Under this pathway, the feed requirements of one food-production sector would approach the equivalent of half of everything currently caught from the wild.

This additional demand would fall on fisheries already under severe pressure. Research by Pauly and Zeller found that global marine catches have been declining more strongly since their 1990s peak than FAO's reported data suggests.¹⁸ Changing Markets investigations in Peru have also documented a marine-ingredient supply chain affected by illegal and unsustainable fishing, regulatory failures and allegations of corruption.¹⁹ Renewed disruption associated with the developing 2026 El Niño shows how environmental shocks can compound these governance risks: global anchovy production was estimated to have fallen by as much as 40% year on year, while anchovy prices rose by 80% to a record high.²⁰ Against this backdrop, Rabobank's warning of looming marine-ingredient shortages reinforces the risks of expanding feed-intensive aquaculture around a finite and increasingly volatile wild-fish supply.

The modelling also identifies a markedly more favourable pathway, demonstrating that rising wild-fish demand is not an unavoidable consequence of achieving FAO's

target. If future growth were steered towards non-fed and lower-FMFO species, while feed conversion improved, fishmeal and fish-oil inclusion declined, alternative ingredients expanded and more processing by-products were used, demand for whole wild fish could fall to 11.8–15.5 million tonnes annually. This would be equivalent to approximately 13–17% of FAO's reported 2020 global wild catch—compared with as much as 46% under the feed-intensive pathway—and around 16–17% below aquaculture's corresponding 2020 demand. Aquaculture production could grow by 75% while relieving some of the pressure the sector already places on finite and increasingly stressed wild-fish populations.

This pathway does not assume that feed-dependent aquaculture disappears: salmon, shrimp and other fed species continue to grow, but a greater share of additional production comes from bivalves, molluscs and lower-FMFO fish such as carp and tilapia. The pathways are not intended as exact predictions of what will be produced in 2040. Rather, they illustrate how different directions of travel—shaped by decisions about which species expand and how they are fed—could either intensify or relieve aquaculture's pressure on wild fisheries.

Even under the diversified efficiency pathway, however, demand would remain substantial. Aquaculture already uses the equivalent of around 15–20% of the entire 2020 global wild catch, placing untenable pressure on wild fish and the people and marine ecosystems that depend on them. The diversified pathway would begin to reduce that pressure, but it would not remove the need for stronger safeguards and a longer-term transition away from reliance on whole wild fish in aquaculture feed.

Rising whole-wild-fish demand therefore raises questions about who loses access to those resources and who benefits from the resulting production. These distributional consequences are examined in Chapter 3.

FAO's undifferentiated growth target fails to account for this risk. Greater efficiency per tonne does not guarantee lower resource use overall: feed ratios can improve while total demand for wild fish nearly doubles or more. Recent company evidence illustrates this rebound effect. A four-year FAIRR analysis of seven leading listed salmon producers found that production growth had outpaced marginal improvements in feed efficiency. Between 2020 and 2024, five companies increased their absolute use of fishmeal or fish oil made from whole wild fish, in one case by 39%.²¹ None of the seven had set a target to reduce its absolute use of fish-based feed ingredients, despite five planning to expand salmon production. The findings demonstrate why improvements in fish in: fish out ratio (FIFO) or other intensity-based indicators cannot, on their own, establish that pressure on wild fisheries is falling.

Scientific assessments have also shown that FIFO estimates vary substantially according to assumptions about yields, allocation, by-products and system boundaries.²² The limitations of efficiency ratios are examined later in this report.

Aquaculture policy must therefore require disclosure of absolute whole-wild-fish-equivalent demand alongside FIFO, eFIFO (which allocates wild-fish inputs according to their relative market value) and feed-conversion ratios, and assess that demand against food-security, biodiversity and climate safeguards. Without clear direction over which systems should expand, efficiency gains risk facilitating further growth rather than reducing pressure on wild fisheries.

What FAO's aquaculture target could mean for wild fish

The same 75% increase in production can place radically different pressure on wild fish. What grows — and how it is fed — determines the outcome.

Figure 3: What FAO's aquaculture target could mean for wild fish.





2. The disappearance of safeguards

2.1 When a salmon superpower helps frame sustainability

FAO's Guidelines for Sustainable Aquaculture, published in 2025, are the first global guidelines dedicated entirely to aquaculture. FAO says they were prepared at the request of members through an inclusive, transparent and participatory process. They are intended to guide policy, decision-making and action at local, national, regional and global levels.²³ Their voluntary status should not obscure their significance. FAO normative instruments frequently shape national legislation, donor priorities, development programmes, certification schemes and perceptions of international best practice. Intended as a common framework for governments, industry, researchers and civil society, they help define what sustainable aquaculture means in practice.

Their reach is especially significant because FAO is promoting major aquaculture expansion through its Blue Transformation agenda and climate roadmap. By defining the conditions under which expansion is considered sustainable, the GSA also serve to confer legitimacy on particular models of aquaculture development. At a time when FAO is promoting substantial growth in aquaculture production, those definitions carry important implications for food security, resource allocation and the future use of marine resources.

The growth orientation was present from the outset. Opening the first expert consultation on the guidelines in 2019, then FAO Assistant Director-General Árni Mathiesen predicted²⁴ that aquaculture would soon become ‘the mainstay of production, supply and trade of fish and fish products, worldwide’. FAO described the purpose of the exercise as identifying pathways to ensure aquaculture’s ‘continued sustainable growth in all possible aquaculture sets and stages of development’. Continued growth was therefore built into the process as its starting premise. The central question was how that growth could be made sustainable, not whether particular production systems should expand.

FAO records show that Norway supported ‘the first steps of scoping and development work’ for the guidelines, while the Republic of Korea and the Korea Maritime Institute financed the first expert consultation and subsequent regional consultations. Norway’s involvement also extended beyond funding. Yngve Torgersen, Director of the Department of Fisheries and Aquaculture in Norway’s Ministry of Trade, Industry and Fisheries, was selected as one of 15 experts and elected chair of the first consultation. That body established the methodology, thematic structure, case-study process and development roadmap used to produce the GSA. Torgersen

had also chaired the drafting committee at the 2017 sub-committee session²⁵ that called for the guidelines and subsequently chaired the 2019 sub-committee session²⁶ in Trondheim, which Norway sponsored and hosted.

Norway’s economic interest was substantial. As the world’s largest producer and exporter of Atlantic salmon – one of the most feed-intensive forms of aquaculture – the Norwegian government actively supports production growth and international market expansion. During the Europe and North America GSA consultation,²⁷ Norway proposed its White Paper on Sustainable Growth in Norwegian Aquaculture Policy as a case study, with the lesson summarised as ‘growth based on environmental indicators’. Norwegian salmon farming was presented as a ‘high-end industry’ distinguished by innovation, while fishmeal, fish oil and alternative feed ingredients were ranked as a priority. This advanced a vision of sustainability where growth could continue by managing environmental performance, rather than feed demand or competing human food needs.

2.2 Sustainable growth, permitted harm

The guidelines cover a broad range of issues associated with aquaculture development, including governance, planning, environmental management, aquatic animal health and welfare, social responsibility, investment, climate resilience and the use of feed and other inputs. The latter is particularly important because feed production links aquaculture directly to wider questions of marine resource use, food security and environmental impacts. It is therefore one of the clearest places to assess how the guidelines approach trade-offs between aquaculture growth and competing demands on aquatic resources.

A closer look at the GSA's sustainable-feed section shows that it contains some useful provisions, but insufficient safeguards. It calls on states and other stakeholders to develop feed strategies based on 'sustainably sourced ingredients'; promote feeds that are affordable, safe and healthy; invest in alternative ingredients, particularly those derived from local resources; and reduce feed waste, pollution and contamination. It also calls for wild fish and fish by-products used in aquafeed to come from sustainably managed fisheries and for their use to 'prevent and, where not possible, minimize negative impacts on livelihoods, food security and the environment'. Most importantly, it says stakeholders should 'support the gradual reduction' of wild-fish use in feed and improve its efficiency. These provisions acknowledge some of the principal environmental, health and food-security risks associated with aquafeed.²⁸

The problem lies in coupling the reduction of wild fish use in feed with efficiency metrics. Reducing the amount of wild fish used in feed is a food-security and resource-allocation objective while improving feed efficiency is primarily a production objective.²⁹ The wording allows industry to answer a food-security question with a relative efficiency metric, even where its absolute use of wild fish continues to increase. A meeting about the implementation of the FAO aquaculture guidelines in 2025 reveals the same underlying governance logic as the final GSA text itself. The central policy objective remained sustaining aquaculture growth while reducing its impacts, not determining whether some marine resources should be reserved for direct human consumption before being converted into feed.³⁰

The mitigation wording creates a second problem. In environmental governance, mitigation hierarchies are often used where some degree of harm is treated as unavoidable. Applied to the right to food, however, the formulation is more troubling. It implies that harms to livelihoods and food security may be considered acceptable

where prevention is judged 'not possible'. However the guidelines do not define who makes that judgement, according to what criteria, or whether affected commu-

nities have meaningful power in the process.³¹ [We examine one deliberation over feed allocation in West Africa later on in this report, to show how multistakeholder meetings are no substitute for strong safeguards written into policy]

Most significantly, the GSA avoids establishing any hierarchy in which direct human consumption takes priority over reduction into feed. Instead, food security becomes one factor to be balanced against continued industrial expansion, and vastly different aquaculture production systems are seen in the same framework of sustainable growth. As the following sections show, this represents a retreat from both FAO's earlier guidance and protections contained in previous GSA drafts.

2.3 What FAO used to say about feeding fish to fish

The final GSA refers back to the FAO's 2011 Technical Guidelines on the Use of Wild Fish as Feed in Aquaculture rather than incorporating the strongest language directly. That earlier guidance is more candid about the ethical and social conflict created by demand for fish feed. Principle 4 states that using fish as feed should not adversely affect livelihoods or compromise food security of poor and vulnerable groups that depend directly on these resources. It recognises that it may be more efficient and ethical to divert limited supplies to human food than to supply fishmeal plants for export-oriented aquaculture. Principle 5 states that the use of fish as feed should not be governed by market forces alone. Principle 6 suggests measures permitting reduction only after food market demand has been satisfied.³²

These principles should have been incorporated into the main GSA text. Instead, the final guidelines use weaker language. Policymakers reading the GSA encounter a general instruction to use undefined ‘sustainable feed’ and improve efficiency; they may not absorb that FAO’s own earlier guidance treated feed-fish allocation as an ethical issue, a food-security issue and a matter requiring regulation beyond market forces.³³

The 2011 guidance also reflects the limitations of older terminology. It repeatedly uses phrases such as ‘trash fish’ and ‘low-value fish’, language that reflects the market value assigned by industrial supply chains rather than the nutritional, cultural or livelihood value of fish to local communities. A fish can be low priced in export markets and still be a critical source of protein, micronutrients and income for local communities.³⁴

2.4 The safeguard that disappeared

FAO did not simply fail to notice the food-for-feed issue. A review of publicly available documents by Changing Markets shows that earlier drafts of the GSA recognised it.

A 2022 draft required members to ensure that international aquaculture trade did not ‘adversely affect the nutritional needs of people for whom fish is critical to a nutritious diet’, particularly where comparable foods were not readily available or affordable. It also called for the benefits of international trade to be equitably distributed. Although this provision did not refer explicitly to fishmeal and fish oil,

it recognised that aquaculture value chains can affect food security more widely by changing who has access to nutritious fish already present within aquatic food systems.³⁵

A 2023 draft addressed aquafeed directly. It called on members to ‘Promote studies to assess the conflicting use of ingredients for aquatic feed and human nutrition, mapping possible interferences in food security/safety and recommend alternative solutions.’

This provision recognised that aquaculture’s contribution to nutrition cannot be assessed solely by counting the farmed fish it produces. It must also account for the wild fish and other food resources used as feed, and whether diverting those resources into aquaculture undermines food security.

Both protections disappeared from the final guidelines. The GSA now call for reduced wild-fish use, improved efficiency, ingredient diversification and harm minimisation, but no longer require governments to examine competition between aquafeed and human nutrition.³⁶

FAO says these provisions strengthened the final draft. But they perform a different function: they seek to manage the effects of continued feed use without requiring governments to investigate competition between aquafeed production and human nutrition. Nor do they establish that edible fish should feed people first or set a timetable or an absolute limit on their use in aquafeed. Finally, they mirror industry narratives, raising questions about the influence vested interests had over the guidelines.

GSA version	Verbatim protection	Final outcome
2022 GSA draft, §9.8	Trade should not ‘adversely affect the nutritional needs of people for whom fish is critical to a nutritious diet’; benefits should be ‘equitably distributed’.	Deleted from the final GSA.
2023 GSA draft, §5.4.9	‘Promote studies to assess the conflicting use of ingredients for aquatic feed and human nutrition, mapping possible interferences in food security/safety and recommend alternative solutions.’	Deleted from the final GSA.
Final GSA, §5.4.3 and 5.4.4	5.4.3 Follow FAO technical guidance in the use of wild fish and fish by-products as aquafeed to prevent and, where not possible, minimize negative impacts on livelihoods, food security and the environment and to ensure they come from sustainably managed fisheries, without compromising safety and quality of aquaculture products. 5.4.4 Support the gradual reduction and improve the efficiency of the use of wild fish stocks as feed.	Harm mitigation replaces an explicit requirement to examine conflicts between feed use and human nutrition.

FAO has provided no public explanation for these deletions. It told Changing Markets that the guidelines resulted from a member-led intergovernmental process but acknowledged that the negotiations were not formally recorded. Published documentation also omits the participant list for the May 2023 meeting at which the final text was agreed. The public record therefore does not identify who proposed or supported the changes. Nor does it disclose the membership of the members’ task force convened in January 2023 to review the draft or the ‘friends of the chair’ group established at the May 2023 sub-committee session³⁷ to prepare the revised version immediately before approval. These bodies were more directly involved in revising the GSA text than the ordinary sub-committee drafting committees, which prepare the official reports of each session. Without their membership, submissions or deliberations, it is impossible to determine how competing national and commercial interests were represented at the decisive stages.

This opacity is not unique to the GSA. Research published in Marine Policy found that FAO has no access-to-information policy and that negotiations over normative instruments often occur behind closed doors.³⁸ The removal of an explicit food-security safeguard from the first global aquaculture sustainability instrument demands a public explanation.

2.5 Warnings heard, the industry playbook repeated

In June 2024, a month before the GSA were adopted, more than 160 organisations, scientists and fishing groups warned FAO that feed-intensive aquaculture expansion could increase pressure on wild fisheries, ecosystems and food security.³⁹ They called for lower-impact aquaculture and action to stop edible fish being diverted into feed.

FAO's response acknowledged the need for sustainability but reaffirmed the expansion target, stating that 'part of the solution is to grow sustainable animal aquaculture by 75% by 2040.' Rather than address the coalition's demand for a food-first rule, it emphasised improved feed formulation, lower fishmeal inclusion, selective use of marine ingredients, processing by-products and technological innovation. Manuel Barange, FAO's Director of Fisheries and Aquaculture, argued that these developments had "allowed aquaculture to grow without requiring a larger volume of marine ingredients as feed".

Barange concluded that there were "no perfect solutions" but that appropriate management and consideration of trade-offs could enable aquaculture to contribute to ending hunger. This response encapsulated FAO's prevailing approach: the direction of growth remained unchanged, while its consequences were framed as risks to be managed through tech fixes, efficiency, innovation and context-specific solutions.

The modelling commissioned for this report challenges that assumption. It shows that lower inclusion rates will not prevent absolute wild-fish demand from increasing

if production continues shifting towards feed-intensive species. What FAO presents as successful optimisation is therefore a growing claim on a finite, concentrated and increasingly climate-volatile supply.



3. Feeding fish while people go hungry: The West African contradiction

3.1 One UN system, two standards on the right to food

The right-to-food framework advanced by UN Special Rapporteur Michael Fakhri shows the importance of the missing GSA safeguards. His 2024 report on fisheries and the right to food in the context of climate change argues that hunger and malnutrition are not primarily caused by insufficient volumes of food production or lack of ambitious volume-based targets, but by inequality, exclusion and failures of access and distribution. From his perspective, the diversion of wild fish into feed for industrial aquaculture raises fundamental questions about allocation, equity and political power.⁴⁰

Fakhri also distinguishes between forms of aquaculture. He warns that industrial fishing fleets and large-scale aquaculture can undermine the rights of small-scale fishers and coastal communities, and recommends that states exercise ‘great caution’ regarding aquaculture expansion where it intensifies ecological pressure or undermines local food systems.⁴¹ This differs from FAO’s broader growth narrative because it treats access to nutritious food not simply as a production problem requiring continual expansion, but as a question of access, rights and control over resources.

These concerns are increasingly reflected across the wider UN human rights system. In 2026, the UN Special Rapporteur on Human Rights and Climate Change, Elisa Morgera, warned that the continued reliance of industrial aquaculture on fishmeal and fish oil derived from nutritionally valuable fish raises “serious human rights concerns in relation to declining access to food”. Morgera further linked industrial food systems to the concentration of corporate power, resource accumulation and the erosion of local food economies, arguing that food-system transformation should prioritise small-scale fisheries, resilience and equitable access to food resources.⁴²

UN Special Rapporteur on the Right to Food Michael Fakhri meeting FAO Director-General Qu Dongyu in 2022 (right), and Elisa Morgera—later appointed UN Special Rapporteur on human rights and climate change—at FAO’s closing event for the International Year of Artisanal Fisheries and Aquaculture in 2023 (left). Their subsequent UN reports raised concerns about industrial aquaculture and the diversion of nutritionally valuable fish into feed. Credits: FAO/Giulio Napolitano; Credits:FAO/Alessandra Bened



Earlier sections of this report showed how explicit references to food-feed conflict were weakened during the drafting process and ultimately replaced with a framework centred on mitigation, efficiency and responsible sourcing. Fakhri and Morgera link the issue with questions of rights, access, power and control over resources.

3.2 Who gets the fish - and who gets the feed?

FAO and blue growth policies often treat rising global fish demand as a given. In aggregate, that can be true: fish can provide protein, essential fatty acids and micronutrients, especially in coastal and riverine communities with few affordable substitutes. But aggregate consumption hides the right-to-food question: who gets the fish, at what price and in what form?



Aquaculture is increasingly the principal source of the fish and other aquatic animals available for people to eat. This trend helps explain why FAO considers aquaculture growth important to future food supply. But it also makes the composition and distribution of that growth more important. An increase in the global supply of farmed aquatic animals does not show which species are being produced, what they consume, where they are sold or whether they improve access to nutritious food among populations facing the greatest need.

The OECD-FAO Agricultural Outlook 2024-2033 projects average global fish consumption to reach 21.4kg per person by 2033, up from 20.8kg in the base period, while also projecting per capita consumption to fall in Africa.⁴³ In Africa, consumption is projected to decline to 9.3kg live weight equivalent by 2033 from 9.6kg in 2021-2023, largely because population growth is expected to outpace the supply. By contrast, in the EU apparent consumption was estimated at 22.89kg per capita in 2023, still far above the projected African level.⁴⁴ These figures do not imply that European consumers should eat no fish; they show that global aquaculture growth cannot be judged by total output while poorer regions face declining per capita access.

Senegal illustrates the distribution problem sharply. FAO's World Aquaculture Performance Indicators (WAPI) factsheet reports that per capita fish and seafood consumption in Senegal fell by more than 10kg: from 28.9kg in 1999 to 17.8 kg in 2019. FAO-linked work on West African small pelagics separately reported a decline in small pelagic consumption in Senegal from 18kg in 2009 to 9kg in 2018.^{45,46} Where fish consumption declines in places where fish remains central to diets, livelihoods and women-led processing economies, whether aquaculture production is increasing elsewhere is beside the point: what matters is that existing aquatic food systems protect access for populations that already depend heavily on locally-sourced fish for nutrition and income.

Mauritania - a major FMFO supplier to the EU - provides a cautionary example of the consequences of allowing FMFO production to expand without effective limits. From the early 2010s, its fishmeal industry diverted large quantities of sardinella and other small pelagics previously supplying regional food markets.⁴⁷ By 2018, factories were estimated to be processing at least 330,000 tonnes of fish annually that had previously been sold for human consumption across West Africa.⁴⁸ More recent regulations, including restrictions on factory supply and a requirement to reserve part of the catch for human consumption, have contributed to a substantial contraction in the industry.⁴⁹ These measures demonstrate that governments can curb FMFO expansion. Mauritania's experience underlines the need to act before industrial demand further depletes shared stocks, including by phasing out the reduction of edible whole fish.

Guinea-Bissau has gone further: new legislation in 2026 prohibits fishmeal and fish oil production, suspends licences for small pelagics destined for reduction, and prevents fish supplied by artisanal fisheries being used for FMFO. The government cited marine ecosystems and food-security concerns, while the Coalition for Fair Fisheries Arrangements (CFFA), which advocates for equitable and sustainable African fisheries, described the decision as a shift towards protecting food security and small pelagics. This shows that some countries in the region recognise that fish should be prioritised for people rather than treated as feedstock.⁵⁰

The affordability of farmed fish also deserves greater scrutiny. The salmon, shrimp, sea bream and sea bass produced using this FMFO are often destined for affluent consumers in the Global North. Multiple supply-chain investigations, including several by Changing Markets, show that carnivorous aquaculture operates as a concentrated, high-value and profit-driven commodity sector. Its affordability has been further called into question by legal action alleging collusion and price-fixing in the farmed Atlantic salmon sector. In 2024, the European Commission informed

six salmon producers that it provisionally considered they had colluded to distort competition in the EU market, while consumer claims in the UK and elsewhere alleged that such conduct had inflated salmon prices. Although these proceedings had not reached final conclusions at the time of writing, they underline how far this sector is removed from the goal of providing affordable nutrition to lower-income populations.⁵¹

BOX : The nutrients lost when fish become feed

A 2024 Nature Food study tracked nine nutrients from edible wild fish used in Norwegian salmon feed into farmed salmon fillets. Six had higher yields in the feed fish. Only 18% of the calcium and 25% of the iodine were retained in salmon fillets, while less than 75% of the iron, omega-3, vitamin B12 and vitamin A was retained.⁵² The researchers found that directing one-third of food-grade feed fish to people while retaining processing by-products for feed could increase seafood supply and improve nutrient retention. The finding challenges industry metrics that measure tonnes or protein produced while ignoring nutrients lost during conversion.

3.3 West Africa: When food security becomes a trade-off

West Africa is the clearest case for why the GSA should put safeguards in place to protect food security and nutrition for the local population, although it is far from the only one. Small pelagic species such as sardinella and bonga underpin diets, employment, women-led processing economies and regional trade across the region, yet growing volumes are diverted into fishmeal and fish oil production for export-oriented aquaculture and livestock industries.

Women processors and traders are not simply one group affected by declining fish availability. They are central to employment, value addition, local food distribution and household food security across the region. Losing access to small pelagic fish therefore undermines both incomes and the systems through which affordable fish reaches consumers.

Changing Markets and Greenpeace Africa have previously estimated in Feeding a Monster that more than half a million tonnes of fish capable of feeding over 33 million people in the region annually is instead reduced into FMFO, largely for farmed fish and livestock production in Europe and Asia.⁵³ UN Special Rapporteur Michael Fakhri subsequently cited the same case study in his right-to-food report, demonstrating that the diversion of edible fish into aquafeed is recognised elsewhere in the UN system as a human-rights concern.⁵⁴

3.3.1. FAO's own research had called for limits to protect local access to fish

FAO had extensive evidence of these risks before the final guidelines were adopted in 2024. By that time, FAO-linked scientific bodies, regional fisheries organisations and commissioned studies had already documented overexploitation risks, declining local fish consumption and threats to livelihoods associated with FMFO expansion in West Africa.

One important strand of this evidence came through the Fishery Committee for the Eastern Central Atlantic (CECAF), FAO's regional fisheries advisory body for the region. CECAF has 34 members, including 22 African countries, and its technical working groups bring together national scientists to assess shared stocks and advise member governments. It has repeatedly warned that key small-pelagic stocks are overexploited, with serious implications for coastal livelihoods and nutrition.

Although CECAF operates with limited FAO funding and depends heavily on externally funded projects, it was through this regional technical process that an assessment of the feed industry's effects on small-pelagic stocks, livelihoods and food security was requested.⁵⁵

The resulting report, Socio-economic and biological impacts of the fish-based feed industry for sub-Saharan Africa, was published by FAO in 2022 and authored by Djiga Thiao and Stuart W. Bunting. It was one of the most extensive examinations of the industry in sub-Saharan Africa, drawing on research across nine countries: Gambia, Ghana, Malawi, Mauritania, the Republic of Congo, Senegal, Sierra Leone, Tanzania and Uganda. The work was supported through two Norway-funded FAO programmes: the EAF-Nansen Programme and an FAO-Norad project on women in small-scale fisheries. It also received support from the CGIAR Research Program on Fish Agri-Food Systems (FISH), led by WorldFish, in collaboration with the University of Greenwich. National consultants conducted country surveys across each country, feeding local evidence into the study and its recommendations.

The study acknowledged that the fish feed industry generated some export revenue, government income and employment, and that some fishers benefited from higher prices. But it found that production was mainly exported and concluded that despite high production levels the industry's 'social benefits remain limited, perhaps benefiting relatively few entities'. These limited benefits were outweighed by threats to livelihoods, employment, food security and nutrition, and community health and well-being. Jobs were often temporary, precarious or held by foreign workers, while competition for fish threatened local fish processors, many of them women. Despite the scale of production, the contribution to domestic aquaculture remained very low.

The country findings showed that the fish-based feed industry had already contributed to an acute regional food-security crisis. In Senegal, where fish is central to diets and small pelagics account for around 70% of landings, FAO projected an annual gap of approximately 150,000 tonnes between fish demand and supply throughout the 2020s. It warned that increasing FMFO production from edible fish would worsen an already critical situation of fish availability and affordability. In Gambia, where annual fish consumption was estimated at 24-25kg per person, FAO projected an additional annual deficit of around 15,000 tonnes. Bonga - a staple fish for Gambian consumers - was already overexploited and remained heavily targeted by FMFO factories. In Mauritania, fish prices had risen from below \$95 per tonne in the early 2010s to more than \$400, disproportionately affecting the poorer households that depended on small pelagic fish.

These deficits coincided with depleted shared stocks, with the report showing that sardinella and bonga were overexploited across northwest Africa. CECAF called for fishing effort and catches of sardinella to be reduced immediately by 50% across the region and for bonga catches to be reduced below 2017 levels. Even sardine, then considered not fully exploited, required catch limits and close monitoring because of its sensitivity to climatic changes.

The report's recommendations reflected these findings. The first priority was to 'regulate and limit the number, capacity and production' of the feed industry according to both fish-stock status and the need for fish for human consumption. It said regulation should privilege 'food security and better nutrition', called for direct political intervention to protect affordable access for local processors and consumers, and recommended alternative feeds that did not depend on food fish.

This food-first approach was not simply the authors' interpretation but the result of extensive regional stakeholder surveys. FAO tested proposed recommendations through a two-round Delphi process involving 150 participants in its first round. Limiting FMFO production according to stock status and human-consumption needs received a median importance rating of 9 out of 10. Permitting production only from species not consumed locally also received 9 out of 10, as did monitoring fish consumption, affordability and nutritional importance. National stock assessment received 10 out of 10 and regional stock assessment 9 out of 10. In other words, stakeholders strongly supported the central principle that feed production should be constrained by stock health and people's need for fish as food.

3.3.2. The global fish feed industry enters the process

The report did not go unnoticed by the global marine ingredients industry. The following year, the Global Roundtable on Marine Ingredients (GRMI) commissioned its own research and later co-organised a workshop with FAO in Ghana to discuss the findings. GRMI is an industry-backed multistakeholder initiative bringing together major companies and trade bodies across the aquaculture and marine-ingredients supply chain, alongside certification schemes and non-profit organisations with close industry links. Its members include IFFO (The Marine Ingredients Organisation - a trade association for the fish feed industry), the Marine Stewardship Council, Aquaculture Stewardship Council, Global Seafood Alliance, BioMar, Cargill, Skretting, MarinTrust and Sustainable Fisheries Partnership. It is chaired by Árni M. Mathiesen, former Assistant Director-General of FAO's Fisheries and Aquaculture Department, linking the initiative to one of the most senior figures in FAO's recent fisheries leadership.

The resulting report's geographical and methodological scope was substantially narrower than FAO's nine-country assessment, limiting

its focus to Mauritania and Senegal.⁵⁶ It did not examine Gambia, despite acknowledging serious allegations concerning stock depletion, rising prices, pollution and food security there, and offered no clear rationale for excluding it. In Senegal, moreover, the field research was confined to artisanal fishers and processors: it did not examine FMFO factories or commercial vessels. Mauritania was the only country in which the assessment engaged directly with industrial actors.

Nevertheless, the industry-funded human rights impact assessment (HRIA) confirmed many of FAO's findings. It classified reduced availability, accessibility and quality of fish for human consumption as an actual adverse impact. It documented fish becoming scarcer and more expensive, competition between FMFO factories and artisanal processors, declining incomes, stock depletion, and pollution from factory smoke and wastewater. Women processors in both countries reported being outbid by better-financed FMFO factories, which could pay higher prices or finance fishing operations. The assessment found that this competition was pushing women out of access to fish, reducing their incomes and their ability to feed their families, and distorting local fish markets.

But the HRIA omitted one of FAO's starkest measures of the crisis: FAO's projection that Senegal would face an annual fish supply-demand gap of approximately 150,000 tonnes throughout the 2020s. A national food-supply deficit was consequently presented as a collection of value-chain impacts without being quantified at the scale identified by FAO. And it was this approach that shaped FAO's later processes in the region.

Both studies found that FMFO production was competing with local processors and consumers, contributing to rising prices and threatening livelihoods and access



Neil Auchterlonie, then Technical Director of the marine-ingredients trade association IFFO, speaking at the FAO COFI side event A Sustainable Future for Aquaculture in 2018. Credit: Giuseppe Carotenuto/FAO.

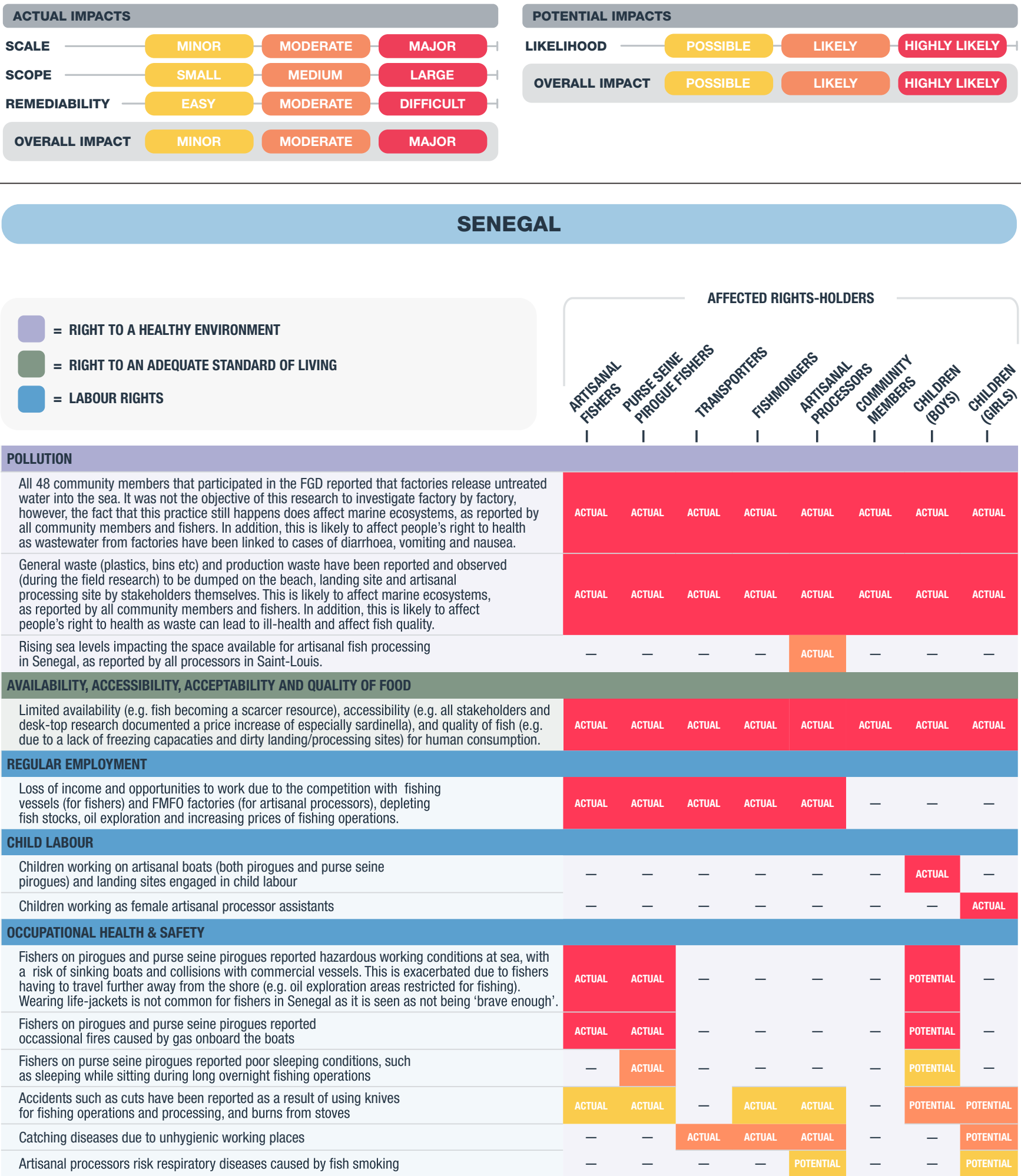
to food. The divergence lay in how that evidence was framed, what outcome was presumed and who was expected to bear responsibility for responding.

FAO’s assessment treated the issue as a conflict over the allocation of a limited and nutritionally important resource. Production should be constrained by stock status and the need for fish for human consumption, with food security and nutrition explicitly privileged.

The GRMI-funded HRIA on the other hand stated that its purpose was not to favour one sector because the artisanal and industrial sectors were ‘important and complementary’. The objective was for both to ‘adapt’ their ways of working. It did not endorse production at its existing scale: indeed, some of its recommendations to governments were robust. But coexistence remained the presumed outcome, and the report did not define stock depletion or unmet local food demand as conditions requiring international buyers to reduce or cease sourcing.

The allocation of responsibility is particularly striking given who commissioned the assessment. The HRIA was funded by a coalition representing international businesses and organisations connected to the marine-ingredients and aquaculture supply chains. Yet its strongest structural recommendation (limiting factory and vessel capacity and the volume of fishmeal and fish oil produced) was directed to governments in the producing countries. Despite apparently being an industry-facing report, international companies financing and purchasing

Figure 4: Excerpts from Track the Fish, a human-rights impact assessment commissioned by the Global Roundtable on Marine Ingredients [the global fish feed lobby]. The table records actual impacts on food availability, livelihoods, health and the environment in Senegal, including competition between FMFO factories and artisanal processors. Similar findings were reported in Mauritania, the other country examined.



these ingredients were not asked to reduce sourcing from the region, stop buying ingredients made from edible fish or withdraw where local food needs remained unmet.

Instead, buyers were positioned as partners in improving continued production: providing technical assistance, supporting audits, encouraging certification and helping factories strengthen their management systems. They were advised to consider stopping purchases only where an individual factory refused to cooperate and address identified impacts. Under this framework, a buyer could continue sourcing from a country experiencing severe fish scarcity while complying fully with the HRIA's recommendations, provided its supplier submitted to audits and demonstrated improved practices.

3.3.3. Ghana: industry access and the retreat from food-first limits

Nine months after the industry-funded HRIA was published, the centre of gravity shifted from the findings of the 2022 FAO/CECAF assessment to a wider, formally convened process. The Ghana workshop in December 2023 was organised by FAO and the Norway-funded EAF-Nansen Programme in formal collaboration with GRMI - the international marine-ingredients coalition that had commissioned the HRIA - and the Iceland Ocean Cluster, an Icelandic business and innovation hub promoting fuller commercial utilisation of fish. It brought together governments, researchers, civil society organisations and small-scale fisheries representatives from the region, alongside numerous international organisations and experts connected to the marine ingredients and aquaculture sectors. EAF-Nansen was not a new participant: it had also helped support the 2022 FAO/CECAF assessment. What was new was GRMI's formal role in organising the discussion and the greater access afforded to international industry-linked actors.

Rather than simply following FAO's own 2022 recommendation that FMFO production be constrained by stock status and human food needs, the workshop adopted the industry-funded HRIA's starting premise that the sectors were 'important and complementary'. Even its title, 'Optimizing food and nutrition security and livelihood benefits of small pelagic species production in sub-Saharan Africa', reflected this shift. The official FAO report of the workshop said only that states 'could consider' policies prioritising fish for direct human consumption, while endorsing a continued role for a 'responsible' FMFO industry. The food-feed conflict was recast as a system to be optimised and better managed, rather than a question of whether industrial sourcing should be reduced. This created a pathway for a 'responsible' FMFO industry to continue operating despite depleted stocks and unmet local food needs.⁵⁷⁵⁸ Subsequent discussions about 'responsible marine ingredients' carried this framing beyond the formal GSA negotiations.

The meeting report shows that presentations from industry-linked participants reinforced this approach. IFFO's Brett Glencross argued that marine ingredients could "magnify the fish outputs from utilized fish at a 5:1 ratio", presenting the conversion of wild fish into farmed fish as a net gain in food. Yet another widely used measure produces the almost exact reverse claim: that around five kilograms of wild fish may be required to produce one kilogram of farmed salmon. As Section 4.1 explains, these contrasting ratios reflect different accounting methods, and neither alone shows whether total wild-fish demand is rising, edible fish are being diverted from people or valuable nutrients are lost through conversion.

Certification representatives also presented aquaculture's claimed climate efficiency, reportedly including comparisons with beef, as evidence supporting continued production under improved governance.

Yet several participants challenged this framing directly. Workshop discussions questioned whether such ratios adequately captured broader food-security trade-offs and warned that governance processes risked “ask[ing] new questions, which distract and delay action” while fishmeal expansion continued. Small-scale fisheries representatives instead called for sardinella to be reserved for direct human consumption and for fishmeal factory expansion to be halted.

A researcher commissioned by Changing Markets spoke with Árni M. Mathiesen, chair of GRMI, who confirmed his central role: “I organised the meeting ... it was done in cooperation with the FAO, so I was directly involved in organising that and was there.” He stressed that FAO did not adopt a formal position, but acknowledged that “there wasn’t total agreement” and that “there was definitely a compromise reached.” FAO subsequently finalised and edited the report.

West African civil society participants subsequently told CFFA that the meeting report did not reflect what they regarded as a broad consensus among African groups against diverting small wild fish into fishmeal. The experience led CFFA to reconsider participation in such processes because, as its coordinator put it, civil society risked being “co-opted by the process”.

Changing Markets also spoke to marine social scientist Christina Hicks, who participated in the Ghana workshop and presented evidence on the importance of small pelagic fish to nutrition, food security and livelihoods. She described how unequal power shaped the discussion: “You can’t have an equal playing field if you bring people into a room who have very different amounts of power and agency, without purposeful facilitation.” In practice, “who gets listened to are those that come across as these experts.” She told us that while participants broadly recognised the severity of the crisis – “everyone agrees that the stocks are close to collapse” – Hicks

felt there was a tendency to “dance around the problem”. Rather than confronting what was driving overfishing and increasing pressure on small pelagic fisheries, discussions increasingly shifted towards questions of management and governance. As she put it, “it’s no longer what’s driving overfishing, it’s ‘who’s failing to manage and govern the fishery?’.” Hicks also cautioned against assuming that governance approaches that may be suitable in the Global North could simply be transplanted to West Africa, noting that “it may be true that stocks are better regulated elsewhere, but it may also be true that that regulation is displacing fishing pressure resulting in disastrous consequences in West Africa.”

The 2022 FAO/CECAF study had also recommended investment in storage, transport, preservation and local processing to keep fish within domestic and regional food systems.⁵⁹ Small-scale fisheries representatives have made the same point: insufficient investment in local preservation and processing means fish that could feed local populations can instead end up in fishmeal factories.



Árni M. Mathiesen, now chair of the Global Roundtable on Marine Ingredients, speaking in 2017 while serving as FAO Assistant Director-General for Fisheries and Aquaculture. Credits: UNCTAD, CC BY-SA

3.3.4. How industry-friendly language took hold in FAO guidance

The process did not end with the Ghana workshop. FAO subsequently cited the workshop in Responsible Use of Fishmeal in Aquaculture. While earlier FAO-commissioned research had recommended regulating fishmeal production according to stock status and human consumption needs, the later publication instead emphasised ‘the social-cultural context’ of different countries, responsible sourcing and optimisation of marine ingredient use. It also referred to ‘negative perceptions’ surrounding the use of fishmeal and fish oil.⁶⁰

This language forms part of a broader tendency to recast criticism as a problem of perception. In his 2026 interview, Barange called aquaculture feed a source of “much misconception” and attributed negative fisheries stories to people pursuing “their own agendas”. He also reviewed a 2024 Marine Policy paper co-authored by Ray Hilborn – described by Greenpeace USA as an ‘overfishing denier’ – which argued that errors and bias in conservation literature distort fisheries policy and public perceptions.⁶¹

In July 2025, the Global Roundtable on Marine Ingredients co-organised a further workshop in Nouakchott with the Mauritanian Institute for Oceanographic Research and Fisheries and the Mauritanian Small Pelagics Fisheries Improvement Project (FIP). Its report explicitly states that the workshop ‘built on the momentum of the FAO’s 2023 Accra meeting’ and ‘laid the groundwork for concrete, collaborative actions.’⁶² It traces this process back to both the 2022 FAO/CECAF study and the industry-funded human-rights impact assessment, while describing the continued implementation and possible regional expansion of the Mauritanian FIP as a principal vehicle for taking the work forward. The report was prepared by the GRMI, with contributions from the other co-organisers and proofreading and involvement from an FAO official, although it does not identify the workshop as a formally mandated FAO process or explain the institutional basis for this follow-up. FAO appears to

have lent its technical authority to an industry-led process addressing matters of public food-security policy, without the mandate, safeguards or accountability of a formal intergovernmental process.

The Nouakchott workshop acknowledged competition between direct human consumption and FMFO production, called for greater investment in local processing and cold-chain infrastructure, and proposed measures to improve the availability of small pelagic fish for local consumers.

Mathiesen also confirmed that the Ghana discussions shaped the FAO’s aquaculture guidelines and the GRMI’s subsequent work. He said they were “the basis for some things I’ve been doing since then” and described the later Mauritania workshop as a meeting that “took things further”. His account reinforces the documentary evidence that the industry-led Nouakchott process was conceived as a continuation of the FAO-GRMI meeting in Ghana.

Guardrails must also apply to the fisheries supplying fishmeal and fish oil. These should include science- and ecosystem-based management, transparent licensing and catch reporting, public access to information and meaningful participation by small-scale fishing communities, including women processors and traders. Implementation of the Guidelines for Sustainable Aquaculture should be coherent with FAO’s Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries, which call for the protection of small-scale fishing communities’ rights, participation and access to fishery resources and markets.

3.3.5. From consultation to capture

While there is nothing inherently wrong about advisory or regulatory bodies consulting industry, the GSA represents the opaque backsliding of organisations like FAO towards representing the needs of industry, rather than the needs of peo-

ple. In this case, GRMI's members have a commercial interest in maintaining or even expanding FMFO production, but no requirement to ensure that commercial interest does not come at the expense of local communities. That requirement should flow from transparent guidance from bodies like the FAO, but relying too closely on industry consultation turns that guidance into a means of justifying the industry's profit-driven expansion. When this happens, it is clear that industry has captured and manipulated the process to its own benefit.

This is not an isolated case. In our work to uncover the tactics used by Big Meat and Dairy to sidestep regulatory action on methane emissions, we found striking similarities. The industry worked hand-in-glove with policymakers to gain concessions, exemptions and delays to major regulations despite its outsized impact on the climate and environment. To date, Big Meat and Dairy remains one of the only sectors free from genuine emissions regulation. As we have described, the aquatic food sector represents a significant and growing portion of the global food economy. The same pattern - continued sectoral growth treated as a given, with its harms managed primarily through efficiency and mitigation - is visible in FAO's evolving approach to aquaculture.

The evidence points to a clear change in FAO's approach. Its 2011 guidance and 2022 CEEAF research treated the use of edible wild fish for feed as a question of food security, resource allocation and the protection of vulnerable groups. The 2022 and 2023 draft guidelines retained nutritional safeguards and eventually named the conflict between aquafeed and human nutrition directly. In the final GSA and subsequent processes, those priorities receded as mitigation, efficiency, responsible sourcing and value-chain optimisation moved to the fore.

Earlier FAO recommendations called for FMFO production to be regulated and limited according to stock status and human-consumption needs, with substantially reduced pressure on key sardinella stocks. The later approach assumes continued FMFO production and focuses on managing its impacts.

Our review (in Annex A) found striking similarities between this later framing and established marine ingredients industry narratives. Both present aquaculture growth as necessary for food security without resolving which systems should expand or who will receive the food produced. Both rely on relative efficiency, certification and responsible sourcing as evidence of sustainability, despite their failure to address overall wild-fish demand. Documented food-security and ecological conflicts are increasingly framed as perceptions, trade-offs or management problems rather than questions requiring clear allocation priorities and absolute limits.

Similar language shows how the industry narratives influenced and infiltrated the FAO policy, undermining effective food-security measures. Although the Nouakchott workshop recognised competition between direct consumption and FMFO production and supported investment in local processing and cold-chain infrastructure, explicit food-first safeguards receded while approaches compatible with continued FMFO production gained prominence. Industry actors played a leading role in FAO workshops, and industry-led initiatives managed to sway the process away from food security priorities.

Annex A documents this change from FAO's 2011 guidance and 2022 West Africa findings through the draft and final GSA, the Ghana workshop, subsequent fishmeal guidance and the Nouakchott process. Annex B sets out the textual evidence of convergence between FAO and industry language on growth, efficiency, certification, responsible sourcing and perceptions of harm.



4. 'Sustainable growth' and continued extraction: certification, capture and contradiction

The GSA define sustainability broadly, encompassing ecosystems, food security, equity, livelihoods and governance. But its practical response to the impacts of feed-intensive aquaculture relies heavily on efficiency, certification, alternative ingredients and circularity. These approaches may reduce some harms, but none establishes an absolute limit on wild-fish use or determines when edible fish should be reserved for people. This chapter examines how these dominant sustainability claims can permit extraction to continue while presenting aquaculture as increasingly sustainable.

4.1 A shrinking ratio can conceal a growing appetite

FAO's response to competition between aquafeed, fisheries and human food systems centres on efficiency gains, alternative ingredients and feed optimisation rather than absolute limits on wild-fish use. The seafood industry and certification schemes use much the same framework, presenting lower inclusion rates and improved conversion ratios as evidence that aquaculture is becoming less dependent on wild fisheries.

The fish-in fish-out ratio, or FIFO, is one such efficiency metric. It estimates the quantity of wild fish used through fishmeal and fish oil to produce a quantity of farmed fish. The aquaculture and marine ingredients industries frequently cite falling FIFO ratios as evidence that production is becoming more efficient and less dependent on wild fisheries.

A widely cited 2008 study⁶³ estimated that producing 1 kg of farmed salmon required 4.9 kg of wild fish. IFFO strongly disputed this figure, arguing that the calculation treated fish oil as the limiting ingredient without crediting all the fishmeal produced from the same fish.⁶⁴ It subsequently advanced the opposite claim: that 1kg of wild fish could support around 5 kg of output across fed aquaculture. At the Ghana workshop, IFFO's Brett Glencross similarly argued that marine ingredients could "magnify" fish output at a five-to-one ratio.

The reversal - from nearly 5 kg of wild fish producing 1 kg of salmon to 1 kg supporting 5 kg of farmed output - shows how dramatically FIFO can change according to the species included and the accounting method used. Calculations depend on assumed fishmeal and fish-oil yields, feed-conversion and inclusion rates, how the

two co-products are allocated, and whether trimmings and by-products are counted. Industry-wide averages can also combine feed-intensive carnivorous species with species requiring far fewer marine ingredients, obscuring the much greater wild-fish dependence of salmon, shrimp and other carnivorous aquaculture.

Another widely cited 2021 global review estimated that producing 1 kg of farmed fish and crustaceans required 0.28 kg of wild fish.⁶⁵ However, its calculation included output from unfed farming systems - which use no compound feed - in the farmed-fish side of the ratio. More than a quarter of the production covered came from such systems.

A 2024 Science Advances study explicitly replicated and then reassessed that calculation.⁶⁶ It included wild-fish-derived trimmings and by-products that had previously been excluded and tested several sources of feed-composition data. Using the same broad production base, it estimated that producing 1 kg of farmed output required between 0.36 and 1.15 kg of wild fish. When the researchers excluded unfed systems and also counted wild fish killed during capture but not ultimately used in feed, the range rose to between 0.57 and 1.78 kg. At the upper end, considerably more wild-fish biomass was killed than farmed biomass was produced.

Even a more complete FIFO calculation captures only biomass. It does not ask whether the wild fish used as feed could have been eaten directly, who might otherwise have eaten it, what nutrients are lost through conversion or what removing forage fish means for marine ecosystems. A 2017 global study found that 90% of fish destined for uses other than direct human consumption - principally fishmeal and fish oil production - were species suitable for human consumption. Much of this catch consists of small pelagic fish rich in protein, essential fats and micronutrients.⁶⁷

FIFO can help indicate dependence on marine ingredients, but it cannot establish that aquaculture growth is sustainable. As the modelling in Section 1.2 shows, ratios can fall while total wild-fish use continues to rise. FIFO should therefore be reported alongside absolute whole-wild-fish-equivalent demand, source species and fisheries, and the consequences for food security and ecosystems.

Calculations also vary according to how trimmings and by-products are counted. As Section 4.3 explains, classifying marine ingredients as by-products may lower estimates of direct whole-fish use without removing aquaculture's wider dependence on wild fisheries.

4.2 Certification and greenwashing

Certification schemes have become a battleground over definitions of 'sustainable' practices, in both fisheries and aquaculture. A 2025 report examined widely recognised farmed salmon certification schemes in Scotland, including the Aquaculture Stewardship Council (ASC), RSPCA Assured and Soil Association Organic, and found that certification can mislead consumers about environmental and welfare standards.⁶⁸ If certification schemes struggle to prevent greenwashing in well-regulated markets, weaker governance contexts should not be expected to rely primarily on voluntary assurances around feed, welfare and ecosystem protection.

The problem is not confined to farms. Changing Markets reports have documented how certification systems applied to reduction fisheries, including fisheries supplying fishmeal and fish oil, have repeatedly failed to apply a precautionary approach.⁶⁹ Rather than constraining extraction, certification can often serve to

legitimise it, allowing fisheries operating under ecological uncertainty or weak governance to continue supplying global aquaculture markets, masquerading as sustainable operations.

Certification generally begins by asking whether the source fishery is managed within accepted stock limits. But even fisheries operating within conventional reference points can impose substantial ecosystem costs. Much fisheries management and certification still relies heavily on maximum sustainable yield (MSY) or comparable single-stock reference points. While avoiding overfishing is essential, critics argue that MSY was developed as a production model for individual target stocks and does not adequately account for ecosystem function, food-web dependencies or the wider social value of forage fish. As French fisheries scientist Didier Gascuel told Changing Markets, "MSY is far, far, far from enough because it already admits a very strong impact on the exploited stock and then a very strong impact on the ecosystem."

This limitation is particularly relevant for small pelagic fisheries used for FMFO production. Gascuel notes: "Small pelagics play a very important role in the functioning of ecosystems and we are not taking that into account sufficiently when calculating quotas."

The Antarctic krill fishery is another example which illustrates the limits of certification-based sustainability as well as the potentially devastating impacts of feed-intensive aquaculture. As Changing Markets' past reports have shown, although krill is a keystone species underpinning the Southern Ocean ecosystem, it is increasingly harvested for ingredients used in farmed fish feed, pet food and supplements.⁷⁰ The fishery has been certified as sustainable by the Marine Stewardship Council since 2010, even as governance concerns, pressure from climate change and scientific

uncertainty have intensified. In 2026, a coalition of civil society organisations including WWF formally challenged MSC recertification of the krill fishery and called for suspension of the label.⁷¹ A decision is awaited.

4.3 By-products: No such thing as a free fish

The growing use of by-products has changed the way marine-resource dependence is measured and discussed. As the FIFO analysis in Section 3.3 shows, separating by-products from whole-fish inputs can make aquaculture’s dependence on

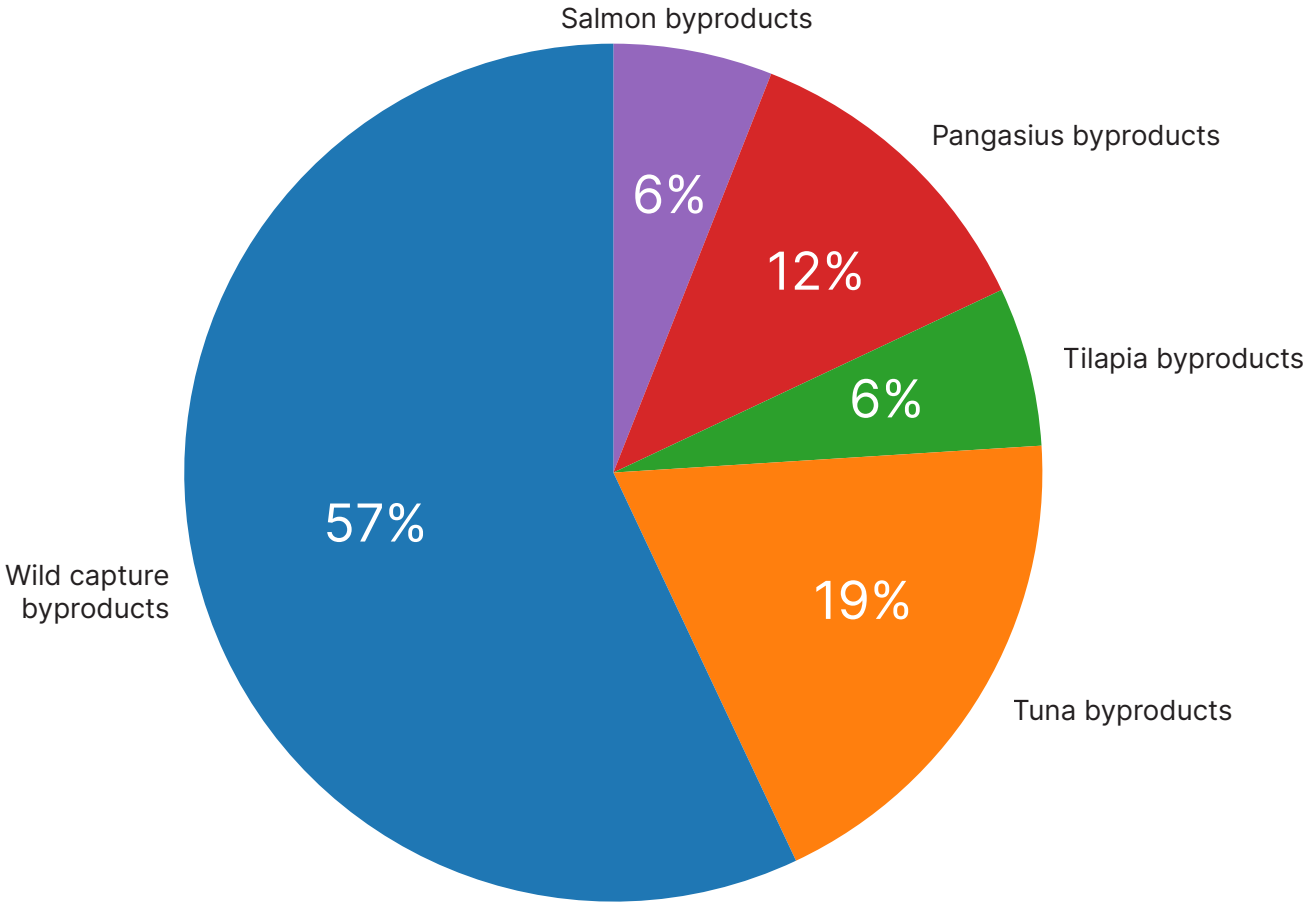


Moonfish in Southern India meant for human consumption, but this catch, damaged by bottom trawlers, is sent to fishmeal plants.
Credits: Changing Markets

wild fisheries appear smaller. Industry, certification and FAO increasingly present fish-processing trimmings and by-products as evidence that aquaculture is becoming more circular and less dependent on whole wild fish inputs.⁷² The sourcing and ecological implications of these materials, however, remain poorly scrutinised.

Trimmings-derived marine ingredients may be presented alongside soy, insect meal or other feed inputs as components of feed formulations. Industry reporting

MOST FISHMEAL BY-PRODUCTS STILL ORIGINATE FROM WILD CAPTURE FISHERIES



Source: Adapted from IFFO 2024. Nearly 60% of fishmeal by-products still derive from wild capture fisheries.

Figure 5: Source of fishmeal by-products. Created from data on by-products at <https://www.iffco.com/by-product>

often counts by-product-derived fishmeal and fish oil separately from marine ingredients made from whole fish. This can make aquaculture's wider dependence on wild-caught aquatic biomass less visible.

According to the feed industry's figures, 42% of marine ingredients used for feed now come from by-products and trimmings.⁷³ Almost 60% of those trimmings and by-products, according to the industry itself, still come from wild caught fish.

Changing Markets has examined materials showing that a substantial proportion of trimmings-derived fishmeal and fish oil originates from wild-capture and whitefish processing streams, including finfish such as sandeel, sprat, blue whiting, pollock, cod, hake, haddock and others, and pelagics such as herring and mackerel.⁷⁴ Some source fisheries rely on bottom trawling, while others use industrial fishing methods associated with high fuel consumption and wider ecosystem impacts.⁷⁵ A fish head may be classed as a processing by-product, but classifying it so does not erase the impacts of catching the original fish. Nor does it mean that the head has no value as food. Fish heads and other parts labelled as by-products are eaten in many cultures and can provide important nutrients. Their classification often reflects the practices and economics of a particular processing industry, rather than whether they are edible or valued in other food systems.

By-products are also increasingly lucrative commodities. Fishmeal and fish oil provide seafood processors with an additional revenue stream and strengthen the economics of the wild capture fisheries supplying them.⁷⁶ Sustainability metrics that treat by-products as effectively free or low-impact inputs risk masking the fundamental dependence of industrial carnivorous aquaculture on extractive wild fishing systems and the wider industrialisation of marine food webs.



5. Aquaculture without feeding fish to fish

5.1 Social and environmental benefits of low-trophic aquaculture

The GSA contain several positive references to low-trophic and unfed aquaculture, including seaweed, bivalves and integrated multi-trophic systems, where different species are farmed together so that waste or nutrients from one can be used by the other. It recognises that unfed aquaculture requires fewer resources and can provide valuable ecosystem services, and calls on governments to promote low-trophic species such as algae, seaweeds and bivalve molluscs. However, the guidelines and the Global Roadmap largely present these systems as one option among many equivalent ones rather than establishing a clear preference for lower-impact forms of aquaculture.

In many coastal developing-country contexts, locally embedded low-trophic systems can also complement rather than displace small-scale fisheries, diversify household incomes, strengthen women's roles in local value chains and integrate with existing coastal livelihoods.

FAO support could give a much-needed boost to better forms of aquaculture. A 2026 global assessment of aquaculture production found that growth since the 1980s has increasingly favoured a smaller number of intensively farmed species with much lower potential to advance food-security, climate and biodiversity objectives. The trend is particularly significant in China, which accounted for 56% of global aquaculture production in 2022. Between the 1976-1980 baseline and 2019-2023, the food-security potential of its production mix fell by 14.1%, its climate potential by 21.6% and its biodiversity potential by 12.9%. In the Americas, the food index improved by only 0.8%, while the climate and biodiversity indices declined by 11.4% and 9.1% respectively.

The study found that bivalves perform particularly strongly across food-security, climate and biodiversity objectives, yet production growth has increasingly concentrated in finfish such as salmon, trout and sea bass, which involve greater resource demands and trade-offs. The authors conclude that aquaculture could reverse these trends by diversifying production and expanding high-performing species already being farmed. The GSA acknowledge this pathway but do not prioritise it. A credible food-security strategy should direct aquaculture growth towards unfed and genuinely low-impact systems, rather than merely adding them to an otherwise undifferentiated expansion agenda.⁷⁷



A fisherman casting a net from the banks of the Tonle Sap River, Cambodia, Credits: FAO/A.K. Kimoto

BOX: **FAO turns a blind eye to dietary shift as a solution to animal agriculture's growing footprint**

In 2006, FAO published a landmark report, *Livestock's Long Shadow*, which put animal agriculture on the global environmental agenda, highlighting its significant negative impacts on climate, biodiversity and pollution of water and air. The estimated share of global greenhouse gas emissions attributable to livestock was put at 18%, including 37% of methane and 65% of nitrous oxide emissions. The study triggered a massive backlash from the industry, which was covered in the *New Merchants of Doubt* report published by Changing Markets in 2024.⁷⁸

The authors of the report came under huge pressure, and FAO slowly moved away from calling out the industry towards adopting industry-preferred language and solutions that focus on techno-fixes and efficiency improvements.

FAO's 2023 study *Pathways Towards Lower Emissions* revised the estimate of global livestock emissions to 12% --a figure at the lowest end of the IPCC's estimated range of 12–20% – while also downplaying the climate potential of dietary shift. An 'emissions intensity' metric was introduced to account for the mitigation potential of using different animal breeds, management practices, feed quality and environmental conditions, while the report stressed that 'collaborative efforts from all industry stakeholders are critical to successfully mitigate the anticipated increase in sectoral GHG emissions.'⁷⁹ The *Pathways* report also foresaw a 20% increase in demand for animal products by 2050, and a 32% increase in related emissions, while at the same time claiming that a shift to more plant-based diets would only cut global greenhouse gas emissions by 2–5%, citing a 2017 paper by Paul Behrens, recipient of the prestigious British Academy Global Professorship and professor at Oxford Martin School, Oxford University.⁸⁰ His paper analysed the health and environmental outcomes of

state-supported nationally recommended diets, but it was outdated, as several countries had drastically reduced their recommended meat intake since its publication.

Another academic cited by FAO in *Pathways*, Matthew Hayek, complained that the study misused a report he had co-written by applying measurements of total agrifood emissions to livestock emissions alone, leading to significant underestimation of the mitigation potential of livestock herd reductions. These and a few other errors led to significant underestimates of the emissions reduction potential of dietary shifts and reducing farmed animal numbers, leading to calls for the report to be retracted.⁸¹ On the other hand, the study was welcomed by industry lobbyists, such as the president of the Animal Feed Industry Association, who hailed it as "music to our ears". Industry lobbyists have been citing this report at many international conferences and events to claim that the emissions of the sector are going down and to downplay the climate potential of dietary shifts. Meanwhile, the number of farmed animals is on the rise: according to a recent NGO report, numbers have gone up by 53% since *Livestock's Long Shadow* was published.⁸²

The parallels with aquaculture are striking. In both cases, absolute ecological limits and structural changes (including dietary shifts and diversification away from resource-intensive production) have been displaced by frameworks centred on efficiency, technology and continued industry growth. This reveals an institutional vulnerability to corporate capture: industry-compatible solutions repeatedly prevail while scientifically proven alternatives and stronger safeguards are marginalised.

5.2 The dietary pathway FAO left out

The GSA is specifically concerned with how aquaculture should develop, but FAO's Global Roadmap for Achieving SDG 2 without Breaching the 1.5°C Threshold places aquaculture within a much wider vision for transforming agriculture, diets and food systems. Its 75% aquaculture-growth target therefore cannot be assessed in isolation from the roadmap's treatment of livestock, crops and dietary change. Examining that wider framework reveals the same growth-oriented logic identified in the GSA: relatively precise ambitions for expanding or increasing the productivity of animal-production sectors, but far less specificity about dietary shifts that could reduce demand for resource-intensive foods.

There is an imbalance in the way FAO's climate roadmap translates different food-system pathways into targets. The roadmap recognises that diets 'absolutely must' change for human and planetary health and aims for everyone to consume a healthy diet by 2050.⁸³ Yet it leaves the composition of that change largely undefined. Healthy diets are described through broad principles of adequacy, balance, diversity and moderation, with no quantified target to expand plant-rich diets, reduce excessive consumption of animal-source foods in high-consuming countries or reduce the use of edible fish and crops in animal feed.

By contrast, the roadmap establishes specific targets for the expansion or increased productivity of animal-production sectors. It calls for at least 75% growth in global 'sustainable aquaculture' production by 2040 and annual livestock total-factor productivity growth of 1.7% through 2050. It also promotes livestock intensification, improved genetics and feeding practices, and presents aquatic food as an important part of the dietary shift. The livestock target measures productivity rather than meat

consumption, and the roadmap also sets productivity targets for crops. But it does not establish corresponding targets for increasing the production or consumption of plant foods for direct human consumption, such as fruit, vegetables, nuts and pulses, which in many countries are below recommended levels.

This imbalance is difficult to reconcile with the wider scientific evidence. The Intergovernmental Panel on Climate Change (IPCC) concludes with high confidence that diets consistent with health recommendations offer significant climate-mitigation potential. Such diets are generally higher in vegetables, fruits, whole grains, pulses, nuts and seeds and lower in animal-source foods, fats and sugar.⁸⁴ They can also reduce pressure on land and deliver substantial health benefits. One study cited by the IPCC found that halving consumption of meat, dairy products and eggs in the EU could reduce ammonia emissions from EU agriculture by around 40%, agricultural non-CO₂ GHG emissions by 25-40% and per-capita cropland use for food production by 23%.

The EAT-Lancet Commission reaches a similar broad conclusion. Its planetary health diet is centred on vegetables, fruits, whole grains, pulses, nuts and other plant foods, with substantially smaller quantities of most animal-source foods than are currently consumed in many wealthy countries.⁸⁵ Its analysis finds that feeding a growing global population within environmental limits requires major dietary change alongside improvements in production and reductions in food loss and waste. The 2025 EAT-Lancet update reinforces the case for healthy, predominantly plant-rich diets adapted to different cultural, regional and nutritional circumstances.⁸⁶

This does not mean prescribing one universal diet - in some countries and populations, greater access to certain animal-source foods may help address nutritional deficiencies. The strongest case for reduction is in wealthy countries and among

middle- to high-income consumers, where consumption is already excessive and diets can shift without compromising nutrition. But that qualification should not obscure the overall direction of the evidence: continued global growth in resource-intensive animal agriculture is neither the only nor necessarily the most effective way to improve food security.

FAO's 2022 foresight report, *Thinking about the future of food safety*, illustrates the problem. Its section on plant-based alternatives recognises that livestock production is often criticised for greenhouse gas emissions, land degradation, water overuse and eutrophication, and that plant-based alternatives are perceived as potentially less resource intensive. It also cites evidence that plant-based diets are associated with higher dietary quality and reduced risk of chronic metabolic disease. But the report then introduces repeated caveats, warning that environmental comparisons may not be straightforward and citing arguments that plant-based meat and beef may be complementary rather than interchangeable in nutrient terms.⁸⁷

The relevant transition, however, is not only about only plant-based meats: it is a broader transition towards food systems based more heavily on pulses, grains, vegetables, fruits, nuts and other minimally processed plant foods. FAO applies much less visible caution when setting targets for aquaculture growth and livestock productivity, despite the land, crops, wild fish and other resources required to sustain these inefficient production systems.

This debate also takes place in an information environment shaped by vested interests. Changing Markets' investigation *Meat vs EAT-Lancet* documented a coordinated network of industry-friendly scientists, doctors, influencers and other actors that worked to discredit the original EAT-Lancet findings.⁸⁸ It found that misinformation, personal attacks and industry-backed communications helped

portray recommendations for healthier, more plant-rich diets as nutritionally dangerous or scientifically unsound. This shows why influential public institutions must be careful not to reinforce an industry-manufactured impression that the fundamental scientific case for dietary change remains unresolved.

A consistent food-security approach should apply the same test to every pathway: improving access to affordable, nutritious and culturally appropriate food, reducing pressure on ecosystems and avoiding the inefficient conversion of edible resources into animal products.



6. Conclusion

At a time when many capture fisheries are at capacity or under pressure from climate change and overfishing, FAO is touting aquaculture as a solution that can contribute to better nutrition and improved livelihoods. However, what kind of aquaculture grows matters. Without effective safeguards and a precautionary approach, rapid growth of fed aquaculture and the pressure this brings on wild-caught fish could undermine food security objectives and lead to depletion of natural resources.

FAO's own data shows that aquaculture has grown from a minor user of marine ingredients into the destination for around 90% of global fishmeal and 63% of fish oil. Yet FAO presents the fact that total FMFO production has largely remained at the same level as evidence that aquaculture has not increased pressure on reduction fisheries. Stable supply is not evidence of decoupling, if aquaculture has captured an increasing share of a finite resource and is now pressing against its limits.

This report does not assume that FAO's 75% aquaculture-growth target is necessary or desirable. Its modelling instead shows that, if substantial growth

occurs, prioritising unfed, low-trophic and lower-FMFO systems would place considerably less pressure on wild fisheries than expanding feed-intensive species. This is not an endorsement of growth for its own sake.

This investigation shows that the FAO aquaculture growth agenda is not supported by adequate sustainability safeguards. While the available evidence does not establish who proposed the deletion of the explicit food-feed conflict provision from the GSA, it shows that industry-linked actors enjoyed significant access to relevant FAO discussions, commissioned their own studies and co-organised workshops with the FAO with a view to influence the process. This resulted in FAO's final policy framing increasingly converging with longstanding industry narratives centred on efficiency, certification, optimisation and responsible sourcing.

Whatever the precise origins of the final wording, the resulting policy gap is clear: neither the GSA nor FAO's Global Roadmap's target explicitly prioritise fish for direct human consumption nor establish a hierarchy distinguishing aquaculture systems according to their food-security and environmental impacts. Without such guardrails, expansion risks increasing pressure on wild fish and local food systems while being presented as a solution to hunger and climate change. Regardless of how efficient or technologically advanced feed-intensive farming systems become, they remain inextricably linked with wild-capture fisheries for the foreseeable future.

If FAO is to remain aligned with its founding mandate, it should recognise that wild fish are not merely industrial raw materials. Forage fish play essential roles in marine food webs, helping climate regulation, sustaining larger fish, seabirds and marine mammals, while also supporting human nutrition and livelihoods. FAO policy should therefore require extraction to remain within precautionary ecological limits and, within those limits, prioritise direct human consumption and the needs of fisheries-dependent communities over reduction into feed for farmed animals.

The election of a new FAO director-general in 2027 presents an opportunity to align the organisation more closely with scientific consensus on climate and nutrition, including around promoting plant-rich diets and proteins such as pulses and nuts as resource-efficient ways to improve global nutrition and contribute to climate and biodiversity goals. This opportunity is particularly important given concerns that FAO has become increasingly receptive to industry narratives and solutions and over the corporate capture of its work on livestock emissions. FAO has also faced allegations that its current director-general, Qu Dongyu, has advanced Beijing's foreign-policy interests, favoured Chinese nationals in senior appointments and placed pressure on parts of the FAO system associated with civil society participation and market transparency.⁸⁹

The next director-general should restore confidence through greater scientific independence, institutional transparency and meaningful civil society participation, ensuring that FAO's food-security policies are shaped by prioritising nutrition and conservation of natural resources rather than the preferences of specific industries and countries.



7. Recommendations

Support the right aquaculture systems: FAO should establish a hierarchy of aquaculture systems in all GSA and Global Roadmap implementation work. Unfed, low-trophic and genuinely locally embedded systems should be prioritised. Industrial feed-intensive aquaculture (including the farming of salmon, shrimp, sea bass, sea bream and tuna) should be excluded from undifferentiated sustainable-aquaculture growth targets.

Restore food-first safeguards and phase out FMFO in feed: FAO should revise the GSA, or issue an authoritative implementation interpretation, to state explicitly that edible wild fish should be prioritised for direct human consumption over reduction into fishmeal and fish oil. It should also establish a time-bound global pathway to start reducing and ultimately eliminating the use of fishmeal and fish oil in aquaculture feed, beginning with ingredients derived from whole wild fish and the most vulnerable regions. Pending that phase-out, the stronger principles in FAO's 2011 guidance should apply: market forces alone should not govern fish allocation, and reduction should be permitted only after local and regional food needs have been satisfied. The GSA should also require disclosure of aquaculture's absolute dependence on wild fish, including publicly reporting total wild-fish use, FMFO volumes, source species and fisheries, country of origin, as well as by-product share and species origin.

Use the 2027 leadership transition to strengthen accountability and transparency:

FAO member states should use the election of a new director-general in 2027 to seek clear commitments to human rights, scientific independence, freedom from conflicts of interest and institutional transparency across FAO's work, including with the introduction of an organisation-wide access-to-information policy. FAO should be transparent about workshop participation, open its processes to independent scientists and civil society representatives and seek to eliminate conflicts of interest, which have led to corporate capture of its important work.

Finally, it is important to pay special attention to the West African region, as this is where competition between food security and aquaculture is the fiercest. West African governments, FAO and development partners should accelerate the regional phase-out of FMFO. Governments should prohibit new whole-fish FMFO facilities and additional capacity and phase out existing production on an accelerated timetable. Participatory regional fisheries management should rebuild small-pelagic stocks and, in line with FAO's Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries, protect fishing communities' rights and participation while prioritising their access to fishery resources and direct human-consumption markets. Governments, FAO and development partners should simultaneously invest in landing sites, ice, cold storage, refrigerated transport, artisanal processing and local marketing, with particular support for women processors and traders. Regional coordination should prevent FMFO production from simply moving between neighbouring countries.



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ANNEX A

Timeline of FAO's narrative drift: from conflicting uses to optimisation

Source/process	How the problem is framed	Key finding or language	Recommended approach
2011 FAO Technical Guidelines FAO (2011), Aquaculture development. 5. Use of wild fish as feed in aquaculture, FAO Technical Guidelines for Responsible Fisheries No. 5, Supplement 5 [Link]	Ethical, distributional and food-security conflict requiring public intervention measures.	‘The use of fish as feed should not adversely affect livelihoods or compromise food security among poor and vulnerable groups’; ‘should not be governed by market forces alone’; reduction fisheries should only expand where fish are not required to satisfy food needs. ‘Using fish as feed should not adversely impact the livelihoods and compromise food security of poor and vulnerable groups.’	Food-first allocation and market intervention: substitute food-grade fish in feed; regulate allocation so it does not diminish food security; develop affordable markets for food fish; and improve access for poor and malnourished people.
FAO 2022 study on the fish-based feed industry in nine African countries D. Thiao and S.W. Bunting (2022), Socio-economic and biological impacts of the fish-based feed industry for sub-Saharan Africa, FAO Fisheries and Aquaculture Circular No. 1236 [Link]	Competition between fish-based feed production, human consumption, livelihoods and food security	First priority recommendation calls on governments to ‘regulate and limit the number, capacity and production’ of the industry according to fish-stock status and ‘need for fish for human consumption’. Regulation should privilege ‘food security and better nutrition’. The report calls for alternatives ‘that do not rely on food fish’. The fish-based feed industry offered ‘some economic opportunities through employment’, export earnings and government revenue, but its ‘social benefits remain limited, perhaps benefiting relatively few entities’ and were outweighed by threats to ‘livelihoods, employment, food security and nutrition’ (p. 29). Many jobs were ‘uncertain or temporary’ and did not always go to local people; in Mauritania, workers were ‘mainly foreigners’, while in Senegal competition for fish threatened ‘thousands of workers operating in artisanal postharvest activities’ (pp. 19–20). Despite substantial production, its contribution to domestic aquaculture and livestock development remained ‘very low’ (p. 29).	Food-first regulation and limits: constrain industry capacity according to ecological conditions and human-consumption needs; protect affordability and local access; and reduce reliance on edible fish through alternative feeds.
2022 Draft GSA [Link]	Nutrition and equitable distribution	‘Promotion of international aquaculture trade does not adversely affect the nutritional needs of people for whom fish is critical to a nutritious diet.’	Nutrition safeguards; distributional considerations.
2023 FAO Draft GSA [Link]	Conflict named directly	‘Assess the conflicting use of ingredients for aquatic feed and human nutrition, mapping possible interferences in food security/safety.’	Assess interference with food security.

Source/process	How the problem is framed	Key finding or language	Recommended approach
Two interlinked FAO roadmaps provide the wider policy framework for the aquaculture growth agenda examined in this report: FAO (2022), Blue Transformation – Roadmap 2022–2030: A vision for FAO’s work on aquatic food systems [Link] FAO (2023), Achieving SDG 2 without breaching the 1.5°C threshold: A global roadmap, Part 1 – How agrifood systems transformation through accelerated climate actions will help achieve food security and nutrition, today and tomorrow [Link]	Aquaculture expansion as a food-security solution	Identifies aquaculture growth as a cornerstone of future food security. Both reports present sustainable aquaculture expansion as a central food-security strategy. Blue Transformation calls for 35% growth by 2030, while the climate roadmap calls for at least 75% growth by 2040.	Growth-oriented framework; sustainability defined through enabling aquaculture expansion.
2023 industry-funded Human Rights Impact Assessment, ‘Track the Fish’ Partner Africa (2023), Track the Fish: A human rights impact assessment of the small pelagic fish value chain in Senegal and Mauritania, human-rights impact assessment commissioned by the Global Roundtable on Marine Ingredients [Link]	Human-rights risks documented	Identifies impacts on pollution, food availability/accessibility, livelihoods and labour rights.	Due diligence and mitigation.
2023 FAO-GRMI co-hosted Ghana workshop FAO (2024), Report of the workshop on optimizing food and nutrition security and livelihood benefits of small pelagic species production in sub-Saharan Africa, Accra, Ghana, 5–7 December 2023, FAO workshop report [Link]	Trade-offs and optimisation	‘Optimizing food and nutrition security and livelihood benefits of small pelagic species production in sub-Saharan Africa.’	Conditional coexistence: food-security protections and encouragement of direct consumption, alongside management, valorisation and a continued “responsible” FMFO industry.
FAO (2025), Guidelines for Sustainable Aquaculture, voluntary global guidelines adopted in 2024 and published in 2025 [Link]	Mitigation, not prioritisation	‘Prevent and, where not possible, minimize negative impacts on livelihoods, food security and the environment.’	Growth-compatible risk management.

Source/process	How the problem is framed	Key finding or language	Recommended approach
2025 FAO information paper: FAO (2025), Responsible use of fishmeal in aquaculture, FAO Innovation for Blue Transformation [Link] A 12-page “Innovation for Blue Transformation” information product. It is not a new set of technical guidelines and does not formally supersede the 2011 document.	Efficiency and innovation	Describes ‘competing demands’ and ‘negative perceptions’ around fishmeal use (p. 1). Its West Africa case study acknowledges livelihood and nutritional concerns and concludes that ‘The social-cultural context [...] should be considered when evaluating the trade-off between fish for human consumption versus fish for animal feed.’	Efficiency and contextual management: selective fishmeal use, improved feed efficiency and low-input aquaculture. Affordability is discussed principally as a requirement for substitute feed ingredients. There is no equivalent call for market intervention to protect poor consumers’ access to fish. It establishes no food-first allocation rule or limit on sourcing edible fish.
2024 GSA communications workshop [Link]	??	‘Raise awareness of improvements to feed use efficiency’ and address ‘incorrect information’.	Efficiency and contextual management: selective fishmeal use, improved feed efficiency and low-input aquaculture. Affordability is discussed principally as a requirement for substitute feed ingredients. There is no equivalent call for market intervention to protect poor consumers’ access to fish. It establishes no food-first allocation rule or limit on sourcing edible fish.
OTHER RELEVANT REPORTS			
UN Special Rapporteur on Right to Food 2024 Fisheries and the right to food in the context of climate change – Report of the Special Rapporteur on the right to food, Michael Fakhri [Link]	Rights and power imbalance	Rights, unequal access and pressure from industrial aquaculture. ‘Hunger and malnutrition are not caused by a lack of food and are therefore not a production problem.’ Many farmed carnivorous fish ‘require feed products harvested from wild fish stock, thereby creating another source of pressure on wild fish stocks and disrupting ecosystems’. The report warns that global feed companies are ‘exacerbating food insecurity in some communities’, citing figures from Changing Markets’ report Feeding a Monster (2019)	States should ‘exercise great caution around aquaculture’ and ‘not support the expansion of the aquaculture sector until the risks are better understood and robustly regulated’, while distinguishing small-scale from large-scale operations. Most directly, states should ‘strictly restrict the imports of fish-based feed from regions where people are food insecure and where fish stocks are proven to be overexploited.’

Source/process	How the problem is framed	Key finding or language	Recommended approach
UN Special Rapporteur on climate change 2026 Transforming food systems for a safe climate and health for all – Report of the Special Rapporteur on the promotion and protection of human rights in the context of climate change, Elisa Morgera [Link]	Human rights, climate, health and structural transformation	Human rights, food access and industrial feed demand: ‘the current reliance of industrial aquaculture on fishmeal and fish oil from nutritionally valuable fish raises serious human rights concerns in relation to declining access to food.’	Calls on states to ‘use all legal tools available in competition, tax and investment law to curtail the accumulation of market power and natural resources by large-scale food businesses’ and to ‘phase out subsidies’ to them. Calls on international financial institutions to stop financing large-scale food businesses and prioritise Indigenous and peasant food systems, and on FAO and other UN bodies to address corporate conflicts of interest and prioritise small-scale food systems.
Global Roundtable on Marine Ingredients (2025), Transforming the Small Pelagic Fish Value Chain in West Africa: Maximizing the Value of Catches, report of the Nouakchott workshop, 10–11 July 2025 [Link] Industry-led workshop report prepared by the Global Roundtable, with contributions from IMROP and the Mauritanian Small Pelagics FIP and proofreading/ involvement from an FAO official.	Parallel value-chain process	The workshop ‘built on the momentum of the FAO’s 2023 Accra meeting’. The Mauritanian FIP was presented as ‘a model for regional collaboration’, while progress since Accra was said to rest on its ‘continued implementation’. ‘Despite the nutritional importance of [small pelagics], their availability and affordability for local populations remain limited due to competition with FMFO industries and infrastructure gaps.’	Follow-up through an industry-linked and funded FIP, certification and market-based cooperation rather than a clearly mandated and publicly accountable FAO process. Investment in local processing, storage and direct human consumption, alongside continued FMFO production.

ANNEX B.

From food allocation to managed growth: convergence between FAO and industry narratives

Many of the concepts that became increasingly prominent in FAO discussions on aquaculture feed – growth, efficiency, optimisation, responsible sourcing, combatting negative perceptions and misconceptions in FMFO use and the communication of benefits – have long featured in industry efforts to defend the sustainability and continued use of fishmeal and fish oil. The parallels below do not establish that

industry actors wrote or directly determined FAO policy. They do show that, as explicit references to competing uses and food security disappeared, FAO’s framing increasingly converged with industry language that treats continued growth as necessary and its consequences as problems to be managed through efficiency, certification and optimisation.

A. Aquaculture growth as a food-security solution

Theme	Industry language	FAO language	Narrative convergence
Growth presented as necessary and inevitable	IFFO (the fish feed industry lobby) states that ‘aquaculture is the future of food’ and argues that future food production will rely on marine ingredients to support its expansion.	Opening the first GSA consultation, FAO stated that ‘soon aquaculture will be the mainstay of production, supply and trade of fish and fish products, worldwide’. In his response to an NGO letter in 2024, Manuel Barange described aquatic foods as ‘part of the solution to end hunger and malnutrition’ and attributed their growing consumption to aquaculture.	Aquaculture expansion is presented as both inevitable and necessary. This shifts the policy question from whether and how particular production systems should grow to how continued sectoral expansion can be enabled.
Expansion equated with feeding a growing population	IFFO describes its role as ‘contributing to feeding a growing population, sustainably and responsibly’ and presents marine ingredients as essential to aquaculture’s contribution to global food security.	FAO’s climate roadmap calls for ‘at least 75% growth in global sustainable aquaculture production’ by 2040. Responding to NGOs, Barange framed the target as comparatively moderate because it represents annual growth of 2.8%, below the 5% recorded between 2000 and 2020. He closed by citing a projected global population of 9.7 billion by 2050 and the resulting urgency of finding ‘technical and sustainable solutions’ to hunger and malnutrition.	Both connect increased aquaculture output directly to tackling hunger. Comparing the target with faster historical growth makes a major expansion appear moderate, while leaving unresolved what species will grow, what they will consume, where the resulting food will be sold and whether it will improve access for populations facing hunger.

Theme	Industry language	FAO language	Narrative convergence
Feed supply treated as a condition of growth	IFFO argues that additional feed ingredients are required to support aquaculture growth and that marine ingredients will remain strategically important. Its stated objective is to ensure sufficient feed to ‘feed a growing population, sustainably’.	The final GSA support the sustainable development, intensification and expansion of aquaculture. Barange’s response emphasises feed formulation, selective marine-ingredient use, by-products and technological innovation as ways to support continued production growth.	Feed constraints are treated primarily as technical problems to be overcome through innovation and optimisation. Neither approach asks whether dependence on edible wild fish should instead constrain the expansion of feed-intensive species.

B. Efficiency, optimisation and responsible sourcing

Theme	Industry language	FAO language	Narrative convergence
Growth claimed to be decoupled from marine ingredients	IFFO says that absolute marine-ingredient volumes have remained stable while declining inclusion rates have enabled aquaculture to grow. It argues that fishmeal and fish oil are increasingly used as strategic ingredients whose use can be ‘optimised’ to support continued expansion.	Barange told NGOs that improved formulation, selective marine-ingredient use and by-products had allowed aquaculture to grow ‘without requiring a larger volume of marine ingredients as feed’. SOFIA 2026 similarly says aquaculture growth has not increased pressure on reduction fisheries globally. The GSA call for reduced wild-fish use and improved feed efficiency.	FAO’s own data show that aquaculture’s share of global fishmeal use rose from around 10% to 90% between 1980 and 2024, while its fish-oil share rose from roughly 1% to 63%. Stable supply therefore conceals aquaculture’s takeover of a finite resource. The modelling shows that absolute whole-wild-fish demand will rise further if feed-intensive production continues expanding.
Farmed output used to demonstrate food-security value	IFFO claims that aquaculture produced more fish protein than it consumed and that every kilogram of wild fish used produced 4.55 kg of farmed fish. At the Ghana workshop, Brett Glencross argued that marine ingredients could “magnify the fish outputs from utilized fish at a 5:1 ratio”.	Barange’s response emphasised aquatic foods’ “high food to flesh efficiency”, while the GSA focus on reducing wild-fish inputs and improving feed efficiency.	Both privilege output and conversion ratios as evidence of sustainability. These metrics do not reveal whether nutrients are lost, whether absolute wild-fish use is increasing, whether additional terrestrial feed inputs are required, or whether the resulting farmed fish is accessible to people who previously consumed the feed fish.

Theme	Industry language	FAO language	Narrative convergence
Edible fish reframed as a strategic feed ingredient	Glencross described marine ingredients as a “highly cost-effective source of widely bioavailable nutrients” whose palatability enables the use of a broader range of feed materials. IFFO similarly describes marine ingredients as ‘irreplaceable’ strategic components of aquafeed.	FAO’s response emphasises ‘selective use’ of fishmeal and fish oil, while the GSA promotes gradual reduction and more efficient use rather than establishing that edible fish should be prioritised for direct human consumption.	Nutritionally valuable wild fish are framed primarily as functional ingredients that improve feed performance. Their value as affordable food is subordinated to their capacity to support and optimise aquaculture production.
Responsible sourcing substitutes for allocation limits	MarinTrust says its standard increases access to responsibly sourced marine ingredients and encourages by-product use. Industry presents certification, traceability and fishery improvement projects as evidence that continued FMFO production can be sustainable.	FAO’s guidance on the ‘Responsible use of fishmeal in aquaculture’ centres responsible sourcing, efficient use, governance and management. The final GSA similarly focus on preventing or minimising harms rather than setting an absolute limit on edible wild-fish use.	Focus shifts from whether edible fish should be diverted into feed to whether that diversion can be managed ‘responsibly’. Responsible sourcing may address conditions of production, but it does not resolve competition with direct human consumption or establish whose nutritional needs should take priority. No precautionary approach as to volumes taken from the sea.
Conflict reframed as perception and trade-off	IFFO argues that the widely cited 5:1 FIFO ratio created ‘an unjustified a priori case against the use of fishmeal and fish oil in aquaculture feed’.	FAO’s fishmeal guidance discusses ‘negative perceptions’ surrounding fishmeal use. Barange writes that there are ‘no perfect solutions’, but that appropriate management and ‘consideration of trade-offs’ can help address hunger and malnutrition. Final GSA speaks of minimising direct impacts rather than resolving them.	Criticism of marine-ingredient use is increasingly treated as a problem of perception, outdated metrics or advocacy rather than a substantive dispute over absolute extraction, food allocation and ecological limits. This framing is visible in Barange’s 2026 interview, where he described aquaculture feed as a source of ‘much misconception’ and associated negative fisheries stories with actors pursuing ‘their own agendas’. It also echoes a 2024 Marine Policy paper co-authored by Ray Hilborn—an influential but controversial fisheries scientist whom Greenpeace has described as an ‘overfishing denier’—and reviewed by Barange, which argued that errors and bias in conservation literature distort fisheries policy and public perceptions. Yet questioning critics’ perceptions or motives cannot answer evidence that aquaculture has become the dominant FMFO consumer, that more than a third of assessed marine fish stocks are fished at biologically unsustainable levels, or that industry analysts anticipate shortages.

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