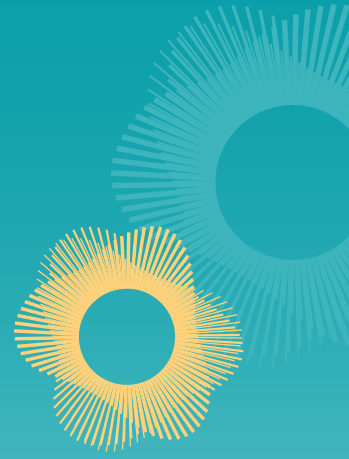


Aquaculture Dynamics

Constraints and Opportunities for Aquaculture Development in Southern Mozambique



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About this report

This report provides insights on the challenges faced by Mozambique’s aquaculture sector, with a particular focus on Southern Mozambique, and proposes actions to overcome them. After providing a snapshot of the state of fish production, the availability of inputs, and techniques and production systems across the region’s value chain, it sheds light on key constraints and opportunities for the development of the aquaculture industry in Southern Mozambique by examining six components, namely, the area’s geography,

local production and commodities demand, access to inputs and production costs, the agroecological situation, technical governance structures, and the environment and ecosystem. Based on these observations, a series of recommended actions is proposed to support the development of Southern Mozambique’s aquaculture sector in line with the Government of Mozambique’s development objectives.

Acknowledgements

This report is based on analysis conducted by a dedicated team led by João Moura (Natural Resources Management Specialist, Task Team Leader). The team included Pierre-Philippe Blanc (Senior Aquaculture Specialist Consultant), Elisa Vicente (Senior Environmental Specialist Consultant), Jorge Barbosa (Senior Aquaculture Specialist Consultant), Juliana Castañó-Isaza (Natural Resources Management Specialist), Manuel Mutimucuío (Natural Resources Management Specialist), and William Leschen (Senior Aquaculture Specialist Consultant). Pierre-Philippe Blanc was the lead writer, crafting the narrative with input from other team members. Jorge Barbosa conducted a survey of feed and fry that provided invaluable insights into the current challenges facing Southern Mozambique. William Leschen provided valuable insights on institutional aspects of aquaculture development. João Moura, Pierre-Philippe Blanc, and Elisa Vicente carried out two field missions, the findings of which underpinned much of this report.

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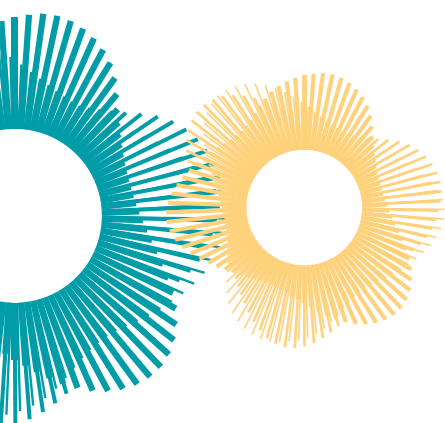
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ACRONYMS AND ABBREVIATIONS

AAM	Mozambique Aquaculturists Association (<i>Associação de Aquacultores de Moçambique</i>)
AMAQUA	Mozambican Aquaculturists Association (<i>Associação Moçambicana de Aquacultores</i>)
ADNAP	National Fisheries Administration (<i>Administração Nacional das Pescas</i>)
CEPAQ	Centro de Pesquisa em Aquacultura (<i>Center for Aquaculture Research</i>)
DPAP	Provincial Directorate of Agriculture and Fisheries (<i>Direcção Provincial de Agricultura e Pescas</i>)
EDA 2020–2030	Aquaculture Development Strategy 2020–2030 (<i>Estratégia de Desenvolvimento da Aquacultura 2020–2030</i>)
EIA	Environmental Impact Assessment
FSRP	Food Systems Resilience Programme
IFAD	International Fund for Agriculture Development
IDEPA	National Institute for the Development of Fisheries and Aquaculture (<i>Instituto Nacional de Desenvolvimento de Pescas e Aquacultura</i>)
INOM	Oceanographic Institute of Mozambique (<i>Instituto Oceanográfico de Moçambique</i>)
IIAM	Mozambique Agriculture Research Institute (<i>Instituto de Investigação Agrária de Moçambique</i>)
INAM	National Meteorological Institute (<i>Instituto Nacional de Meteorologia</i>)
INAQUA	National Aquaculture Development Institute (<i>Instituto Nacional de Desenvolvimento de Aquacultura</i>)
INIP	National Institute of Fish Inspection (<i>Instituto Nacional de Inspeção do Pescado</i>)
MADER	Ministries of Agriculture and Rural Development (<i>Ministérios da Agricultura e Desenvolvimento Rural</i>)
MIMAIP	Ministry of Sea, Inland Waters and Fisheries (<i>Ministério do Mar, Águas Interiores e Pescas</i>)
SDAE	District Services of Economic Activities
UEM	UEM Biotechnology Center Maputo (<i>Universidade Eduardo Mondlane Centro Biotecnologia</i>)
VAT	Value added tax

LIST OF SCIENTIFIC NAMES

Black tiger prawn	<i>Penaeus monodon</i>
Carp	<i>Cyprinus carpio</i>
Catfish	<i>Clarias species</i>
Chichlids	Family <i>Cichlidae</i>
Freshwater shrimp	<i>Macrobrachium rosenbergii</i>
Indian white prawn	<i>Penaeus indicus</i>
Marine brown mussel	<i>Perna perna</i>
Milkfish	<i>Chanos chanos</i>
Mud crab	<i>Scylla serrata</i>
Mullet	Family <i>Mugilidae</i>
Sand mussel	<i>Modiolus philippinarum</i>
Sea cucumber	<i>Holothuria scabra</i>
Seaweed	<i>Eucheuma denticulacum</i> and <i>Kappaphycus alvarezii</i>
Tilapia	Native to Mozambique: <i>Oreochromis mossambicus</i> Non-native: <i>Oreochromis niloticus</i>



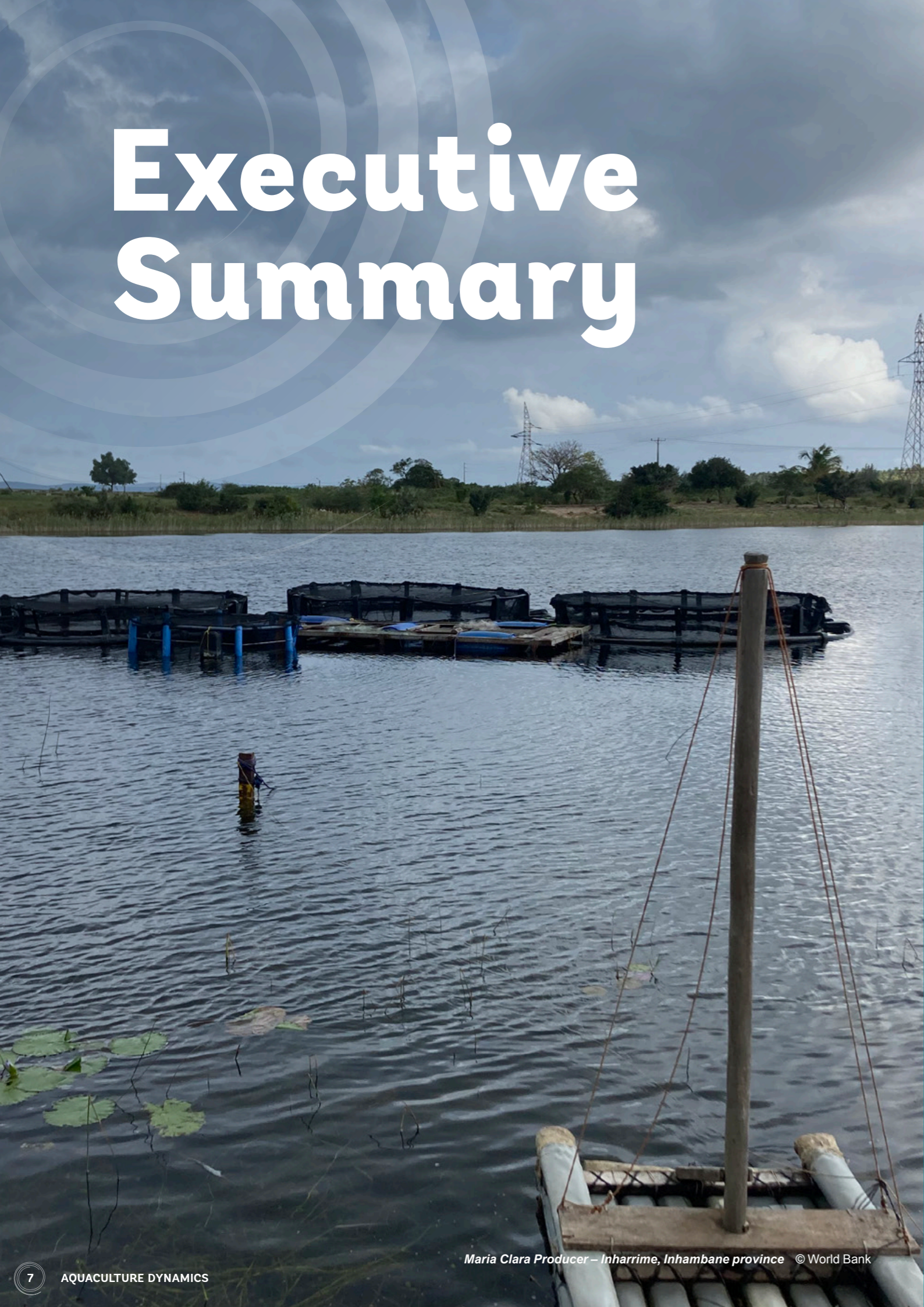
Executive Summary

Aquaculture in Mozambique remains at an early stage of development despite more than 30 years of investment by the Mozambican government, development partners, and the private sector, complemented by a growing demand for fish and fish products. Production in 2021 was estimated at 4,123 metric tons (tons), which is about 1 percent of the total wild catch of the country. In the same year, the total value of the country's aquaculture production was estimated at US\$6.9 million.

The stagnant growth of the aquaculture sector can be attributed to several constraints. Southern Mozambique, particularly the provinces of Maputo, Gaza, and Inhambane, has shown potential for aquaculture development, with a significant portion of the production originating from commercial farms.



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Constraints

Mozambique's aquaculture sector faces a wide array of challenges that limit its development. Our study identified the most impactful challenges as follows:



Insufficient and poor-quality aquaculture inputs, including commercially formulated fish feed and fingerlings, have hindered the sector's growth.



Limited access to credit has been a significant bottleneck for aquaculture development in Mozambique.



Limited investments in research and extension services have hampered the development of the aquaculture industry.



Climate change and a cooler environment can lower production volumes, and Southern Mozambican farmers must adapt their strategies to these conditions.



The reduced number of technicians and extension workers has limited the dissemination of technical knowledge among local fish farmers.



The small sector size results in a mismatch between supply and demand, limiting the growth of both sides of the equation.



Inefficiencies in sector governance and the limited connections between the actors limit coordination for sector development.



Administrative requirements place time and cost burdens on existing and new aquaculture actors.



Poelela farm, Inhambane province © World Bank

Opportunities

For the past few decades, the government has expressed renewed interest in freshwater fish farming in particular as a means to supply fish to rural populations that have limited access to animal protein and are beyond the reach of existing marine and freshwater fish distribution networks.



The demand for aquatic products is significant, particularly in and around major urban centers such as Maputo, Inhambane, Xai-Xai, and Maxixe.



The tourism and catering industry represents a significant opportunity for increasing demand for aquaculture products.



The region offers development potential for various aquaculture commodities—including tilapia, mussels, catfish, sea cucumber, seaweeds, freshwater shrimps, carps, clams, milkfish, and mullet—tailored to market specificities.



The aquaculture sector has the potential to contribute to poverty reduction and create job opportunities, particularly for the youth and women, who make up more than 50% of the sector's workforce.



Southern Mozambique's seasonal lakes present unique opportunities for extensive aquaculture which requires fewer inputs than intensive aquaculture.



Infrastructure links offer good access to domestic and international inputs and enable market access and demand for aquaculture products.

Recommendations

The report makes several recommendations that aim to address the challenges and take advantage of the opportunities for aquaculture in Mozambique, with a focus on the South. These recommendations include:



Revise and update potential areas for aquaculture development to inform public policy and investment facilitation efforts.



Strengthen technical knowledge and skills among local fish farmers through coordinated actions and network development within the public and private sector.



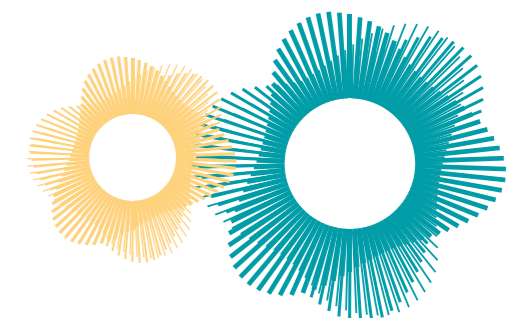
Efficient extension services—both government and private sector led—are crucial for the sustainable development of aquaculture. Adapt the coordination and technical preparation of government extension services to sector development challenges and align it with extension initiatives of the private sector.



Develop stronger networks and connections between public and private sector actions to adapt to sector needs and support the implementation of sector-specific solutions and assistance.



The aquaculture sector in Southern Mozambique has significant potential for growth. Addressing the identified constraints while leveraging the available opportunities can lead to sustainable and resilient development of the industry.

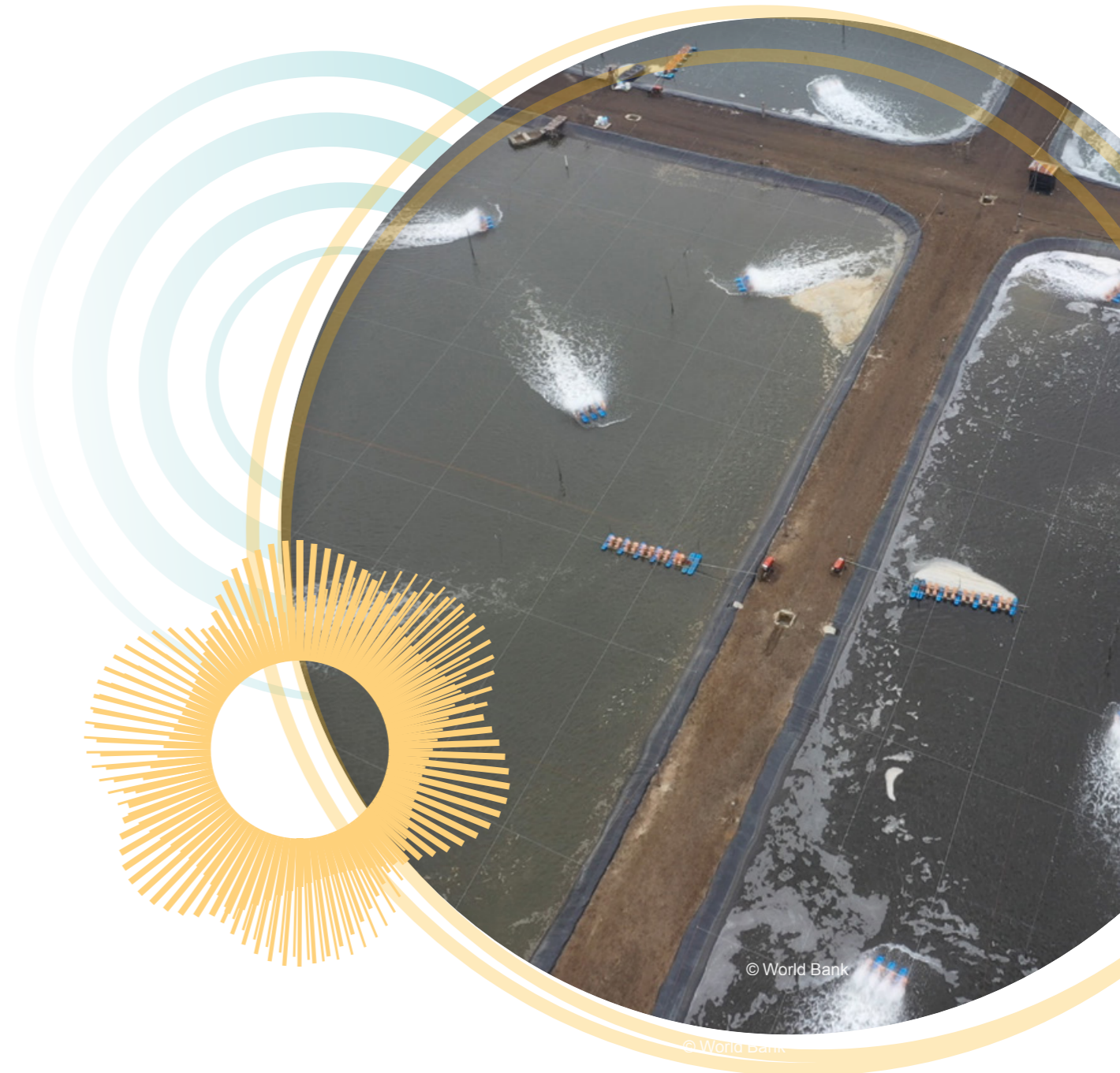


1

Introduction



This report consolidates the analytical findings of two technical missions to Mozambique between 2022 and 2023 and subsequent thematic studies that focus on the status of feeds and seeds and their impact on sector development, and the governance and interactions between the public and private aquaculture actors in Southern Mozambique. It concludes with a set of recommendations to further develop aquaculture in three Southern Mozambique provinces (Maputo, Gaza, and Inhambane) in line with the Government of Mozambique's objective of developing aquaculture to improve nutrition security and enhance livelihoods.



Overview of Mozambique's aquaculture sector



Policy and institutional context

National strategy

The aquaculture sector is a government priority (ProAzul 2021) and has the potential to contribute substantially to the country's socioeconomic development by providing affordable protein and creating jobs and income-generating opportunities. The first Aquaculture Development Strategy in Mozambique 2008–2017, approved in 2007, was concomitant with the creation of the Instituto Nacional de Desenvolvimento de Aquacultura (INAQUA, the National Aquaculture Development Institute), which aimed to promote the development and sustainable management of aquaculture in Mozambique (Mapfumo *et al.* 2009). The strategy focused on more effectively exploiting natural resources, with aquaculture identified as having the potential to support economic growth and reduce poverty levels. In particular, the strategy aimed to create a more competitive, sustainable, and diversified sector.

The follow-up Aquaculture Development Strategy 2020–2030 (*Estratégia de Desenvolvimento da Aquacultura 2020–2030*, EDA 2020–2030) was approved by the Council of Ministers in 2020 with the aim of promoting the development of aquaculture in Mozambique. EDA 2020–2030 aims to promote the development of aquaculture in Mozambique by exploiting the existing national potential in a way that is socioeconomically and environmentally sustainable. The approach prioritizes minimizing wild catching by increasing farmed fish production while combating malnutrition and income generation in households by promoting, expanding, and managing aquaculture activity. Box 1 below provides key details on EDA 2020–2030.

BOX 1: OVERVIEW OF MOZAMBIQUE'S AQUACULTURE DEVELOPMENT STRATEGY 2020–2030

The objectives of Mozambique's Aquaculture Development Strategy 2020–2030 (EDA 2020–2030) are organized into four pillars: (i) production and productivity, (ii) private investment and access to financing, (iii) access to the market, and (iv) training and institutional development.

The EPA 2020–2023 includes establishing aquaparks, industrial catalysts, and producer clusters. Specific locations (centralities) are identified to prioritize interventions in a way that ensures efficient resource allocation, while private-public community partnerships are encouraged to support development of the value chain.

The aquapark model allows producers to pool infrastructure and resources, thereby improving zoning plans, the use of aquaculture area, and overall freshwater body management. These aquaparks are classified according to production infrastructure (tanks or cages), the system adopted (extensive, semi-extensive, intensive), likely production volumes (low/135 tons, medium/200 tons, or high/more than 200 tons), and whether the supporting investments are private, public, or mixed. The Ministerial Diploma 108/2023 of 11 August approved the legal framework for aquapark implementation.

EDA 2020–2030 provides a detailed action plan for the first five years of its implementation, with a mid-term evaluation in the third year. At the end of the five-year period, a comprehensive evaluation will be conducted to take stock of achievements and prepare a new action plan for the remaining duration.

While EDA 2020–2030 aims to drive the sustainable growth of aquaculture in Mozambique by setting clear objectives, prioritizing interventions in specific locations, and fostering partnerships between the public, private, and community sectors, implementation is slow largely due to insufficient human and financial resources being directed to its implementation.








CEPAQ Research Center, Chokwe District, Gaza province © World Bank


Key national and subnational institutions

The Government of Mozambique appointed the *Ministério do Mar, Águas Interiores e Pescas* (MIMAIP, Ministry of Sea, Inland Waters and Fisheries) as the government entity responsible for fisheries and aquaculture, among other responsibilities, in 2015. While the country has many other institutions with some role on aquaculture development, the main ones based at MIMAIP are:


 **The Instituto Oceanográfico de Moçambique (INOM, National Oceanographic Institute of Mozambique)**, which is responsible for developing fisheries and aquaculture and contributing to the wellbeing of fishery and aquaculture communities. INOM oversees the Centro de Pesquisa em Aquacultura (CEPAQ, Center for Aquaculture Research) (see box).


 **National Fisheries Administration (ADNAP)**, which is tasked with ensuring the responsible and sustainable development of fishing and aquaculture, and with contributing to the conservation of aquatic resources.

 **National Institute of Fish Inspection (INIP)**, which is responsible for ensuring food safety in fishery and aquaculture products.

 **The Blue Economy Development Fund (ProAzul)**, which promotes blue economy activities through funding and project support.

Mozambique's provinces consist of districts and municipalities that oversee local governance and administration. Mozambique also legally recognizes the authority of traditional community leaders, who are responsible for smaller community structures. At the subnational level, key institutions from an aquaculture perspective are:

 **The Provincial Service of Economic Activities (SPAÉ)**, which is responsible for preventing and controlling pests and phytosanitary diseases; supporting local seed production; providing training to aquaculture professionals; controlling fishing activities through licensing and monitoring; and managing marine conservation areas.

 **The Provincial Directorate of Agriculture and Fisheries (DPAP)**, which is responsible for aquaculture development, licensing, technical assistance, and building capacity and providing training to aquaculture producers.

These government bodies each play an important role in aquaculture development. However, for a sector producing just a few thousand tons of product, the risks of overlapping and replication are high and present an important constraint for private sector involvement.

In addition to the entities noted on previous page, the *Instituto Nacional de Desenvolvimento de Pescas e Aquacultura* (National Institute for the Development of Fisheries and Aquaculture, IDEPA) was established as a public entity by decree (No. 3/2016) in February 2016 through the merging of the National Institute of Aquaculture and the National Institute

of Small-Scale Fisheries Development. IDEPA's primary objective is to promote the development of fisheries and aquaculture. It is also responsible for coordinating the activities related to experimentation, demonstration, and extension of fishing activities by providing a unified platform for fisheries and aquaculture in Mozambique.

BOX 2: CEPAQ, THE CENTER FOR AQUACULTURE RESEARCH

CEPAQ, managed by the Instituto Oceanográfico de Moçambique (INOM, the Oceanographic Institute of Mozambique), is a project developed to supply quality tilapia fry to the market, manage genetic selection, and provide a place for research activities. CEPAQ's main function is to act as a service center to facilitate private sector investment in the field of aquaculture by: (i) developing faster-growing strains of tilapia, (ii) producing high-quality fry for fish farms, (iii) breeding broodstock for other ponds, and (iv) drawing up production support protocols (Norges Vel and KPMG 2023). The center currently has the support of Norway and Iceland from 2013 to 2024, covering most operating costs.

The center offers an area for research and development, a hatchery, and the presence of technical knowledge hosting government institutions. Today, it focuses on the genetic selection of *Oreochromis mossambicus*, a program started six years ago. However, fingerling production does not use the center's full potential and it sells very low volumes (about 300,000 fingerlings yearly) to the private sector. The center faces a lack of connection with the private sector. Its activities in research and development are also limited.

Figure 1: CEPAQ research center



Source: Norges Vel

CEPAQ is an appealing asset for aquaculture development in the area. However, despite more than 10 years of support, it has still not settled on a development model or an economic model, and has very few income-generating activities. A report by Norges Vel and KPMG (2023) stated that "building the sustainability of CEPAQ will take many years to accomplish. During that period, CEPAQ needs to have a clear role in the value chain, with a combination of predictable public funding (national and international) and independently generated income.

The independent income will require a different business model (CEPAQ Operating Company or an alternative), a line of services to be sold, and possibly other forms of research collaboration at the international level".

Legal and regulatory framework

The Constitution of the Republic of Mozambique defines the right of all citizens to a balanced environment and the duty to protect it (Article 90). In addition, the state is required to ensure the promotion of initiatives to ensure ecological balance and environmental preservation, and the implementation of policies to prevent and control pollution and integrate

environmental concerns in all sectorial policies so as to guarantee citizens the right to live in a balanced environment supported by sustainable development (Article 117). Annex B presents all existing legislation and regulations relevant to aquaculture development.

Associations

Associations are one of the main channels to govern and connect private sector and public sector actions in aquaculture. Currently, Mozambique has two formal aquaculture associations: the *Associação Moçambicana de Aquacultura* (AMAQUA) and the *Associação de Aquacultura de Moçambique* (AAM). AMAQUA was founded in 2015 and is

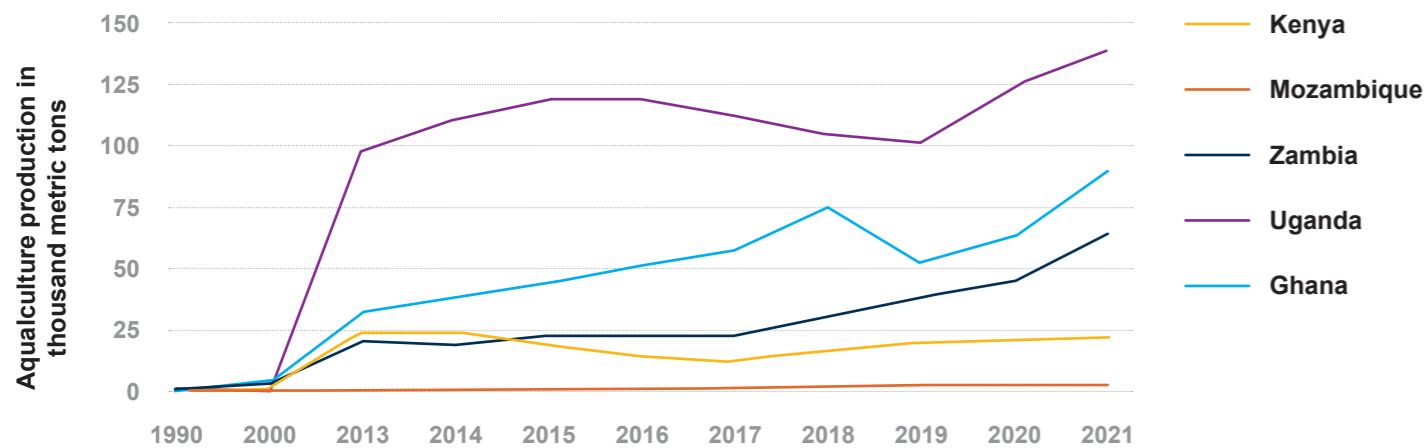
fully registered as an association. It has seven members that represent 80 percent of Mozambique's aquaculture production due to the larger commercial farm members. AAM is a fully registered association founded in 2023. It focuses mainly on small-scale aquaculture and its members represent many actors in Mozambique's three southern provinces.

Current production

Between 2000 and 2021, global aquaculture nearly trebled in size due to investments and innovations in associated value chains (Belton and Thilsted 2014, FAO 2022b, Pauly and Zeller 2019). This pattern was amplified across Eastern and Southern Africa, where aquaculture production multiplied by 5.5

(from 74,000 to 410,000 tons), and in Western and Central Africa, where production multiplied by more than 12 times over the same period, with Uganda and Ghana at the forefront (Figure 2).

Figure 2: Aquaculture production in thousand metric tons for the past two decades for Mozambique, Kenya, Zambia, Uganda, and Ghana



Source: World Bank 2023.

Data regarding aquaculture production within Mozambique vary greatly depending on the source of the study, likely due to the lack of a formal registration and licensing mechanism. Some government estimates indicate that aquaculture production increased 6.5 times, from less than 850 tons in 2010 (79 percent which came from industrial shrimp) to just more than 5,500 tons in 2022 (Table 1) (MIMAIP 2022).

Of this, almost half the production came from small-scale production units. However, this sixfold increase in production was not matched by a proportional increase in value, which, according to government estimates, increased just more than four times, from 105 million meticaís (Mt) to 442 million Mt (US\$1.6 million to US\$6.9 million) (Table 2).

Table 1: Mozambique's aquaculture production (in tons)

Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Industrial	667	512	194	207	387	276	241	408	590	1,312	1,454	2,203	2,832
Marine shrimp	667	506	39	10	0	0	0	0	21	33	150	260	0,190
Marine fish	0	6	70	130	150	0	0	0	0	0	0	0	0
Freshwater fish	0	0	85	67	237	276	241	408	569	1,279	1,304	1,943	2,642
Small scale	177	284	409	514	792	857	939	1,427	2,654	2,458	1,858	1,920	2,688
Freshwater fish	177	284	409	514	792	857	939	1,427	2,654	2,458	1,858	1,920	2,688
Total	844	796	603	721	1,179	1,133	1,180	1,835	3,245	3,770	3,312	4,123	5,520

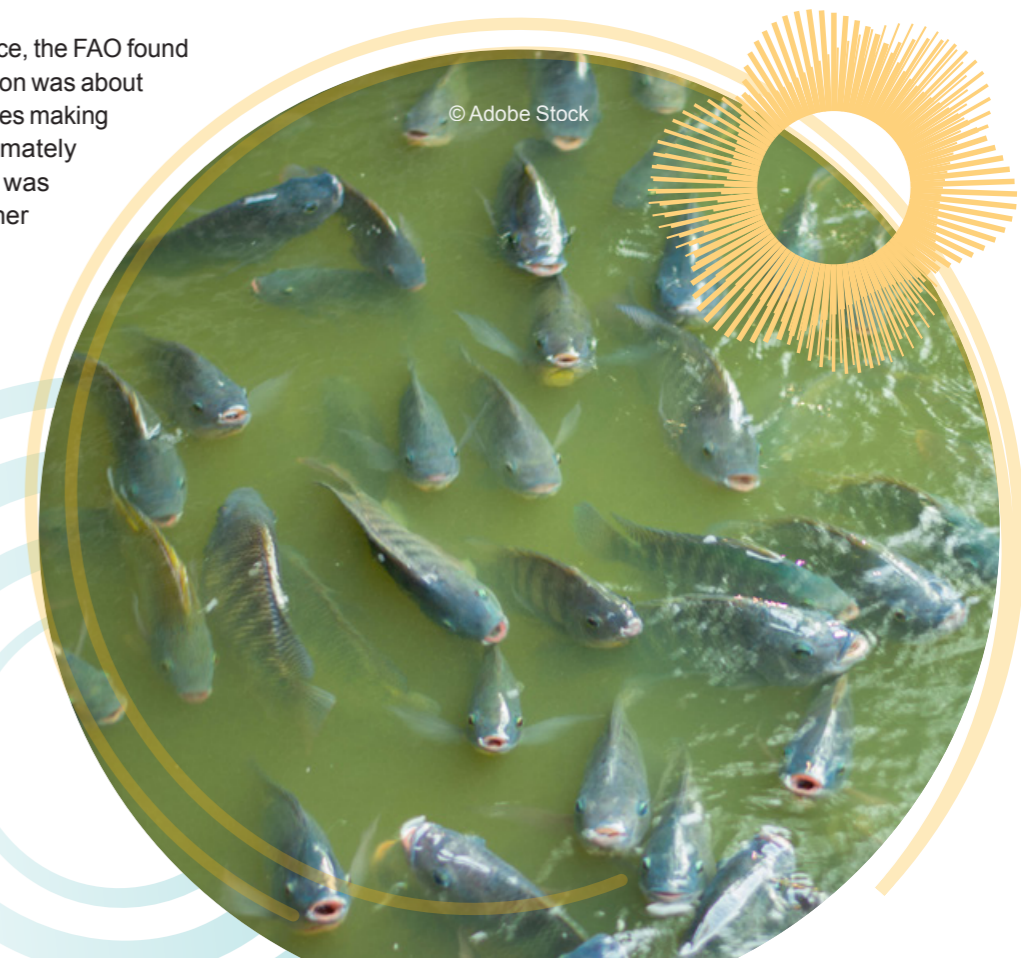
Source: MIMAIP 2022.

Table 2: Value of aquaculture production in thousand meticaís

Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Industrial	667	512	194	207	387	276	241	408	590	1,312	1,454	2,203	2,832
Marine shrimp	667	506	39	10	0	0	0	0	21	33	150	260	0,190
Marine fish	0	6	70	130	150	0	0	0	0	0	0	0	0
Freshwater fish	0	0	85	67	237	276	241	408	569	1,279	1,304	1,943	2,642
Small scale	177	284	409	514	792	857	939	1,427	2,654	2,458	1,858	1,920	2,688
Freshwater fish	177	284	409	514	792	857	939	1,427	2,654	2,458	1,858	1,920	2,688
Total	844	796	603	721	1,179	1,133	1,180	1,835	3,245	3,770	3,312	4,123	5,520

Source: MIMAIP 2022.

Demonstrating how data differs by source, the FAO found that 2022 national aquaculture production was about 3,200 metric tons, with freshwater species making up the bulk of production (at approximately 2,900 tons). Of this, nearly 300 tons was shrimp and 2,900 tons came from other aquaculture species, primarily tilapia.



BOX 3: PRODUCTION ASSUMPTION AND PROJECTIONS

The Aquaculture Development Strategy 2020–2030 presents overly ambitious average annual growth projections, with 2023 production projections far from being realized (Table 4).

Table 3: Aquaculture Development Strategy's annual average aquaculture production projections between 2019 and 2030 (in tons)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Commercial	1,313	1,648	2,059	2,677	3,748	5,997	59,800	74,750	112,125	168,187	252,281	349,500
Small-scale	2,458	2,471	6,438	13,036	19,642	21,923	30,832	34,050	37,605	41,534	45,877	50,675
Total	3,771	4,119	8,497	15,713	23,390	27,920	90,632	108,800	149,730	209,722	298,158	400,176

Source: EDA 2020–2030.

FAO projections based on the actual increase in aquaculture production in Mozambique between 2017 and 2021 found that the country's aquaculture production is expected to reach 6,224 tons by 2030 in a business-as-usual scenario.

However, in order to generate sufficient supply to cover the additional demand that population growth will place on fish products by 2030, the country's aquaculture production should reach 138,275 tons to cover needs (with a 43.7 times growth; 45.91 percent per year between 2020 and 2030) without relying on additional imports (FAO 2024).

The current report draws on FAO figures for 2022, which was cross-checked using data collected from farm owners and with aquaculture associations during field visits in 2023. This data points to 3,200 tons of production on the national level in 2022, of which 500 tons can be attributed to the three provinces of Southern Mozambique.

Based on this data, and assuming a tenfold increase in aquaculture by 2030 (an optimistic yet feasible assumption based on regional trends—see below), the current analysis expects Mozambique to produce 32,000 tons as a whole, of which about 15 percent (4,800 tons) could come from Southern Mozambique by 2030. A tenfold increase in annual production is still less than 1 percent of the government's EDA 2020–2030 projection of 400,000 tons for the country by 2030.

Regional trends in aquaculture production

East African countries are experiencing rapid growth in aquaculture production:

- **Zambia** increased its aquaculture production by more than six times in 10 years: from 10,000 tons in 2010 to 63,000 tons in 2020.
- **Uganda** increased its aquaculture production more than twelvefold in 15 years: from 10,000 tons in 2005 to 123,000 tons in 2020.
- **Ghana** increased its aquaculture production almost ninefold in 11 years: from 10,000 tons in 2010 to 83,900 tons in 2021.

Source: World Bank and FAO 2021

Annual aquaculture production of 32,000 tons would create about 15,000 jobs in production and input supply alone across the three provinces. These figures have been extrapolated from 2022 production and number of workers, and do not include income-generating activities created in other segments of the value chain, such as retailers, wholesalers, and at market level.

Development programs supporting aquaculture sector growth should look beyond 2030 to ensure that the sector is equipped to handle at least a twentyfold increase in production¹. Such value chain development programs should focus on activities that would proactively drive the sector's growth, such as ensuring adequate animal feed and seed supply; extension services; disease control measures; and all other necessary controls to support the sector's development.

Current export markets

Countries in the Southern Africa Development Community (SADC) and Southern Africa Custom Union (SACU) present an important export market for Mozambique's fish products. Of the SADC and SACU countries, South Africa and Zimbabwe reported the highest import volumes of fish products from Mozambique in 2015. In terms of Mozambique's global export values, South Africa and Zimbabwe ranked fourth and fifth, respectively, surpassed by Portugal, Spain, and China (UNCTAD 2017). Zimbabwe in particular imports large volumes of freshwater small pelagic fish (kapenta) from the semi-industrial sector.

Shrimp currently has the highest export market value of all aquaculture species, while industrial aquaculture has improved tilapia's modest value and irregular production. Commercial farms (such as Chicoa and Papá Pesca) take an export approach and their expansion model primarily focuses on niche urban markets.

Traditional and artisanal fish processing methods (salting, drying, and smoking) used for fisheries products are also used in rural areas for aquaculture fish, of which an unknown quantity is informally exported to neighboring countries (Tanzania, Malawi, Zimbabwe, and the Democratic Republic of Congo). Fish exports to Tanzania come from Cabo Delgado province, and exports to Malawi come from Nampula, Zambézia, Sofala, and Cahora Bassa dam. Fish exported to Zambia comes from Tete (Cahora Bassa Dam). Most of the products are dried or smoked, except for those exported to South Africa, which tend to be frozen shrimp and fish (WorldFish Center 2007).

The demand for tilapia aquaculture in the region is exemplified by the purchase and informal export of dried, small-size marine tilapia from Zambézia province. These aquaculture products are reportedly bought in Quelimane and transported to Malawi and Zimbabwe by local wholesalers. This spontaneous demand and distribution network illustrates the potential dynamism of the aquaculture sector.

Table 4: Mozambique's aquaculture production from 2017 to 2021 in tons (excluding seaweed)

Type of Aquaculture	Volume (metric tons)					Annual average
	2017	2018	2019	2020	2021	
Marine – shrimps	0	21	33	150	260	93
Freshwater – commercial	408	569	1,279	1,304	1,944	1,101
Freshwater – artisanal	1,427	2,654	2,458	1,858	1,920	2,063
Total	1,835	3,244	3,770	3,312	4,124	3,257

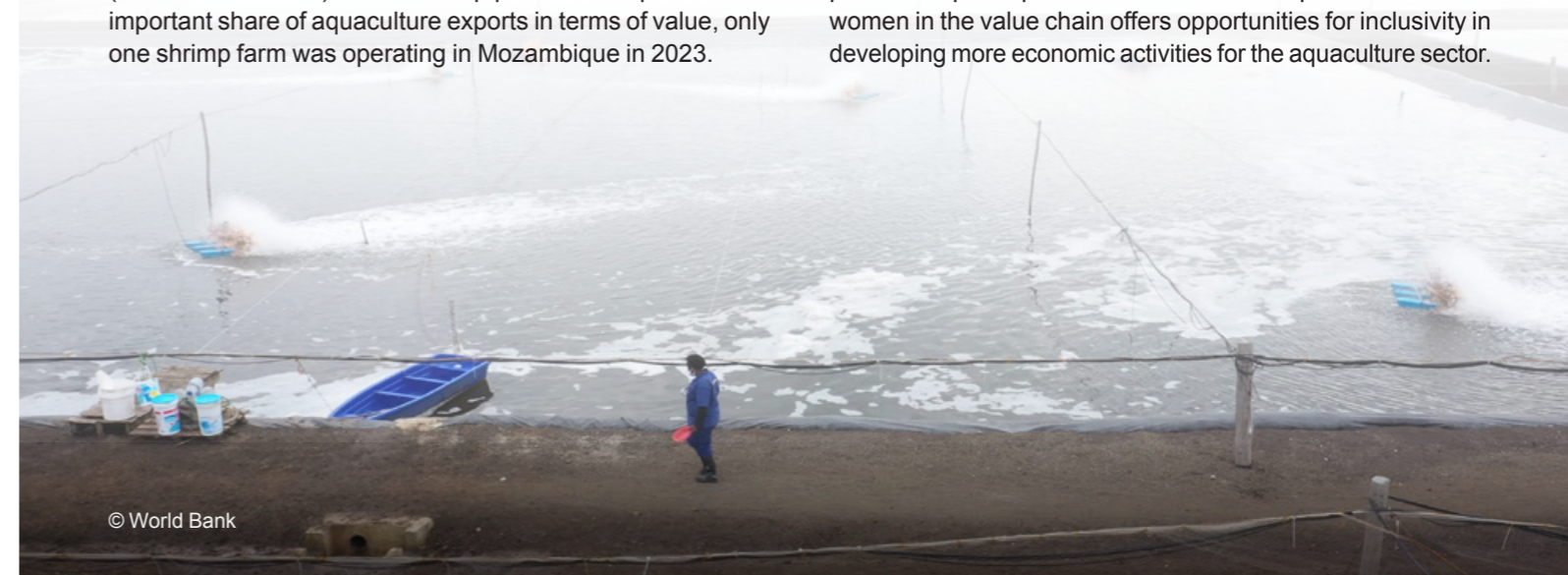
Source: IDEPA 2022.

Farmed species

Commonly farmed marine species in Mozambique include finfish, seaweed (including *Eucheuma spinosum* and *Kappaphycus alvarezii*), and shrimp (*Peneaus monodon*). Freshwater fish farming is currently dominated by freshwater species of tilapia (genus *Oreochromis*), with pond sizes ranging from 150 square meters (m²) to 300 m² on average (Muhala et al. 2021). While shrimp production represents an important share of aquaculture exports in terms of value, only one shrimp farm was operating in Mozambique in 2023.

Contribution to employment

The preliminary results of the *Censo da Pesca Artesanal e Aquacultura* (CEPAA, Artisanal Fishing and Aquaculture Census) (IDEPA 2022) found that Mozambique's aquaculture sector employs 23,305 people, of which 2,682 are based in Southern Mozambique (Table 5 and Table 6). Women represent 71 percent of aquaculture owners and almost 51 percent of participants in the sector. The predominance of women in the value chain offers opportunities for inclusivity in developing more economic activities for the aquaculture sector.



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¹ A twentyfold increase in the aquaculture sector by 2030 would mean an annual production of 65,000 tons of product for Mozambique, and up to 10,000 tons for the three southern provinces

Table 5: Number of people involved in aquaculture in Mozambique by type of involvement, sex, and province, in 2022

Province	Owners			Workers			Other professionals			Total people
	Men	Women	Total	Men	Women	Total	Men	Women	Total	
Maputo City	3	23	26	70	10	80	0	0	0	106
Maputo	20	124	144	520	345	865	112	315	427	1,436
Gaza	50	90	140	503	497	100	0	0	0	1,140
Inhambane	83	147	230	370	248	618	11	5	16	864
Sofala	65	461	526	727	397	1,134	20	1	21	1,681
Manica	215	975	1,190	2,832	2,119	4,951	0	0	0	6,141
Tete	15	249	264	1,142	720	1,862	2	0	2	2,128
Zambézia	55	398	453	1,292	1,312	3,604	11	5	16	4,073
Nampula	23	182	205	1,065	805	2,870	7	1	8	3,083
Cabo Delgado	9	83	92	507	237	744	0	0	0	836
Niassa	19	190	209	980	602	1,582	20	6	26	1,817
Total	557	2,922	3,497	12,018	7,292	10,310	183	333	516	23,305

Source: MIMAIP 2022.

Table 6: Number of farmers by type of aquaculture, by province, 2022

Province	Type of aquaculture							Total people
	Subsistence	Artisanal	Experimental	Semi-industrial	Industrial	Research	Training and education	
Maputo Cidade	0	25	0	0	0	1	0	26
Maputo	4	122	13	1	0	3	1	144
Gaza	22	102	4	10	0	1	1	140
Inhambane	34	187	5	1	0	1	2	230
Sofala	45	467	1	9	1	1	2	526
Manica	1,024	150	8	2	1	1	4	1,190
Tete	215	44	2	2	1	0	0	264
Zambézia	169	267	13	2	0	0	2	453
Nampula	116	77	2	10	0	0	0	205
Cabo Delgado	21	71	0	0	0	0	0	92
Niassa	153	51	3	1	0	0	1	209
Total	1,803	1,563	51	38	3	8	13	3,479

Source: MIMAIP 2022.

Extension services

Efficient extension services are crucial for the development of sustainable aquaculture. Extension services help disseminate knowledge, technology, and best practices to farmers, leading to increased productivity, income, and overall growth of the aquaculture sector. Strategies for efficient extension services in aquaculture development include:

- **Tailored training and workshops** that are specific to farmers' needs and the local context
- **Field demonstrations** to show farmers best practices in a real-world setting

- **Farm visits and consultations** to provide on-site guidance, answer questions, and offer recommendations
- **Bringing back information from the field** using a structured methodology and clear objectives to develop a broad understanding of sector development.
- **Regular monitoring and evaluation** to continuously assess the impact of extension services and adjust strategies accordingly.

The government provides extension services to the country's aquaculture sector on an ad hoc basis, free of charge. Field actions appear to be effective, with good connections to existing aquaculture initiatives. The support provided by the government's extension services is real, and many field activities depend directly on the government supplying fry and feed. However, because the support is not provided in sufficient quantities or duration to achieve a satisfactorily

managed cycle, current extension services do not result in sustainable and viable economic improvements.

The private sector also provides extension services through aquaculture schools and youth training programs. Such programs offer financial or operational support to trainees that show promise after several months on production units. This model increases technical capacity in aquaculture by producing skilled technicians with practical production experience.



Fish farmers of Baixa de Macuamene, Inhambane province © World Bank

Challenges faced by the aquaculture sector

The aquaculture sector in Mozambique is nascent and dominated by small-scale aquaculture, which accounts for about 65 percent of total production. The growth of the sector has been affected by climate change, diseases, and economic challenges, including insufficient and poor-quality aquaculture inputs (such as commercially formulated fish feed and fingerlings), limited investments in research and extension services, a reduction in the number of technicians and extension workers, and limited access to credit.

Climate change and other environmental challenges

Climate change

Mozambique is highly vulnerable to extreme weather events, being cyclically affected by floods, cyclones, and droughts, which are becoming increasingly common. According to the United Nations' 2022 Global Assessment Report on Disaster Risk Reduction (UNDRR 2022), Mozambique is the third-most vulnerable country in Africa to disaster risks including droughts, floods, tropical cyclones, and epidemics.

The country's susceptibility to climate variability is due to a combination of geophysical and human factors. More than 60 percent of the country's population lives in low-lying coastal areas, which is vulnerable to rising sea levels and intense

storms from the Indian Ocean. High temperatures and changes in rainfall patterns will also affect the country in years to come.

Aquaculture faces both direct and indirect risks from climate change, including: (i) sea level rise, storm surges, and increased run-off from inland; (ii) changes in rainfall patterns and evaporation rates; (iii) increase in extreme weather events, including more frequent drought periods; (iv) possible changes in habitat and ecosystems; and (v) increased conditions for disease and predation. Any proposed aquaculture model must consider these risks and aim to mitigate their impacts.

Diseases

Biosecurity and aquatic animal health are of paramount importance for a nascent aquaculture sector for several reasons:

- **Prevention of disease outbreaks.** Biosecurity measures help prevent disease outbreaks, protecting the industry from economic losses and maintaining investor confidence.
- **Sustainable growth.** The health of aquatic animals is crucial for sustainability, as healthy animals grow faster and have higher survival rates, leading to increased production and profitability.
- **Market access and consumer confidence.** Compliance with biosecurity standards and disease-free status enhance consumer confidence and facilitate access to domestic and international markets.
- **Environmental protection.** Biosecurity measures help protect local ecosystems from potential ecological damage caused by disease outbreaks.
- **Risk mitigation.** Proper biosecurity planning can mitigate risks associated with limited expertise and infrastructure in a nascent aquaculture sector.

- **Long-term viability.** Early establishment of biosecurity and animal health practices ensures the sector's long-term viability and is more cost-effective than dealing with outbreaks later.
- **Attracting investment.** A commitment to biosecurity and animal health attracts investors, who see it as an indicator of a well-managed and sustainable industry.
- **Compliance with regulations.** Mozambique is engaged in following international trade regulations which include World Organization for Animal Health (WOAH).
- **Knowledge transfer.** Developing expertise in biosecurity and aquatic animal health helps the industry improve over time and adapt to changing conditions.



Currently, Mozambique’s aquaculture industry has very few measures in place for disease prevention and management. However, biosecurity, disease management, and aquatic animal health are critical for the short-term success of a nascent aquaculture sector and its long-term sustainability and growth. Implementing rigorous biosecurity measures and ensuring the health of aquatic animals are investments that pay off in economic, environmental, and social terms.

Mozambique undertook a Performance of Veterinary Services (PVS) evaluation of the Aquatic Animal Health Services in July 2023 to serve as a baseline for biosecurity implementation measures. Manuals based on this evaluation will help to enhance future biosecurity efforts.

The University of Eduardo Mondlane has an ISO-accredited biotechnology laboratory that could be a useful resource to the aquaculture industry. Currently, the lab is the reference laboratory for shrimp white spot disease and can potentially add more analysis to its activities.

Pollution

Pollution challenges to aquaculture include:

- **River water pollution** from industrial activities, agriculture, and domestic waste reaching coastal and marine environments
- **Air pollution** from wood fuel and mining activities
- **Inadequate sewage treatment**, especially in Maputo and the bay ecosystem in the South.

Economic challenges

Economic challenges to the development of the aquaculture sector at the national level include:

- The cost of feed
- Poor coordination of the fry value chain
- The cost of seed and fingerlings
- The size of the aquaculture sector
- An underdeveloped value chain and distribution networks.

These challenges are discussed in greater detail on the next page.

The cost of feed

The price of feed has a major impact on the cost of production and the farm’s profitability. Because fish production depends on feed, a farm’s success depends largely on the quality of the feed it uses.

In 2023, quality feed in Mozambique cost between US\$1.30 and US\$2.35 per kilogram. At US\$1.30 per kilogram, feed represented more than 46 percent of the total production cost; at US\$2.35 per kilogram, a farm cannot make a profit on its fish products. Only bigger farms that can afford to import larger volumes (>100 tons) are able to secure feed at US\$1.30 per kilogram. Most farmers pay significantly more for smaller volumes.

One reason feed is so expensive is the choice of protein source. Fish feed producers and farmers predominantly use fishmeal and vegetable source (mainly soya), although Papá Pesca was testing insect meal and chlorella (see Box 4). However, land-based proteins (such as blood meal and chicken meal) are both cheaper and authorized for aquaculture use in Mozambique and internationally. An optimized formulation could drive down the cost of commercial feed prices to farm arrival prices of less than US\$1 per kilogram. At that price, feed would represent only 30 percent of the production cost.

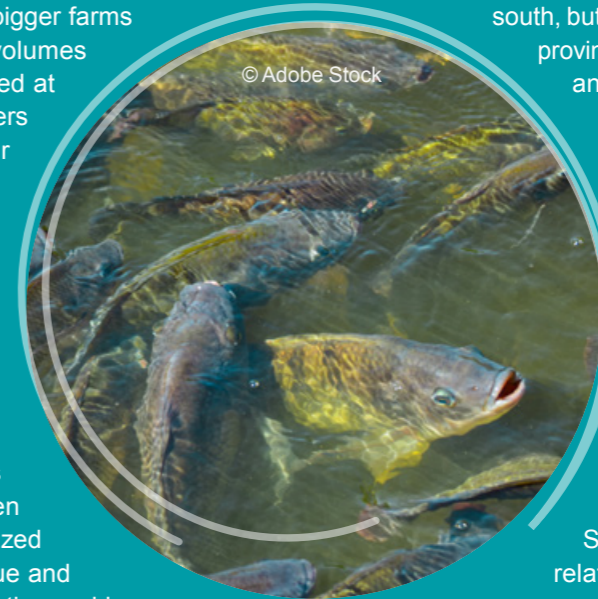
Before 2022, imported fish and tilapia feed was not subject to value-added tax (VAT) or customs tax. That changed in December 2022, when the country included fish feed in the list of duty subject to taxation at an import tax of 7.5 percent (with exemptions for imports from the European Union or SADC countries) and 16 percent VAT on imported feed for tilapia. While farmers can theoretically recover VAT from

imported feed by submitting a reimbursement request from the government, in practice none of the private sector stakeholders consulted reported being able to recover those costs. This import tax, in addition to raw material increases arising from the global economic situation, has made importing feed extremely expensive.

Local production fails to meet fish farmers’ requirements in terms of cost or quality. The problem is worse in the south, but it also affects the central and northern provinces. To mitigate this challenge, ProAzul and IDEPA have funded the construction of several small to medium-sized feed production facilities for the center and the north of the country. Building is scheduled to take place in 2024. One industrial-level feed mill would meet current demand three times over.

For their part, local manufacturers blame lack of demand and the high administrative burden of unit inspections and licenses needed to produce and sell feed. Some of the licenses, especially those relating to health regulations, need to be renewed every three months, which becomes challenging when analyses of production batches are delayed.

As imported feed prices continue to increase, small-scale subsistence fish farmers resort to making their own feed, often under inadequate technical conditions. This low-quality feed is highly inefficient, leading to poor growth, increased costs, and decreased earnings, forcing farmers to abandon aquaculture as a viable option.



Poor coordination of the fry value chain

The rearing of fry is a crucial stage in fish farming, serving as the basis for future commercial production. One of the most pressing challenges in Mozambique's aquaculture value chain is the mismatch between supply of fingerlings and demand from fish producers. Even though hatcheries have ample capacity to produce more fry, fish producers find it difficult to source high-quality fry when they need to. This mismatch has significant implications for the sustainable development of the sector and can be attributed to several factors, including:

- **Lack of production planning.** Some fry producers overproduce due to a lack of market research or prior negotiation with potential clients. Better guidance needs to be given on sizing production in relation to market demand.
- **Lack of efficient distribution channels** can prevent fingerlings from promptly reaching potential buyers.
- **Marketing challenges.** Many fish fry producers need stronger marketing and negotiation skills to better market their products.
- **Lack of logistics.** Farmers cannot afford the logistics required to obtain seeds from a hatchery, and few hatcheries offer delivery.

- **Information asymmetry.** Some fish producers are unaware of the benefits of using quality fingerlings to improve production. Lack of access to information about reliable fry suppliers can also restrict demand.
- **Financial constraints** can limit a farm's ability to acquire good-quality fingerlings, and access to credit is limited.

Many of these issues stem from the quantity of seeds needed: small farmers only require fry infrequently, and in limited amounts. This makes it difficult for hatcheries to plan production around periods of little or no activity.

This mismatch between supply and demand for fingerlings has direct implications for the aquaculture value chain in Mozambique. It affects the financial stability of fingerling producers and the ability of fish producers to achieve their production goals. Further, it creates an atmosphere of uncertainty in the market, which can inhibit investment and aquaculture industry expansion. Resolving this mismatch will be key for promoting a more stable and prosperous business environment for all those involved in the aquaculture value chain in Mozambique.

The cost of seed and fingerlings

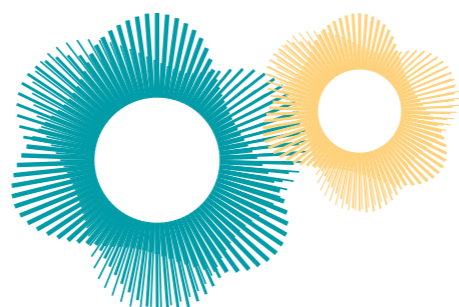
Fry prices range from 5 to 15 Mt per fingerling in Mozambique and the cost to seed 1 kilogram of tilapia is significantly higher in Mozambique than in the rest of the world (at seven to nine times higher than in Brazil and two to three times higher than in countries like Zambia and Uganda). This calculation considers the volume of fry to produce a kilogram of final product, which is directly related to survival rate and size of fish at the harvest. For instance, assuming 80 percent survival one would need 1.25 fry to harvest to 1 kilogram of tilapia, while a harvest of 300 g tilapia with 60 percent survival would need 5.5 fry per kilogram of tilapia.:

Table 7: Price of fry (US\$ per fingerling)

	US\$ per fingerling	Cost of seed to produced 1 kilogram of Tilapia
Mozambique CEPAQ	0.078 to 0.11	0.40
Mozambique Poелеla	0.078	0.312
Mozambique Other	0.07 to 0.094	
Tanzania	0.06 to 0.12	0.34
Zambia	0.046	0.138
Uganda	0.053	0.159
Brazil	0.04253	0.045

Source: World Bank, Aquaculture Association of Tanzania (2023), Associação Brasileira de Piscicultura (2023).

Seed price depends on the hatchery production costs and farm production strategies (the size of their products, survival, and performances). Different farm and feed management strategies could reduce the number of fingerlings needed to reach one kilogram of finished products by two or more by improving survival rates. Most of these improvements do not depend on seed production or hatchery features, but rather on farm management practices. Genetic quality is the only external variable that can be strengthened to improve seed quality.



Aquaculture sector size

Mozambique's aquaculture sector is currently not large enough to enjoy industrial levels of supply and demand. The lack of critical mass means that products and services for the sector are expensive or unavailable in the country. This problem affects all parties in the sector: feed manufacturers and seed suppliers complain about the lack of demand from fish farmers, while farmers complain about the lack of available seeds and feed.

Consider feed production. A medium-sized extruder will produce between five to eight tons per day of feed, or about 1,200 to 2,000 tons per year. Current demand in Southern Mozambique is less than 700 tons per year, or 100 to 180 days of activity of a medium-sized extruded feed unit.

Currently, aquaculture in Mozambique represents a significant risk for potential investors, despite its natural wealth and suitability for aquaculture activities. Development projects could drive demand and supply improvements to support the transition to viable levels.

The critical mass necessary to ensure aligned demand and supply should be considered an objective and not a prerequisite. To achieve a critical mass that will attract further investment, sector development efforts would usefully consider production projections and focus on flexible feed production solutions. Potential production units in the south of the country would do well to focus on meeting national demand in terms of volume and quality.

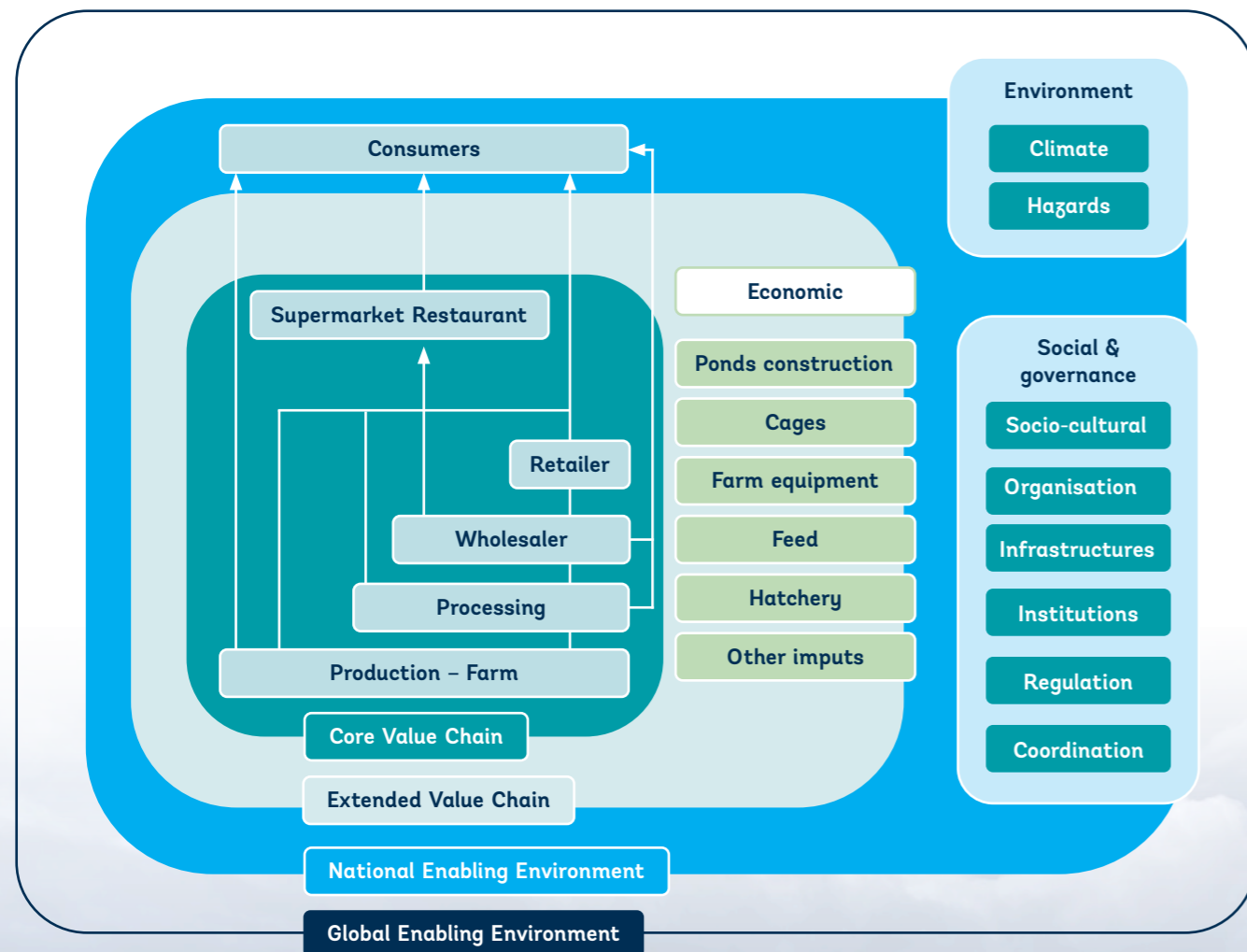


Underdeveloped value chain and distribution networks

The aquaculture value chain consists of a core value chain (focusing on production of the commodity), an extended value chain (focusing on inputs and equipment), and national and global enabling environments (Figure 3). Because the sustainability of the core value chain depends on the extended value chain, it is best to view the aquaculture value chain holistically.

Actors from both value chains need to collaborate and find mutually beneficial business models, supported by a national and international enabling environment. These enabling environments include environmental, economic, and social and governance aspects. Southern Mozambique's value chain is discussed in greater detail in the next chapter.

Figure 3: Aquaculture value chains and enabling environment



Source: World Bank



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Even though Mozambique produces fish, the distribution network for fish—especially fresh fish—within the country is not well developed (Benkenstein 2013, World Bank 2018). Most fish harvested by artisanal fishers are for their own consumption or distribution close to landing sites. The same trend is observed in commercial aquaculture, where direct sales are typically made on farms or at nearby markets.

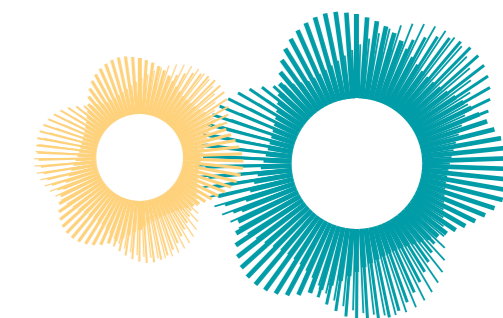
The few wholesalers that do exist typically consist of women who buy small quantities of fish that are then transported to local fish markets and sold fresh. Some wholesalers may buy these products for further processing (such as drying, salting, or smoking). Processed fish products are usually packed in sacks and transported by bicycle or pick-up truck to local fish markets in villages and larger towns and cities. This system is more developed for fisheries and less so for artisanal aquaculture, where volumes are limited.

Local fish markets are concentrated in the comparatively densely populated regions, where buyers and sellers can negotiate the price. However, as more traders sell the same product, prices will drop.

Market access and market linkages are pillars of the nation's development strategy and have been identified as important aspects of PRODAPE, a five-year, US\$50.22 million investment that forms part of a long-term (15-year) partnership between IFAD and the Mozambican government to develop the country's aquaculture sector. Initiated in 2021, PRODAPE aims to reduce poverty and enhance nutrition and food security of rural households by increasing production, consumption, and incomes among rural households and other actors in the aquaculture value chain. Among other activities, PRODAPE aims to develop extension services for aquaculture (including revising extension training material, capacity-building, and strengthening all organizational operations of extension officers) for 23 districts in seven provinces.



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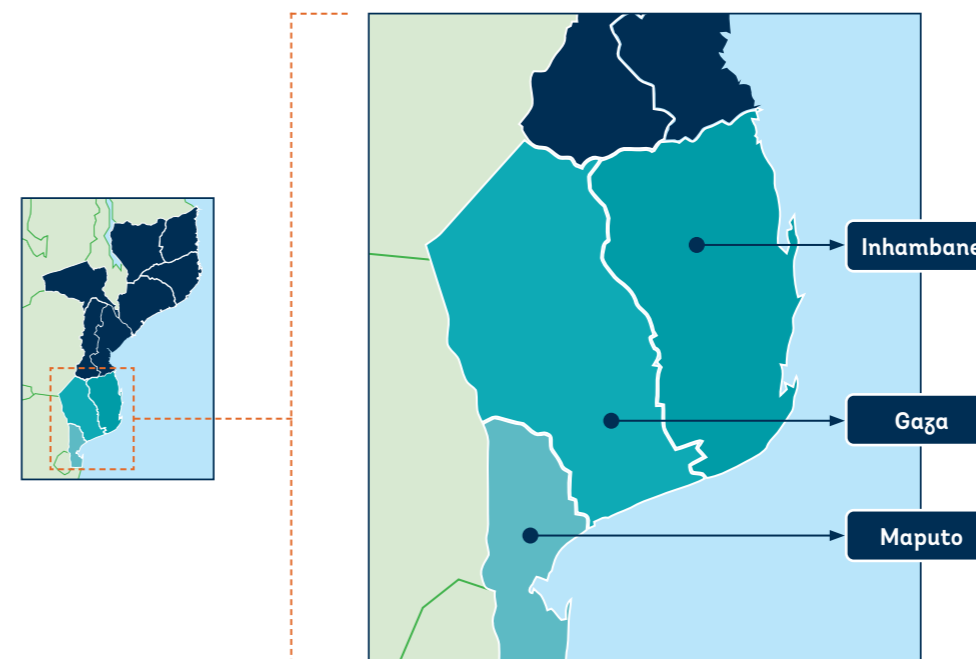


The case for aquaculture in Southern Mozambique



Aquafish farm, Inhambane province © World Bank

Figure 4: Map of Southern Mozambique



Source: World Bank

The status of aquaculture in Maputo, Gaza, and Inhambane

Commercial aquaculture activities in Mozambique primarily occur in the provinces of Cabo Delgado in the north; Zambézia, Manica, and Tete in the center of the country; and Gaza in the south (IDEPA 2018). The main types of aquaculture are pond and cage aquaculture.

Mozambique's southern region—consisting of the Maputo, Gaza, and Inhambane provinces—is especially well suited for further aquaculture development due to its climate and infrastructure. However, despite its natural suitability, current development remains limited to small-scale, artisanal farms. Key findings of the main aquaculture areas in Southern Mozambique include:

- **In Maputo province**, aquaculture consists primarily of small-scale production, which totaled 135 tons of fish and 0.8 tons of mussels in 2022 (IDEPA 2022). Mussel production growth is constrained by limited demand in nearby markets.

- **Gaza province** contains more medium-sized ponds than its counterparts and is home to two private commercial farms in Chokwe and Bilene. The province logged 1,612 tons of fish in 2022, of which 320 tons came from Chokwe and 219 tons came from Bilene. However, flooding in 2023 affected infrastructure and production inputs, resulting in a decrease in total production for the year.

- **In Inhambane province**, fish production in 2022 totaled 311 tons of tilapia, of which 106.7 tons came from commercial farms and 204.3 tons came from small-scale farms (IDEPA 2022).



Preliminary data from the 2022 CEPAA identifies how many production units (by type) and producers (by segment) there by province in Mozambique. Data for Southern Mozambique has been summarized in Table 8 and Table 9.

Table 8: Production units by type in the Southern Mozambique system

Region	Earth ponds	Cages
Country	10,518	872
Maputo	534	43
Gaza	796	125
Inhambane	875	177

Table 9: Number of aquaculture producers by segment in the Southern region

Region	Artisanal	Semi-industrial
Maputo	126	1
Gaza	124	10
Inhambane	221	1

Source: IDEPA 2022

Source: IDEPA 2022

BOX 4: PAPÁ PESCA, A SUSTAINABLY ESTABLISHED AQUACULTURE FARM IN GAZA, SOUTHERN MOZAMBIQUE

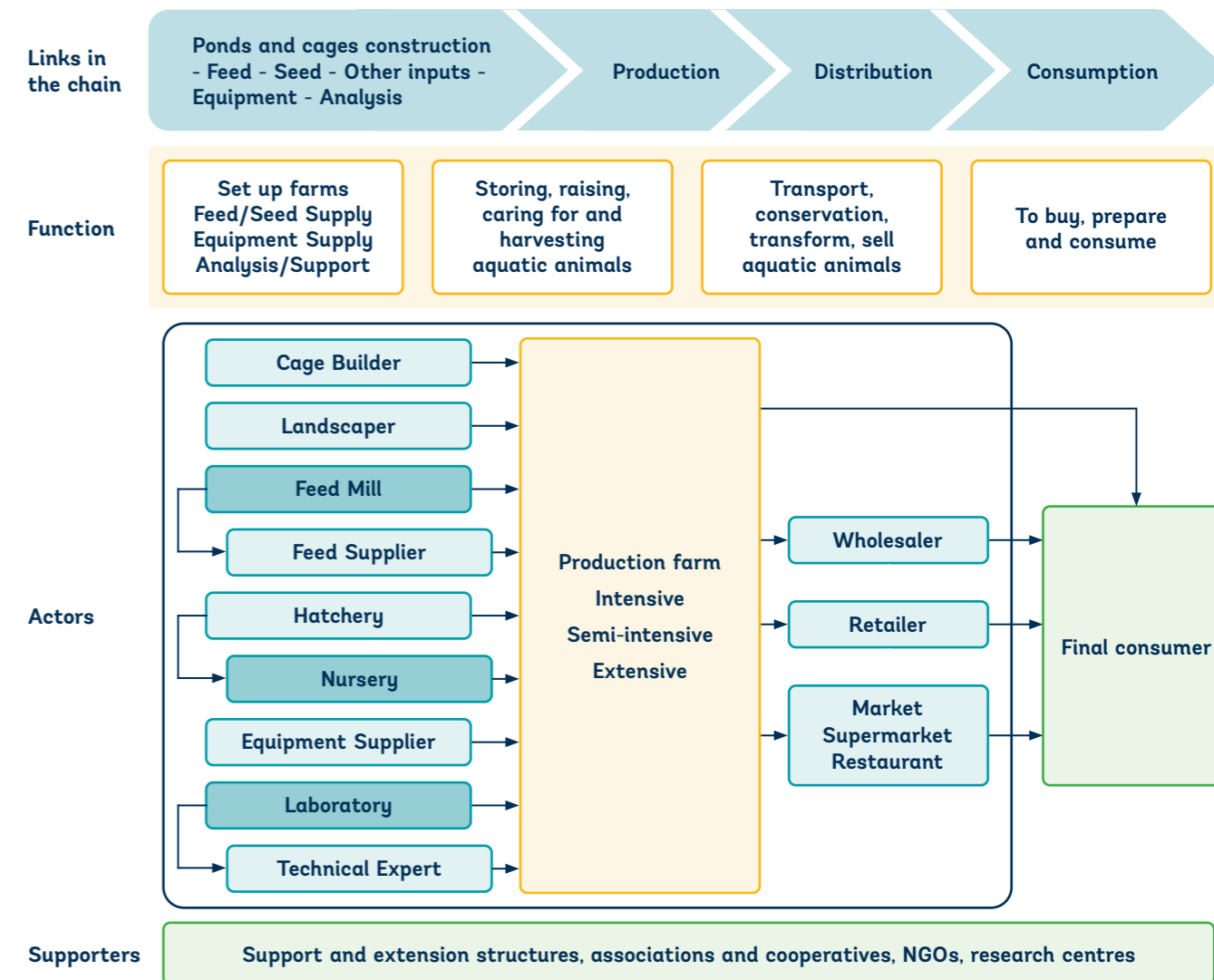
Papá Pesca's farm in Gaza province exemplifies a meticulous approach to sustainable aquaculture in Mozambique. The farm undertook extensive feasibility studies to identify potential sites, optimal fish varieties, and suitable marketing strategies. Once the site was identified, water management, farm layout, and stocking strategies were developed to ensure optimal fish growth.

The pilot site, launched in 2015 with the support of Norwegian NGO Norgesvel, successfully validated the viability of raising tilapia using imported feed and locally sourced fingerlings. The farm boasts a well-designed infrastructure with 136 ponds and designated wetland areas for conservation. The farm's hatchery has the capacity to produce more than 3 million fries and has been instrumental in producing sufficient fingerlings for the operation. Since its inception, Papá Pesca has produced a total of 390 tons of fish, including 105 tons in 2023, with production expected to increase in the future. To reach international markets, Papá Pesca constructed an EU-compliant processing plant awaiting final approval by the time of writing this report. Additionally, it has begun a black soldier fly production operation to reduce production costs through innovative waste management. While initial results are promising, further funding is needed for expansion.

Mapping the value chain in Southern Mozambique

Figure 5 shows the interaction between various players in the aquaculture value chain in Southern Mozambique. Mozambique suffers from a lack of national actors in many parts of the value chain, including feed mills, laboratories, nurseries, and wholesalers. There are no actors specializing in nursery activities. Some private hatcheries have a nursery for their own use, but do not sell fry to other producers. Additionally, tilapia wholesalers are currently absent in Southern Mozambique.

Figure 5: Mapping value chain function, actors, and relationships



Source: Amian et al. 2018



Value chain diagram and product flow

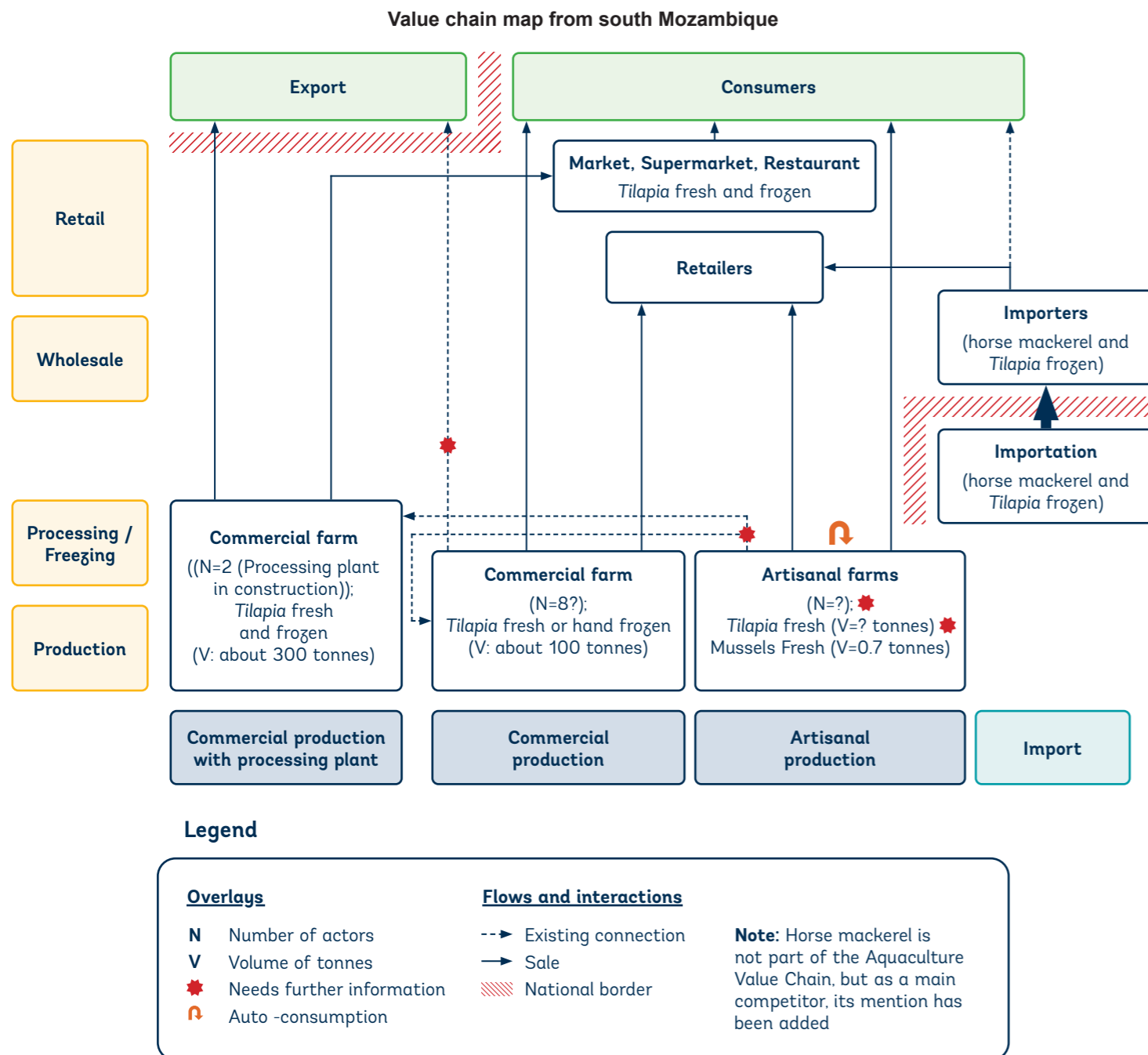
The links in the value chain constitute four types of actors: developers, who are the suppliers of inputs and equipment; producers; distributors and processors; and consumers (Figure 6). One of the features of the Southern Mozambican aquaculture value chain is limited flow of product. Commercial farms deal directly with buyers, while artisanal farms use their produce or sell it locally. Wholesalers are absent from the value chain, most likely due to low production volumes.

While job creation focuses on producers, increased production will likely lead to retail network growth, opportunities for wholesalers, and increased development across the value chain. Similarly, because women make up approximately

51 percent of the aquaculture workforce, sector development will create economically empowering opportunities for women.

Support services and equipment supplies are not readily available to farmers or hatcheries, largely due to the small size of the aquaculture sector. Aquaculture producers need to work with local middlemen—who often enjoy a quasi-monopoly position—or procure supplies from outside Mozambique at extra cost and at a delay.

Figure 6: Aquaculture value chain actors and connections in Southern Mozambique



Source: World Bank

High-quality feed and seeds contribute greatly to better production yields, but the farmers themselves play a vital role in this equation. Most artisanal farmers lack the technical skill to optimize their production environment, leading to lessened impacts and greatly increased production costs when they switch to higher-quality inputs.

Many small-scale farmers currently rely on extensive farm methods that cost less but offer low returns on investment. These farmers would benefit from investigating more intensive techniques.

Ideally, seed should be robust enough to allow for high yields under suboptimal conditions while remaining affordable to keep production costs low. Feed should also be affordable while offering good nutrition in a variety of contexts. Because few Mozambican farmers are able to optimize their feed conversion in production management to levels required with the use of imported feeds, feed quality should instead focus on providing optimal economic returns for existing farms.

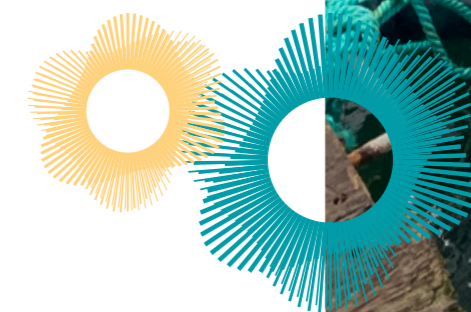
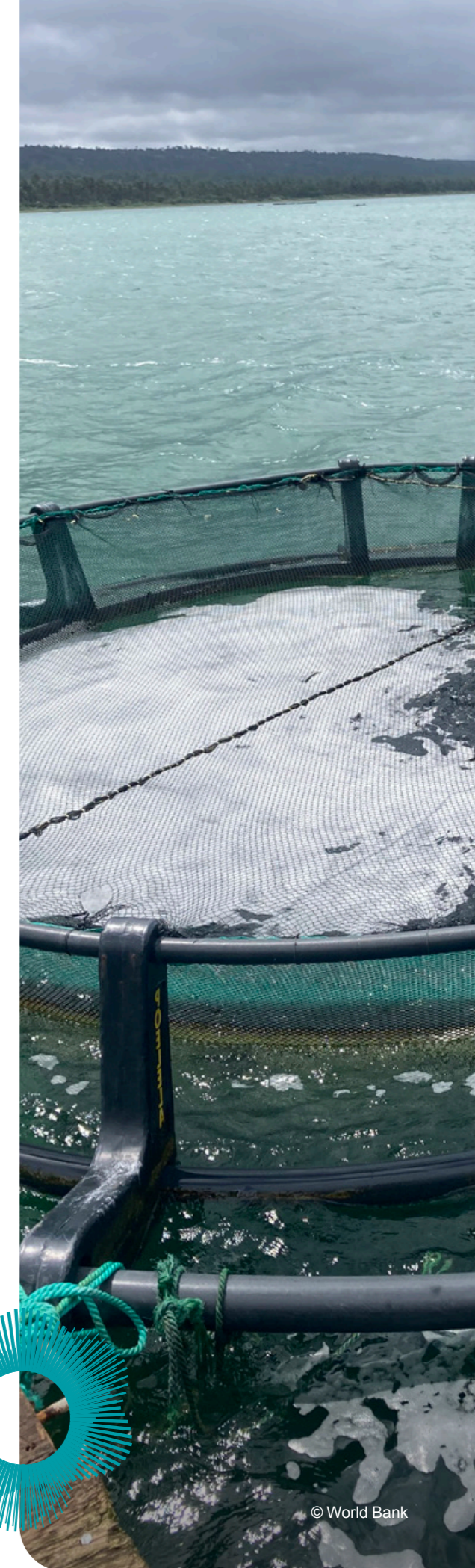
Challenges facing southern Mozambique's aquaculture sector

The challenges and characteristics of Mozambique's aquaculture sector also apply in Southern Mozambique.

Climate variability and temperatures during the cold season

Mozambique's extreme climate vulnerability demands solutions that facilitate and promote the adaption capacity of the country's population. The south, with its dry climate, is more prone to droughts than the center and north of Mozambique. However, its lower temperatures may represent an advantage in protecting aquaculture investments in these areas. Diversifying the economy with fish farming could make communities more resilient to climate-related challenges, especially since aquaculture is adaptable to changing environmental conditions.

The southern provinces experience cooler temperatures during dry season, which directly impacts fish growth and survival. Low temperatures can slow down the metabolic rates of many aquatic species, resulting in reduced growth rates and increased susceptibility to some parasites and diseases. Fish may require more energy to maintain their body temperature, leading to higher feed conversion ratios and increased production costs.



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Economic challenges

Lack of coordination between feed manufacturers and buyers

In addition to the national-level challenges to accessing feed (discussed in Chapter 4), feed production in Southern Mozambique suffers from a lack of coordination, which leads to a lack of critical mass to sustain aquaculture in the region

and substantial opportunity costs. Suppliers are unaware of the buyer's market, while buyers are unaware of the options available to them, resulting in missed opportunities for both.

Lack of coordination between hatcheries and producers

The lack of coordination between hatcheries and producers (discussed in Chapter 4) is also evident in Southern Mozambique, where hatcheries are underutilized (Table 10) yet fish producers struggle to obtain seed and fingerlings.

Table 10: Hatchery, actual production and declared production capacity

Hatchery	Province/district	Production/yearly sales	Capacity of yearly production	Use of installed capacity
Centro de Pesquisa em Aquacultura (CEPAQ, Center for Aquaculture Research)	Gaza	300,000	3,000,000	10%
Papá Pesca	Gaza	900,000	3,000,000	30%
Tilapia do Bilene	Gaza	300,000	1,500,000	20%
Poelela	Inhambane	800,000	2,000,000	40%

Source: World Bank

Lack of access to quality fry and fingerlings

Despite Southern Mozambique's logistical advantage and its numerous import channels, the aquaculture sector lacks access to quality inputs. This limitation arises principally from insufficient access to quality fish feed and fingerlings. As in the rest of Mozambique, fry price in Southern Mozambique

represents a significant percentage of the price of the final product for both extensive and intensive production systems. Fry price can vary from one supplier to another according to its hatchery production, size of the fingerlings, fingerlings availability or season.

Lack of technical capacity

As a nascent industry dominated by artisanal actors, aquaculture in Southern Mozambique faces challenges related to a lack of knowledge and training among local fish farmers. This lack of knowledge can result in poor management practices, low productivity, and irregular product survival and growth, impacting the activity's economic return and sustainability. Actions that strengthen general aquaculture technical knowledge include extension services, which could take the form of aquaculture schools that offer practical learning opportunities.



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Advantages in Southern Mozambique

Southern Mozambique is especially well suited for aquaculture development due to its:

- **Agroecological characteristics.** These include water availability; good soils and climate; and the presence of both native and exotic fish species for farming, such as Mozambique tilapia (*Oreochromis mossambicus*), blue tilapia (*Oreochromis aureus*), and Nile tilapia (*Oreochromis niloticus*) (Salia and Alda 2008).
- **High population densities** with potential peri-urban market demand.
- Economic activity.

The southern part of the country also hosts the government aquaculture research center, Centro de Pesquisa em Aquacultura (CEPAQ, Center for Aquaculture Research) in Gaza's Chokwe District. CEPAQ acts as a service center to facilitate private sector investment in aquaculture by developing faster-growing strains of tilapia; producing high-quality fry for fish farms; breeding stock for other ponds; and drawing up production support protocols (Das 2019). However, CEPAQ's activities do not fully align with southern Mozambique's aquaculture needs in the following ways:

- The center manages a genetic program of marine tilapia with low practical application in aquaculture for three southern provinces in that it does not offer genetic selection or broodstock supply for *Oreochromis niloticus*.
- Its research activities are limited and not designed to bring practical, rapid answers to the private sector. For example, only two studies were done in the past three years that do not apply to private sector farms.
- The center does not have activities on cage aquaculture.

CEPAQ will play a necessary role in all potential projects in southern Mozambique, although special care should be given to avoid replication of activities or resource allocations.

Area mapping for aquaculture is currently limited to an early evaluation conducted in 2011 (INAQUA 2011). The study does not consider all relevant species or farming practices, and needs to be updated to provide a clearer picture of potential aquaculture sites in the country.

Conducive agroecological characteristics

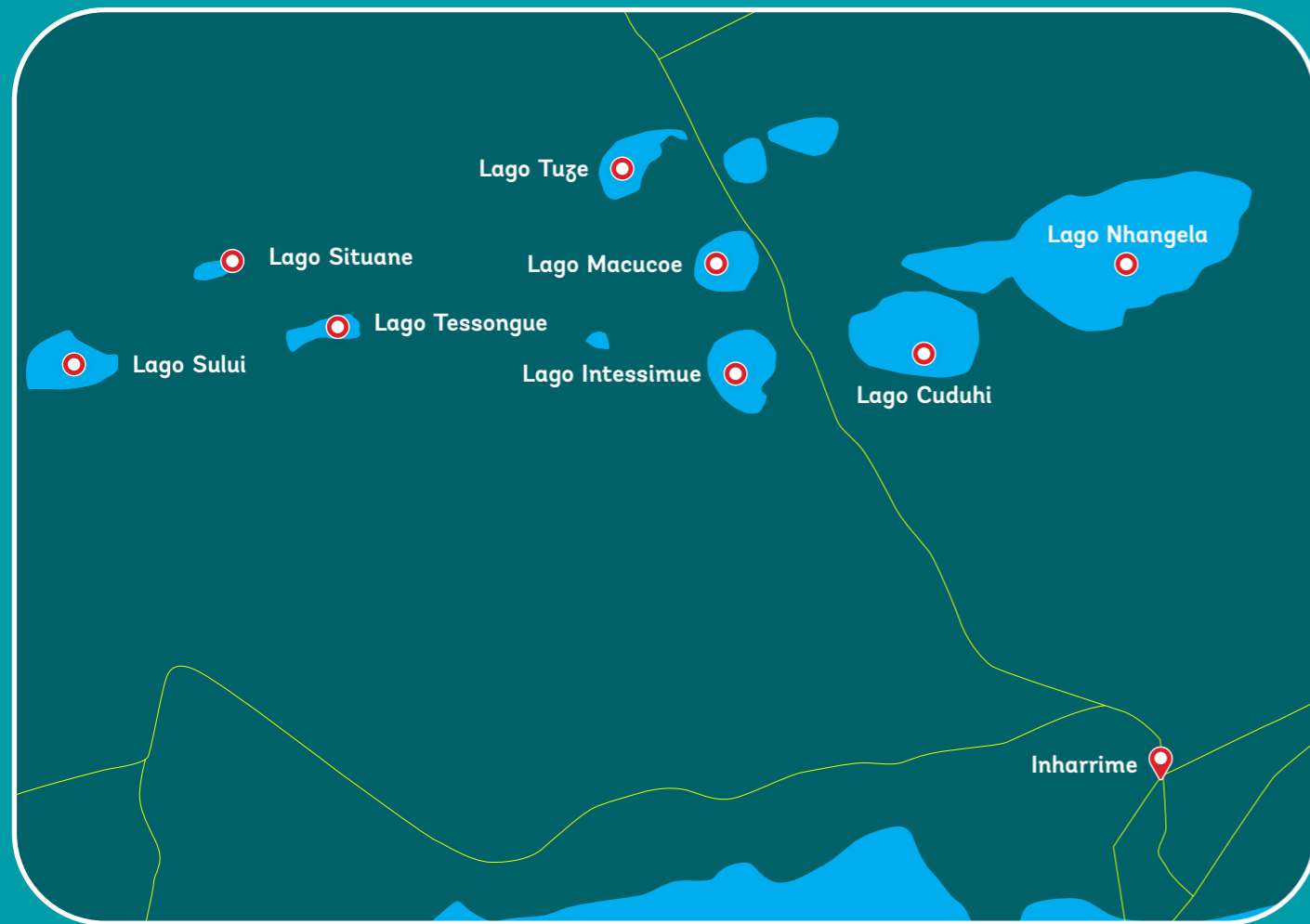
The three southern provinces have a dry savannah climate characterized by a longer dry season and summer rainfall. Regular tropical cyclones present a clear risk for aquaculture producers. However, the region's overall ecological diversity and favorable climate conditions during most of the year makes the region suitable for aquaculture systems.

The main rivers and artificial dams (including two hydroelectric dams) in Maputo and Gaza provinces offer multiple opportunities for aquaculture development.

Inhambane province has less of a surface water network, although seasonal lakes (lasting between six and 11 months) appear during the rainy season (Figure 7). These water bodies could be stocked with a very low density of fingerlings that would feed on the algal bloom and natural production of these seasonal lakes, providing a novel food source for local populations.

© Freepik

Figure 7: Map of Southern Mozambique



Source: World Bank

Although Southern Mozambique lies along the Tropic of Capricorn, the climate is relatively mild due to the ocean. The three southern Mozambican provinces have a combined coastline of more than 800 kilometers (km), with several mangrove estuaries (mainly in Maputo and Inhambane bays) and some islands in Inhambane province. These bays offer shelter against otherwise rough seas, creating suitable conditions for cage aquaculture, while mangrove areas offer

ecosystems for many aquaculture species (oysters, clams, shrimps, brackish water fish species, sea cucumbers, crabs, and so on). The region also has a rich aquatic biodiversity, which provides opportunities for the cultivation of a wide range of fish and shellfish species. This diversity could support both commercial and conservation-focused aquaculture projects.

The presence of suitable fish species

Both freshwater and marine aquaculture in Mozambique benefit from a diverse natural environment and the availability of suitable native species for farming. Some species present in the southern part of the country stem from neighboring countries through shared water networks and catchment areas. This section describes the key existing and potential marine and freshwater farmed species in Mozambique.



Marine species

The main marine species farmed in Mozambique include the black tiger prawn, Indian white prawn, and seaweed. Some initiatives have targeted bivalves such as the marine brown mussel, sand mussel, mud crab, and others (*Meretrix meretrix*, *Eumarcia pauperkulata*, *Sacrostrea cucullata*, *Crassostrea gigas*, and *Veneruspis japonica*) (WorldFish Center 2007, Blanc 2021).

Species with aquaculture potential present in Mozambique's natural environment include the sea cucumber, mullet, milkfish, and several tropical and inter-tropical marine species produced in other parts of the world (grouper, rabbitfish, sea urchins, sea-scallops, and more) (Blanc 2021).

Freshwater species

Freshwater aquaculture in Mozambique is dominated by the farming of native cichlids and tilapia. Other popular species include non-native tilapia, catfish (specifically the *Clarias* species), freshwater shrimp, and carp (FSC 2017, Blanc 2021). Freshwater aquaculture species must be considered according to market availability and local consumption.

Some amphihaline species (species that can survive in both salt and freshwater) such as mullet and milkfish may also offer additional opportunities. Tilapia currently offers the best market, technical, and development opportunities for the area.

Aquaculture species

The choice of aquaculture species for Southern Mozambique should be based on the available market and their price (regional market and export possibilities); the temperatures recorded in the region; the areas suitable for aquaculture production and their specific features (such as lakes, estuaries, mangroves, coastal areas, ponds, and dams); as well as the available technical aspects of the production units.

The aforementioned species are all present in Southern Mozambique. However, only tilapia, catfish, and mussels are reportedly used in aquaculture, despite the opportunities that exist with other species.

Decreased temperatures in the cold season may impact the economic model of aquaculture based on tropical species, but may also offer opportunities when focusing on species that are more adapted to colder climates such as mussels, some marine fishes, and several freshwater ponds species, including tilapia.

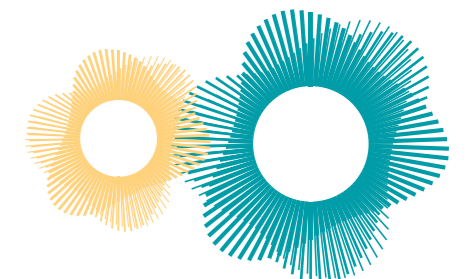
The following species show potential for profitable aquaculture in Southern Mozambique:

- **Sea cucumber and seaweed**, which are in high demand on the international markets. Southern Mozambique experiences the same climatic conditions as other countries at the same latitude where these types of aquacultures have been developed, such as Southern Madagascar.
- **Mullet and catfish**. These are suitable stock for farmers or production models with less technical expertise.
- **Milkfish, mullet, freshwater shrimp, and some tilapia strains** that are tolerant to variations in salinity or brackish water, which is found in some Inhambane lakes and seasonal ponds.
- **Sea cucumbers, seaweed, mussels, and clams**, which can be produced directly in the sea using sea-ranching models.

- **Sea cucumber, seaweed, mussels, clams, mullet, milkfish, and carp**. These could also be produced in multitrophic systems with other aquaculture species under specifically adapted financial and operational viability models.

In conclusion, diversifying aquaculture species and products could be considered for:

- **The flexibility of production environment** of some amphihaline species that can survive in fresh and sea water, such as mullets and milkfish.
- **Species with low trophic levels** (herbivorous or without external feeding) such as mullets, milkfish, clams, or sea cucumbers.
- **Robust species with high resistance during production phase**, such as catfish
- **Species with high international export market demand**, such as sea cucumber
- **A niche market sector**, such as higher-value marine fish production for export or sale to hotels and restaurants, or freshwater prawns for national urban markets
- **The possibility of developing artisanal aquaculture models** for sea cucumbers, clams, and an extensive selection of fish.



Relatively high economic activity

As in the rest of the country, agriculture is the most important economic activity in Southern Mozambique. Most of the population depends on subsistence farming and there is a significant commercial agricultural presence. Other economic sectors in the southern provinces include fishing, tourism, and industry. The natural resources sector has also grown in recent years, with natural gas exploration in Vilanculos district (Inhambane) and a heavy sands prospecting program in Chibuto district (Gaza).

Marine fishing in Inhambane, Gaza, and Maputo provinces is mainly practiced by semi-industrial and artisanal fleets that use small (<10 meters long) or no vessels. Fishing occurs throughout the year, except for January and February, when shrimp fisheries are closed (in line with MIMAIP rules).

Artisanal fishing is one of the main subsistence and income-generation activities for people living along the Southern Mozambique coastline.

Maputo is the most industrialized of the three provinces. The 700-hectare Belulane Industrial Park in Maputo's Boane district is the country's main industrial zone, while Matola is the province's main commercial area. Gas production dominates industry in Inhambane (EDM 2019), where Maxixe is the main commercial zone. Gaza province's main commercial zone is Xai-Xai. Its industrial sector is still under development, with several planned projects.

Sufficient population

According to the National Institute of Statistics, the populations of Southern Mozambique's provinces were 1.5 million for Inhambane; 1.5 million for Gaza; and 1.8 million for Maputo in 2016. All three provinces follow the typical age pyramid structure for developing countries, with a larger youth population and smaller elderly population.

Together, the three southern provinces represent 20 percent of the country's population, offering an important potential workforce and market demand for aquaculture.

Local market size and demand

The Mozambican aquaculture sector currently represents less than 2 percent of national fish consumption. However, demand for fish is growing, driven by an increase in local consumption (from 11.4 kilograms per capita in 2014 to 16.4 kilograms per capita in 2020) and an increase in fish exports (from 37,268 tons in 2010 to 77,769 tons in 2019). At the same time, total fish production has stagnated, with production decreasing from 420,845 tons in 2019 to 373,563 tons in 2021 (Sitoe 2022, MIMAIP 2020). Aquaculture is well placed to bridge the potential gap between demand and supply.

Assuming fish consumption of 16.4 kilograms per person, Southern Mozambique's population of 4.8 million people represents a potential demand of about 78,000 tons of fish per year. This demand is concentrated around the Maputo area and major provincial towns such as Inhambane, Xai-Xai, and Maxixe. Maputo, Gaza, and Inhambane all contain popular Mozambican tourist locations, and the tourism and catering sector in these provinces also creates a niche market for aquaculture products. This market typically prefers marine products, although demand for fresh local fish products does include freshwater species.

Fish weighing between 200 grams (g) and 300 g costs between 200 Mt and 250 Mt (US\$3.13 and US\$3.90) per kilogram. Prices increase for larger fish sizes and can reach 600 Mt (US\$9.39) per kilogram for frozen tilapia fish filet.

The main competitor to tilapia on the local market is imported mackerel (carapau), which sells at between 150 Mt and

180 Mt per kilogram (US\$2.35 and US\$2.80) frozen, representing a protein source of less than US\$3 per kilogram. Frozen horse mackerel is also exempt from Mozambique's 16 percent VAT.

Currently, the price of tilapia is very close to that of chicken. Prices vary dramatically between imported and locally raised chicken, with the latter reaching more than 125 percent of the price of imported chicken due to consumer preference. Similar trends have also been seen for tilapia, where locally produced fish are more attractive on local markets.

These prices illustrate an opportunity for the sector. As the sector develops, technical and input market improvements will increase the quantity of tilapia that can be produced while reducing the cost of production. If import taxes are simultaneously gradually changed in line with increases in production volumes, fish producers in Southern Mozambique (and indeed across the country) would be able to compete with chicken and mackerel on local markets.

Mozambique tilapia production prices would get closer to global market prices, where the price of tilapia in 2023 ranged in the vicinity of between US\$2 (Brazil) and US\$2.55 per kilogram (in the Philippines and Egypt) (Delgado 2023, CEIC data 2023).

A final point relates to the dynamics of production and demand in Southern Mozambique: the three southern provinces are more dependent on the other provinces of Mozambique and on imports than their northern and central counterparts (Soethoudt 2015, WFP 2016).



Tilapia do Bilene, Gaza province © World Bank

Developing cold chain infrastructure

All three southern provinces have reasonable road networks. Inhambane and Maputo have local and international air and maritime links. The main road connecting the southern and northern provinces travels along the coastline, representing an important arterial link for freight transport.

Urban and peri-urban areas are well supplied with electricity and water, although rural areas to the north of Southern Mozambique have gaps in coverage. Ice blocks or flake ice are available for purchase within two hours' travel by road between Maputo and Inhambane.

However, access to ice for preserving fish products becomes limited the further away you get from the coast.

Three aquaculture projects in Southern Mozambique (Papá Pesca, Poelela farm, and Sihaka farm) have started to develop processing facilities with cold storage and freezing capabilities. These cold chain projects offer opportunities for development of formal labor in fish processing.

Proximity to suppliers

Although Maputo is home to three large and several smaller feed producers, none of the big producers and very few of the smaller feed producers have the equipment needed to produce the floating feed used in fish aquaculture. While a few producers are trying to break into the aquaculture feed market, most are inefficient or offer low-quality feed.

All feed production equipment is imported. South Africa represents an excellent opportunity (in time and cost) to import aquaculture materials and equipment for farms in Southern Mozambique. This is further facilitated by the fact that Maputo represents a dynamic hub to import overseas feed and aquaculture material.

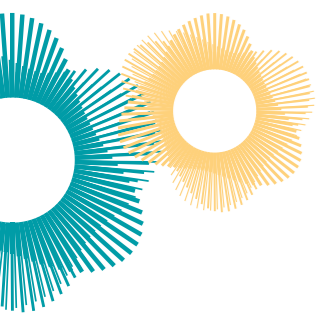
Proximity to export and local markets

All existing and potential production in the region is located less than 700 km (about 10 hours by road) from the capital city, which itself is about 90 km (two hours by road) from the border with both South Africa and eSwatini. Road access between Maputo and three key South African cities (Johannesburg/Pretoria and Durban, which are each about 550 km away) is good and well frequented by commercial trucks. Maputo also has a concentration of trade and processing companies, and facilities for international export.

As mentioned earlier, Southern Mozambique is home to 20 percent of the country's population. The cities of Maputo and Matola in particular are key markets for fresh, frozen, and processed fish products.

Tourism is an important sector in Southern Mozambique, with beaches, outdoor activities and World Heritage Sites attracting local and international tourists to the coastlines of Inhambane, Gaza, and Maputo. In 2022, the number of foreign tourists staying in Mozambican hotels exceeded 461,000—a 43 percent increase from the previous year. However, this is still only a fraction of the tourists that visited the area before the COVID-19 pandemic. Maputo continues to be the most popular region among foreign tourists (200,113 visitors), followed by the provinces of Inhambane (106,109) and Gaza (53,057) (Club of Mozambique 2023).

The tourism industry employs many local people in hotels, restaurants, and bars, while creating a market for some aquaculture products through coastal restaurants. However, this category of consumer typically prefers marine species that are not commonly available in aquaculture. Nonetheless, the tourist market should be considered in plans to develop aquaculture activities.



Fish farmers of Baixa de Macuamene, Bloc 6, Inhambane province © World Bank

BOX 5: AQUAPARK

Terras Salinizadas in Chokwe, Gaza province, is the country's first aquapark. It spans 6,000 hectares and contains the CEPAQ aquaculture center. Several projects have supported aquapark's creation and development, including supplying water through a system of channels and dikes.

The aquapark follows the cluster approach used in other countries such as Nigeria, Tanzania, and southeast Asia to concentrate activities and needs. By concentrating investments, it can incentivize further investment, facilitate shared learnings, and improve the viability of supporting industries to enable the sector to grow as rapidly as possible. Existing aquapark preparation and government incentives provide the bulk of development support.

Aquaparks create a competitive advantage by sharing costs and resources. Capital expenditures are estimated to be reduced by 69 percent through reduced pond-building costs due to water flow and access to the irrigation scheme; shared licensing and concession costs; a subsidized environmental impact assessment; shared electricity, water, and road infrastructure; and the possibility of shared operational assets. Operating expenditures are estimated to be reduced by 14 percent from bulk feed purchasing, reduced fingerling costs, reduced transport costs, shared or subsidized training costs, and reduced infrastructure usage costs (TechnoServe 2022). An aquapark also serves as an information cluster, and different private operators can monitor the park to improve overall performance. There could also be spin-off benefits to those outside the park, such as farmers buying quality fingerlings and feeding.

However, the aquapark model in Chokwe has encountered some difficulties. The company managing water supply has struggled to satisfy existing farms, and the land acquisition process has been a long, multi-stage process that limits initiatives. Terras Salinizadas still needs to reach a critical mass to attract services and inputs.

After one decade, only a few aquaculture farms have started activities in Terras Salinizadas. The biggest one is Papá Pesca, which has about 5 hectares of ponds, a tilapia hatchery, and poultry farm. Its tilapia production

model is oriented to the local market, but the farm has recently installed a processing facility that will allow Papá Pesca to access some export markets. Papá Pesca is not yet sufficiently profitable. In 2023, the company was experimenting with locally made feed protein (insects and algae) to reduce production costs, but it appears that this model's potential has not yet been fully exploited.

That the aquapark in Chokwe has failed to attract sufficient private sector investment for more than a decade of operation suggests that initiatives require more than a launching investment facility approach (matching grants and preparation of land for starting an activity). Stakeholders have identified feed and seed availability and ease of access as major constraints. The guarantee of a stable economic environment and long-term trust for business development are also currently lacking. Recent changes in taxes² on imported feed have created difficulties for all commercial aquaculture pioneers in the country and the absence of interim solutions could be seen as a significant risk for future major investments.

The PRODAPE project (a five-year, US\$50.22 million investment funded by IFAD and implemented in partnership with the Mozambican government) also supports aquapark development as a vehicle to integrate smallholder farmers in rural communities into the aquaculture value chain. Connecting the aquapark with their efforts would promote national coordination.

The economic and operational model of the aquapark could also be discussed with the various stakeholders (government, projects, companies already on site, and producers' associations) to find ways to improve its development. Proven models, such as those in Nigeria, which are based on private-sector management with local authority structures, may provide food for thought. The current model has not succeeded in attracting companies, and there is a need to rethink the system to better adapt it to the needs of investors (not only for the initial investment, but also for longer-term management guarantees).

Aquaculture schools

Southern Mozambique has two aquaculture schools: Escola de Pesca (School of Fisheries) in Matola, Maputo province, and the Instituto Superior Politécnico de Gaza (ISPG, Higher Polytechnic of Gaza) in Chokwe district, Gaza province.

The School of Fisheries is a public institution offering professional and vocational-technical education for the fisheries sector. It was created in 1979 as the Fisheries Training Center, although its name was changed by decree in 1990. The school offers the following courses: navigation and fishing; marine machines; aquaculture; biology; and fisheries extension. These courses last between three and 3.5 years, and the school graduates an average of 33 students each year. The school also offers short-term professional technical courses. Candidates must be at least 16 years old and have completed grade 10 or grade 12 (or equivalent), according to the National Education System.

Courses at ISPG aim to promote agricultural sciences with a view to stimulating the socioeconomic development of Mozambican communities by offering research and extension services in the fields of agriculture and economic sciences.

The Aquaculture Engineering diploma provides theoretical and practical knowledge for the design of aquaculture projects as well as rearing, harvesting, conservation, and processing of fish. Students develop skills, abilities, and strategies that respond to the demands of the labor market and that support the development of Mozambique's aquaculture sector. About 190 aquaculture students graduate from the ISPG each year.

A memorandum of understanding between IDEPA and ISPG aims to ensure cooperation on research and extension activities, to facilitate dissemination of results, and to support the training of students and qualified professionals to meet the sector's development needs regarding production, testing, and the use of sustainable technologies.



² As described previously in the report, prior to 2022, imported fish and tilapia feed were exempt from VAT and customs tax. However, in December 2022, the country imposed a 7.5% import tax (excluding imports from the EU or SADC) and a 16% VAT on tilapia feed. Despite the theoretical option for farmers to claim VAT refunds, private sector stakeholders have not successfully reclaimed these expenses. Coupled with global economic factors driving up raw material costs, the importation of feed has become significantly costlier.

Recommendations for developing the aquaculture sector in Southern Mozambique

Fish is a valuable source of protein and essential nutrients. Ensuring access to an adequate supply of fish could help address malnutrition and food insecurity in Mozambique. In 2014, fish protein accounted for about 50 percent of total animal protein consumed nationally (Souto 2014). Aquaculture also has a role in alleviating poverty by providing livelihood opportunities for disadvantaged communities.

Despite this potential and the country's extensive coastline and abundant terrestrial water resources, aquaculture production in Mozambique lags its regional counterparts (FAO 2022a). While fish products are the primary source of animal protein in the country, aquaculture currently contributes only 2 percent to overall fish production.

The three provinces in Southern Mozambique—Maputo, Gaza, and Inhambane—have medium to high levels of food insecurity, but high potential to develop aquaculture. However, the region lacks public aquaculture investment due to the focus on aquaculture projects in the central and northern regions.

This section presents a set of 14 activities and recommendations based on the World Bank's analytical work and elaborated in line with the Government of Mozambique's expressed objective of developing the country's aquaculture sector. These activities should ideally be executed by a broad base of stakeholders including key government and provincial institutions, academic institutions, extension agents, and the private sector to enable knowledge-sharing, create an environment that is conducive to investment, and support a partnership approach to stimulating aquaculture in Southern Mozambique.

Table 11: Summary of recommended activities to develop aquaculture in Southern Mozambique

Component	Province/ district
Aquaculture research, strategy, and information systems	1. Map areas with potential for aquaculture
	2. Support research and development
	3. Aquaculture Development Strategy: Mid-term review
Extension services and aquatic animal health	4. Extension services
	5. Aquatic animal health/diseases
Feed and seed support	6. Fingerling production support
	7. Aquaculture feed production support
Governance and productive alliances for aquaculture producers	8. Aquaculture Desk (Balcão do Aquacultor)
	9. Coordination of aquaculture producers
Development of production models and support for investment	10. Stocking of artificial dams and seasonal ponds
	11. Support for resilient aquaculture models
	12. Financing the commercial aquaculture value chain
Transversal activities	13. Environmental and social impact assessments, safeguards, and monitoring tools
	14. Gender-responsive actions and targeting

Aquaculture research, strategy, and information services

This group of activities aims to map areas suitable for aquaculture development, review ongoing country development strategies and realign them where necessary, and strengthen the research and development sector.

1 Mapping areas with potential for aquaculture

In 2011, mapping work was initiated to define the area for aquaculture development and to connect the different existing databases. Completing this work to include an assessment of the aquaculture potential in the southern provinces, including the potential of existing permanent and seasonal lakes, would support the development of aquaculture in Southern Mozambique. Enhanced database management would support this mapping exercise and monitoring of subsequent sector development efforts. Possible actions under this activity include the following:

- **Update area maps for aquaculture development** (marine and land, including seasonal and permanent lakes)

- **Undertake a more detailed pre-study on areas where aquaculture businesses could operate** (lakes, development zones), including assessing ecosystem carrying capacities and determining biomass recommendations
- **Map lakes** selected for cage-based aquaculture development
- **Build capacity** for database management.

2 Support for research and development

Supporting research and development projects at universities and educational institutions would strengthen local technical knowledge and capacity while developing the country's aquaculture sector. One way to do this would be to provide grants to undergraduate students studying aquaculture-related courses at the School of Fisheries or ISPG. Study support

could also be provided for postgraduate research into topics related to aquaculture development such as new species, market research, post-harvest, and community approaches for aquaculture. The private sector could also offer bursaries for study based on a work-back system.

3 Aquaculture Development Strategy: Mid-term review

In 2025, Mozambique will be halfway through implementing its 10-year Aquaculture Development Strategy 2020–2030. A consultative mid-term review on the implementation of this strategy would provide useful insights that could be used to formulate an action plan to ensure that the second half of the implementation journey achieves the strategy's objectives. Including the private sector in such a review would serve to identify farm and production-scale challenges and achieve consensus on the country's projections data.



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Extension services and aquatic animal health

This group of proposed activities aims to enhance and expand existing extension activities and support the monitoring of aquatic animal diseases.

4 Extension services

Effective extension services that are provided by operationally and technically proficient extension officers are the cornerstone on which Southern Mozambique's aquaculture sector will be built. Key questions that need to be answered when designing extension services include:

- **Is there alignment between extension services and other efforts to develop the sector?** All sector development actions should be aligned with existing technical knowledge and field situations.
- **How is the technical information being communicated?** Capacity building and documents for farmers should ideally be produced in a format and language that is understandable to all. Extension systems should also be designed to facilitate communication between field actors, the public sector, and associations to allow for better access and dissemination of information. For example, a website will not have the same impact as a mobile phone application or a local focal point. Communication methods should be adapted and potentially contain multiple channels.
- **Who is providing the extension services?** An extension service that is only provided by the government runs the risk of being disconnected from the technical and economic realities of the private sector. Complementary private sector extension is therefore important, although possible competition between public and private extension actions should be considered.
- **How is the effectiveness of extension services being measured and monitored?** Government extension services should be measurable using relevant indicators such as changes in production mass or increases in profit. These indicators should align with overall objectives to develop the aquaculture sector.
- **Is a robust data management system in place to support such monitoring?** An operational database with a proper registration system and verified production and activity records would provide accurate production statistics from fish farms, inform more meaningful extension services, and enable better management of fish diseases.
- **Is an external, independent team monitoring extension services?** An independent assessment of extension services after three years of implementation in Southern Mozambique would provide important insights for improving extension efforts. Factors to consider include the staff involved, their contribution, the cost of the services, and the results obtained. The size of the three Southern Mozambique provinces and their low level of aquaculture production offer an opportunity to serve as a pilot area for extension service activity monitoring, which could then be rolled out at the national level.

The main recommendations are to involve the private sector in most extension actions, measure and monitor the efficiency of the services provided by extension officers, and to link their actions to observable impacts. Monitoring can provide information to increase extension service efficiency and offer impactful services by developing a "profitable" extension model in which the cost of the service is offset by the improvement experienced by the aquaculture sector.

Practical experience of extension officers

It is strongly recommended that each extension officer have hands-on private sector experience. At least a month of practical experience on private sector farms, repeated at intervals of less than three years, would serve to connect a theoretical technical extension approach with field production reality and operations. This practice would also enable useful and constructive interaction with the private sector for overall sector development.

A potential mechanism for ensuring that small-scale farmers receive practical training would be for private sector farms to act as demonstration hubs by offering services to farmers at a small fee. In this way, farmers would gain hands-on training and insight into how private sector farms operate, showing the realities of aquaculture as a business.

Coordination between extension activities

Extension activities should ideally facilitate coordination between the private and public sectors to coordinate sector development activities; adapt extension services to better support the development of the sector; and build a comprehensive aquaculture framework that supports the sector's sustainability. Indeed, extension services reinforce almost all aquaculture sector activities and ensure coordination throughout the aquaculture sector.

Another aspect to consider is the coordination between public sector institutions and extension activities. The roles of field officers should ideally be structured and well defined, and not in conflict with other public sector activities.

Current extension services would benefit from an operational, reliable database of aquaculture activities for sector management and monitoring. Such a database would serve as a tool to consolidate extension service field activities and data collection but would also monitor sector development strengths and weaknesses.



Tilapia do Bilene, Gaza province © World Bank

5 Aquatic animal health and diseases

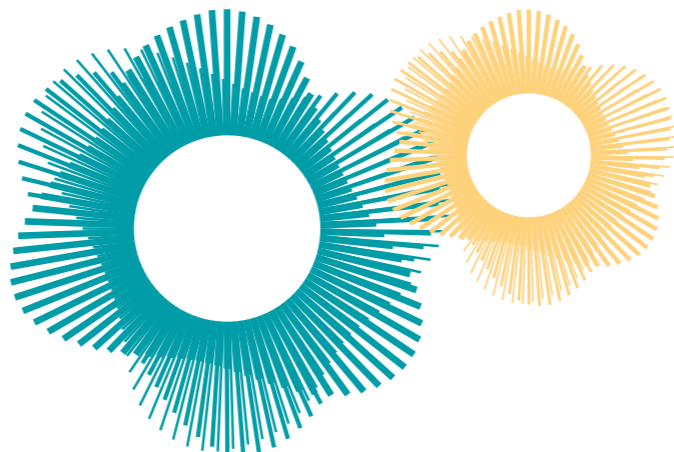
The Government of Mozambique has a responsibility to monitor and control aquatic animal diseases in line with sector development objectives and international regulations. The proposed activity focuses on building capacity, increasing diagnostic knowledge, and ensuring that laboratories are equipped to provide pathology identification services for aquatic animal diseases. The Biotechnology Center at the Universidade Eduardo Mondlane, which is able to process certain tilapia diseases and conduct other aquatic animal health analyses, appears to have the most relevant technical capacity and experience. The laboratory is already the country reference laboratory for diagnosing white spot disease, a shrimp virus.

Possible actions under this activity include the following:

- **Upgrade the current laboratory and provide officials with training** in aquatic animal health (fish and other species), lab management, lab equipment use, interlaboratory controls, and laboratory audits.

- **Implement official controls**, including a surveillance campaign, in Southern Mozambique
- **Provide hands-on training** on key tilapia pathogens and the use of pond tanks and cages to both fish farmers and extension staff.
- **Develop protocols, standard operating procedures, and manuals** on taking farm samples, biosecurity, and aquatic animal health using methods that are adapted to the local context.

Ideally, these actions should be combined with extension service activities and with activities of the private sector, which will be the first to implement biosecurity measures.



Feed and seed support

Stakeholders indicated that feed and seed support will be key for aquaculture sector development. The following actions may support Southern Mozambique's seed and feed production and supply.

6 Fingerling production support

The general quality of fingerlings, their survival rate, and the coordination of supply and demand are key issues in fingerling production. Greater coordination of the sector would improve production and fingerling genetics and variability.

The genetic resource in Southern Mozambique is currently managed by private sector hatcheries. CEPAC has no genetic program for *Oreochromis niloticus* and there is no control or monitoring strategy for breeders, or fry genetics. One solution would be to roll out a center (or a group of hatcheries) that maintains germ plasm adapted to regional specificities for use by fish farmers and hatchery owners. The government or a private sector association could manage and monitor this system and coordinate communications throughout the value chain.

Given that Southern Mozambique is vulnerable to cool temperatures during the dry season, the production cycle would benefit from considering seasonal changes to ensure an optimal return on activities by, for example, avoiding high biomass content during the cold season. Farmers could consult with other African countries that have successful aquaculture initiatives and face the same seasonal challenges. For instance, Egypt produces the most tilapia by aquaculture in Africa and has also a suboptimal climate with a cold season. It may therefore be worthwhile consulting Egyptian tilapia farmers to teach production methods and strategies in the three southern provinces in Mozambique.

Possible actions under this activity include the following:

- **Design adapted protocols and standards for fingerlings** to improve the quality of seed and support monitoring
- **Provide material and technical support** in the form of international exchanges, thematic workshops, and by providing support for hatchery feed to improve hatcheries production
- **Establish a cooperative of producers** to improve coordination of production
- Improve access to **quality broodstock and traceability** to improve genetic availability
- **Equip aquaculture schools** with small, functioning hatchery units backed by training by subject matter experts.



© World Bank

7 Aquaculture feed production support

Efficient and optimized formulation could reduce the production cost of commercial feed to US\$0.77 per kilogram, with farm arrival prices reaching about US\$1 per kilogram. At that price, feed would represent 30 percent in the simulated production costs, a reduction of about 30 percentage points of the production price per kilogram of fish compared with the minimum price of US\$1.30 per kilogram, observed at farms in 2023.

Sustainable aquaculture development requires local feed production. While a nascent sector can rely on imported feed (with government incentives), as it grows it will eventually produce enough demand for a feed industry. Mozambique's aquaculture sector is not yet ready for industrial feed production, but it is time to consider small and medium-scale solutions to meet the sector's needs.

Today, the total feed requirement for southern provinces is about two tons of feed per day,³ which could be met by medium-sized companies based in Maputo or the provinces.

At both the national and the regional level, the best strategic option for providing feed at the desired quantity and quality would be determined by the sector's development approach. Government support could usefully focus on avoiding monopolies and distinguishing between commercial and artisanal farm requirements. Commercial farms need high-quality feed for optimal results, while artisanal aquaculture focuses on cheaper feed. Diversifying feed offerings in terms of cost and quality would support a wide range of production models.

To manage the transition in a way that does not compromise farms and investments, the focus would need to be on feed quality and price competitiveness. Possible actions under this activity include the following:

- **Develop an e-voucher system** for providing imported feed to producers until the country can afford local production in quantity and quality. This system could cover between 10 and 20 percent of the price of imported feed, up to a maximum of 50 percent of feed used by farmers. Local feed producers and start-ups would need support to stimulate production and to ensure that their business models are not affected by the e-vouchers.
- Establish a sector **feed monitoring** and support group with an action plan.
- **Improve local feed quality**, both in terms of formulation and by improving technical processes at feed producers in Southern Mozambique.
- **Enhance availability of feed analysis** by providing materials, training, and support for the development of a business plan to offer competitive feed analysis.
- Enable aquaculture schools to provide training on feed-extruded production, including practical formulations.
- **Improve feed use at farm level through capacity building** that focuses on the low-input pond fertilization model and good manufacturing practices.
- Provide multi-stage **training** for local producers on **how to use feed effectively**
- Conduct a **study on locally available raw material**.

Governance and productive alliances for aquaculture producers

Proposed activities under this component aim to strengthen the coordination of actions between the private and public sectors. The governance of the value chain and relationships between players would benefit from being optimized to enable adaptive sector development, solve problems, and guarantee sustainable and reasoned development.

One way to enhance governance would be to develop a Balcão do Aquacultor (Aquaculture Desk) or platform between the private and public sector. The role of this platform would be to provide information on administrative and regulatory obligations for aquaculture production structures (including hatcheries and feed producers) and to offer direct support for ongoing and new activities.

³ Two tons per day represent 620 tons per year, covering tilapia production of about 500 tons.



Aquafish, Inhambane province © World Bank

8 Balcão do Aquacultor (Aquaculture Desk)

The suggested Aquaculture Desk's aim would be to provide support to aquaculture investors in developing and implementing their business plans. This technical assistance would strengthen productive relationships between industry players.

The Aquaculture Desk would include an online platform that provides expert technical assistance on:

- Designing business plans
- **Developing and documenting environmental and social safeguards** that align with good manufacturing practice manuals and environmental screening standards, and that integrate gender recommendations
- Coordinating with private sector representatives
- **Disseminating emerging knowledge and data** from a proposed database of regional production and actors
- Obtaining information on the status and actions of other aquaculture projects

- Proposing internal governance and validation mechanisms to avoid duplication of procedures
- **Monitoring government efficiency indicators** on extension activities and administrative work.

The Aquaculture Desk would serve as a "one-stop shop" that offers administrative assistance to financing seekers by simplifying administrative procedures. In particular, the desk would enable private sector applicants to make a single "joint application" for licenses that meets all the information requirements by multiple government institutions. A simplified licensing model would provide government institutions with the validation they require while reducing field inspections. (An alternative recommendation would be to either have longer license periods of three to five years to support investments and production activities, or to have a "start-up phase" secured by conformity analysis that leaves sufficient time for subsequent administrative phases. Such a system for the local market would comply with current regulations that apply to small-scale farms that can operate without a license.)

9 Coordination of aquaculture producers

The goals of this activity would be to: (i) provide support to strengthen the private sector, formal and informal aquaculture associations, and farmers' networks, and (ii) strengthen the private aquaculture regional network through regular coordination meetings. General governance between the private and public sectors could need additional actions, such as establishing indicators to monitor the sector's development and governance.

There are currently two associations active in Mozambique. Both associations would benefit from structuring their organization and adapting their business plan to be more sustainable and provide better services. The associations would also benefit from support with generating their own incomes to cover running costs and offer services.

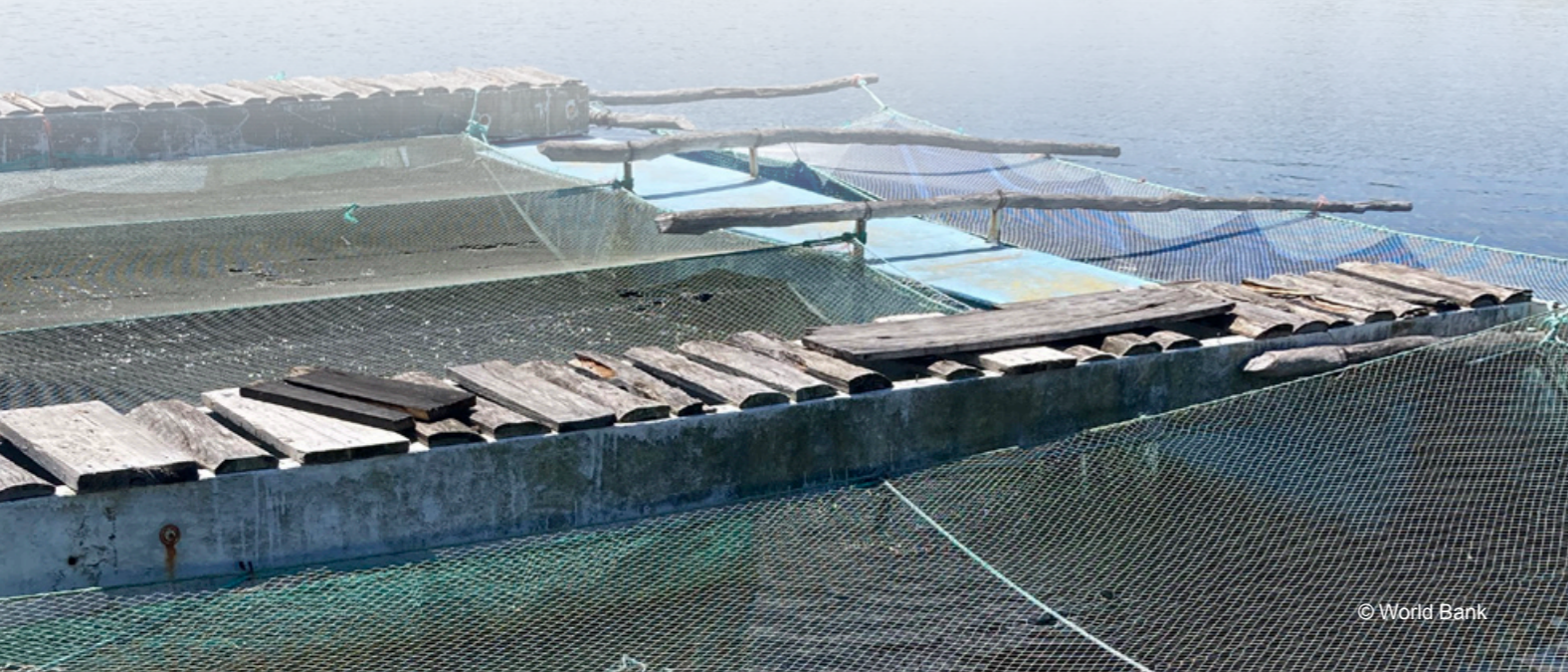
Possible actions under this activity include the following:

- **Establish governance indicators for monitoring coordination** and collaboration between extension services and the private sector. These indicators could act as a constructive and functional tool for coordinating, measuring, and collaborating between stakeholders during project implementation and sector development. A possible collaboration with the ongoing Wageningen University-led Aquaculture Governance Indicators project⁴ could be considered.

- **Develop business and action plans** for the two formal associations. Ultimately, the business plans would answer the question, "What can associations offer that people are willing to pay for?"
- **Develop step-by-step manuals** on starting up a small-scale business and investor guidelines.
- **Conduct a study** on the enabling environment for small-scale and commercial aquaculture development.
- **Provide support to a technical group** that includes the private and public sectors and aims to propose solutions for reducing existing administrative constraints and requirements for starting up aquaculture enterprises. The group would need to analyze the current situation, make recommendations, and see those recommendations through.
- **Launch an "Aquaculture Prize Competition"** that incentivizes stakeholders across the aquaculture value chain to submit ideas that could improve the performance of the value chain.
- **Host an aquaculture farmers' conference** or a National Aquaculture Day in Maputo on a regular basis to promote their products and communicate on their activities.
- Convene an **annual coordination** meeting with IDEPA.

Development of production models and support for investment

This component focuses on stocking artificial dams and seasonal ponds, providing support for resilient aquaculture models, and that support investment in the commercial aquaculture value chain.



⁴ More information about the Aquaculture Governance Indicators project is available at: www.aquaculturegovernance.org.

10 Stocking of artificial dams and seasonal ponds

Gaza province has several artificial dams and reservoirs, and both Inhambane and Gaza have seasonal reservoirs suitable for extensive aquaculture. Stocking (or restocking) appropriate water bodies with tilapia and catfish would provide the area's most vulnerable communities with a potential income source and a valuable source of protein. At the same time, fingerling demand would increase, supporting hatchery efforts.

Possible actions under this activity include the following:

- Establish **resource management committees** for these water bodies
- **Conduct a consultative study** to determine which water bodies are suitable for stocking and develop biomass management guidelines to optimize communities' benefits and prevent ecosystem and environmental impacts

11 Support for resilient aquaculture models

IDEPA and INOM have identified three possible pilot projects for assessing various aquaculture techniques to identify those that are more resilient and suitable for implementation in Southern Mozambique:

- **Mussel farming.** Existing farms show good production outcomes, but encounter market issues and require better market access and post-harvest processing options. Mussel farms offer passive aquaculture possibilities at an artisanal level.
- **Cage construction, aquaculture equipment, and rethinking "standard" ponds.** Production models that use locally sourced materials to build cages or provide other aquaculture equipment would facilitate new product initiatives. Support could include developing manuals and field protocols about simple, low-cost equipment options.
- **Developing production of other aquaculture species.** Alternative products could help diversify and develop aquaculture in Southern Mozambique but would require a pilot study or production action plan. IDEPA has identified sea cucumber as a potential alternative product.

Site selection will be critical, as will choosing individuals to run the pilot project. Both IDEPA and project specialists should be involved in the selection process.

- **Build capacity on harvesting strategies**, especially for seasonal lakes, and post-harvest conservation techniques
- **Develop stocking and management plans** for seasonal ponds and artificial dams in the southern provinces, and monitor progress on these plans
- **Support catfish production** to provide more resistant species for some seasonal lakes.

Possible actions under this activity include the following:

- **Support the establishment of two production cycles at three pilot farms over three years.** Support could include capacity building and training tailored to conditions in Southern Mozambique, conducting a market assessment and post-harvest study, and developing a strategy for continuation.
- **Develop local construction expertise** for building simple, effective artisanal aquaculture equipment by supporting two pilot projects. Support could include capacity building and demonstration training. In addition, material and support could be provided to four new projects, along with communications materials.
- **Explore aquaculture production alternatives to be developed** by selecting two species according to opportunity, culture constraints, market opportunities, and resilience.

Support should ideally emphasize business and investment models that clarify the recovery time of the initial investment. This work would need to be done at the pilot scale but should ultimately provide a return on investment at a larger scale.

12 Financing the commercial aquaculture value chain

ProAzul's current Mais Peixe Sustentável⁵ ("More Sustainable Fish") matching grant scheme supports MSME aquaculture projects that could have a large impact on sector development by adapting financing models for commercial and small-scale aquaculture initiatives. This activity could support aquaculture projects through a cofinanced funding model for initiatives that aim to:

- Economically revitalize salinized lands in Chokwe through community involvement
- Increase production capacity of fish feed to commercial levels.

The main action under this activity would be to develop structured investment plans that support sector development.

- Increase the productive capacity of floating cages and medium-scale aquaculture projects

Cross-cutting activities

Aquaculture development actions ideally include cross-cutting activities to strengthen the actions' environmental and social impact.

13 Environmental and social impact assessment, safeguards, and monitoring tools

An environmental and social impact assessment is crucial for preparing an area for aquaculture and should be paired with an environmental and social management plan that includes standard operating procedures, manuals, impact communication tools, and emergency plans. The proposed

activity would draw on the proposed mapping activity (Activity 1) to identify suitable areas and assess and direct their subsequent development.

14 Gender-responsive actions and targeting

Women will be prioritized when targeting project activities, including under Mais Peixe Sustentável, and when it comes to stocking artificial lakes and seasonal ponds. Through the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), ProAzul has partnered with MUVA, a non-profit social incubator for women's economic empowerment,⁶ to

develop tools to embed gender aspects in projects that support aquaculture SMEs. These tools could be leveraged in Southern Mozambique.

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5 See more information on Mais Peixe Sustentável at: <https://www.proazul.gov.mz/maispeixe-sustentavel/>.

6 See www.muvamoz.org

Annexes

Annex A – Stakeholders consulted for Southern Mozambique aquaculture development and additional technical studies

Field missions

Two World Bank technical missions undertook discussions and field visits in the context of the completing the aquaculture component of Mozambique FSRP-3. The first mission was carried out between 27 February and 7 March 2023, and the second between 1 and 12 June 2023.

The missions consisted of convening meetings at a central, provincial, and district level with local stakeholders, NGOs and CSOs, and relevant agencies working on livelihood generation for local communities, vulnerable populations, and host communities. Besides the government institutions, meetings were held with other project and cooperation partners to create positive synergies and avoid activity duplication. The details of stakeholders consulted during the missions are presented in Table 12: a total of 47 individuals consulted from 18 different

institutions or private companies for the first mission and 53 from 32 institutions and private sector representatives for the second.

At the end of the second mission, a workshop was held with the private sector involved in aquaculture production to present the project in design and collect further inputs for its improvement. The workshop was led by MIMAIP, with the participation from MADER, to explain the project's main objectives, the selected areas, and the institutions involved. Thirty-six participants participated in the workshop (in the room or remotely). A question-and-answer session was held at the end of the workshop and the inputs were captured in this report.

Table 12: Types of stakeholders

Types of stakeholders	Details
Government institutions	ProAzul, MADER, IDEPA (national and provinces delegation), INOM (national and provinces delegation), INIP (provinces delegation), SDAE, and SPAE
Other projects	IFAD, UNIDO, Embaixada de Noruega
Animal feed producers and aquaculture inputs providers	Merec, Leaders in Development, ABT Consultant, Agronorte, Companhia Industrial de Matola, Intermed, Tilápia de Bilene, and Agrobusiness
Producers associations (formal and informal)	AAM (Associação dos Aquacultores de Moçambique), AMAQUA (Associação Moçambicana de Aquacultura), Association Block 4, Association Block 6, Association of Dingane
Producers of fingerlings	Tilápia de Bilene, CEPAQ, Poelela, Papá Pesca
Farmers	Tilápia do Bilene, Holy Fish, Papá Pesca, Sihaka, Samora Machel Productive unit, Poelela, Association of Dingane, Aqua-Fish, Maria Clara Producer, Block 4, Block 6, Kulhuvuka Banganhe fish farmers, and Chicoa fish farm
Aquatic animal health	INOM's Genetics Laboratory, UNIDO, and University Eduardo Mondlane Centro de Biotecnologia.
Aquaculture university/school	Instituto Superior Politécnico de Gaza (ISPG)
Other institutions	ART Consultant, ANAC (Parque Nacional de Maputo)

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Table 13: Stakeholders consulted and relevance to the project

No	Institution	Role / relevance to the project
1	ProAzul	Fiduciary agency responsible for the implementation of aquaculture related activities.
2	Fisheries and Aquaculture Development (IDEPA)	Technical responsibility of the Subcomponent 1.5: Aquaculture Research, Extension, and Information Systems. IDEPA is experienced in the leadership and implementation of development projects.
3	National Oceanographic Institute (INOM)	Technical responsibility of the Subcomponent 1.5: Aquaculture Research, Extension, and Information Systems. INOM has research and experimentation capacities to support the development of aquaculture.
4	Producers associations (formal and informal)	National competent authorities, WOAH focal point for monitoring of diseases in aquaculture products. Improve MIMAIP's capacity for research, detection, and prevention of diseases in aquaculture species together with INOM and CEPAQ. INIP is responsible for all export agreements and conformity of aquaculture structures with export requirements. INIP will inspect all processing facilities and control the product, pre-requisite for export.
5	National Fisheries Administration (ADNAP)	Experience in fisheries administration and is present in all provinces and has shown willingness to integrate aquaculture administration at central, provincial and district levels.
6	Ministry of Agriculture and Rural Development (MADER)	Implementing Agency. The majority of the proposed activities will be under the fiduciary responsibility of the Mozambique Institute of Agricultural Research (IIAM).
7	Provincial Services of Economic Activities (SPAЕ), Maputo	Government implementing agencies at district level
8	Provincial Services of Economic Activities (SPAЕ), Gaza	Government implementing agencies at district level
9	Provincial Services of Economic Activities (SPAЕ), Inhambane	Government implementing agencies at district level
10	Aquaculture Research Center (CEPAQ)	CEPAQ is developing research for the genetic improvement of tilapia (<i>Oreochromis mossambicus</i>) and is currently in its 5th generation. This program aims to encourage the culture of tilapia in brackish and saline waters and the results of resistance to salinity trials have shown to be satisfactory. In parallel, CEPAQ produces and sells tilapia fingerlings (<i>Oreochromis niloticus</i>), however, sales are low, and the center only uses 20 percent of its installed capacity. While CEPAQ will certainly have a role in the project, studies agreed to be done will allow for better identifying the specific role (e.g. training) that they can provide.
11	UEM Biotechnology Center	The Biotechnology Center (at Eduardo Mondlane University) is very well equipped and is currently preparing for the ISO 17025 certification process, which shows a great capacity to comply with international standards. The team showed capacity and willingness to establish partnerships to address issues related to aquatic animal health: technical support to include needed PCR and bacteriology tests for fish diseases (all needed equipment is already in place), and for interlaboratory control and analysis calibration. There is also a need for a sample preparation unit for tissue analysis (equipment to i. prepare tissue for micro-sliding for microscope observation, bacteria analysis and colorimetry and ii. for tissue fixation for histology)
12	National Administration of Conservation Areas (ANAC)-Maputo National Park	Pilot mussel production
13	Mozambique Technical Secretariat for Food Security and Nutrition (SETSAN)	SETSAN is the entity responsible for food security statistics, as well as for the promotion of multisector nutrition campaigns, among other activities. The possibility of establishing partnerships in nutritional campaigns and promotion of aquaculture products and on an adaptation of the existing nutrition manuals to include more information on fish aspects, which are largely excluded.

Table 13 (continued): Stakeholders consulted and relevance to the project

No	Institution	Role / relevance to the project
14	United Nations Industrial Development Organization (UNIDO)	UNIDO is implementing the MAMAP project. Their overall objective is to enhance market access for Mozambique's SMEs of the aquaculture value chain, through strengthening their quality and compliance capacity. UNIDO is working with INIP, IDEPA and INOM on the issue of hazard and operability analysis (HAZOP) certification of aquaculture to target other markets. INOM has the responsibility to create standards. UNIDO also intends to invest in multi-sector capacity building to improve post-harvest practices and also promote the transformation of associations into cooperatives. While there is scope for collaboration, specific activities are yet to be defined. Considering women's informal role in the aquaculture supply chain, MAMAP project will collaborate to develop the gender analysis of the aquaculture sector in Mozambique.
15	IFAD	IFAD is financing the IDEPA-led PRODAPE project, the biggest aquaculture project ongoing in Mozambique, which covers Central and Northern Mozambique (US\$50 million). The Project foresees the preparation of the aquaculture national extension strategy and is also working with INOM for the certification process and has started the process of creating standards. IFAD will finance a network of extension workers (about 251) who will receive training and salaries through the project for two years and then move on to the government payroll. Given the size of the project, it is critical to ensure close coordination with PRODAPE. Methodologies developed in certain areas (e.g., cooperative strengthening) may be applied in the Project area.
16	Norwegian Embassy	Norway supports CEPAQ activities and collaborates with private local aquaculture companies as Papá Pesca.
17	Instituto Superior Politécnico de Gaza (ISPG)	Institute Superior Politécnico de Gaza provides training of Aquaculture Engineering. They have about 30 students per year. and are already involved in many activities such as artisanal feed production, water quality analysis and have set up a business center to support initiatives for creating aquaculture activity (support in business model and providing funds (from government and project) up to US\$200 to support between one to three projects per years). They are interested to support project actions and to get support for creating a small feed production unit of extruded feed.
18	Sihaka	Aquaculture farmer
19	Leaders of Development Lda	Aquaculture farmer
20	UEM Biotechnology Center	INTERMED currently produces dog and chicken feed. They are in the process of setting up a fish feed production plant in the center of the country (under Mais Peixe, MOZRURAL) but they also have a feed production unit for chicken feed and pet food in Maputo. For this last unit, they are in the process of acquiring equipment to set up a bigger extruder unit with capacity to produce up to four tons per day. The production line for dog feed can be used to produce aquaculture feed. The raw material can also be similar for protein sources. The main concern they have shown is related to cash flow for acquiring local raw material during the seasonal period when prices are relatively lower, and thus guaranteeing that the price of the feed is more affordable to the producers. Currently, they import the protein from Eastern Europe.
21	Tilapia do Bilene, Gaza	Aquaculture farmer, feed and fingerling producer
22	MEREC	MEREC is a company that sells fish feed, imported from Mauritius. They reported that they do not produce locally because the demand is too low and does not justify a large investment to establish a fish feed production line. MEREC's expectation is to obtain financing through aquaculture projects in order to share the investments risks.
23	AAM (Associação Aquacultores de Moçambique)	MEREC is a company that sells fish feed, imported from Mauritius. They reported that they do not produce locally because the demand is too low and does not justify a large investment to establish a fish feed production line. MEREC's expectation is to obtain financing through aquaculture projects in order to share the investments risks.
24	AMAQUA (Associação Moçambicana de Aquacultura)	AMAQUA is the Associação Moçambicana de Aquacultura, fully registered as association since 2015
25	Aquafish, Inhambane	Aquaculture farmer

Table 13 (continued): Stakeholders consulted and relevance to the project

No	Institution	Role / relevance to the project
26	Papá Pesca	Aquaculture farmer and fingerling producer
27	Aquacultoria, Lda	Aquaculture consultancy support
28	Poelela Fisheries	Aquaculture farmer Fingerling and feed production
29	Holy fish	Aquaculture farmer
30	Companhia Industrial de Matola	Food and animal feed producers
31	ABT Consultant	Aquaculture consultancy support
32	Agronorte	Animal feed producers and aquaculture inputs providers
33	La Cooperativa, LDA	Supplier country wide
34	Samora Machel Productive unit	Aquaculture farmer
35	Luziathe (Aqua Plus)	Feed supplier
36	Nutrition hub	Feed supplier (South Africa)
37	Specialized Aquatic Feeds	Feed supplier (South Africa)
38	Association of Dingane	Producers' associations
39	Association Block 4	Producers' associations
40	Association Block 6	Producers' associations
41	Maria Clara	Aquaculture farmer
42	Kulhuvuka Banganhe fish farmers	Aquaculture farmer

Additional studies

To get more information after the first field mission and first findings on the main challenges and needs of aquaculture support coordination aspects in the southern area, two pre-studies were commissioned to list priorities and define the perimeter of action:

- Situation and priorities for seed and feed in the three southern provinces
- Governance of aquaculture to structure government and private sector connection and cooperation to optimized extension and technical support for sector development
- Pre-study on feed and seed.

The first study was a participatory review of the current supply of feed and seeds in the south of Mozambique for tilapia aquaculture. This review considered existing situations and possible options around logistic, storage and production challenges and possibilities, and private sector and public institution actors' needs projection and production capacities. Special focus was given to quality and price ratios adapted to existing aquaculture models and technical know-how. The outcomes of this study are developed in this report and the full report is available on-demand.

The objective of the pre-study on feed and seed were as follows:

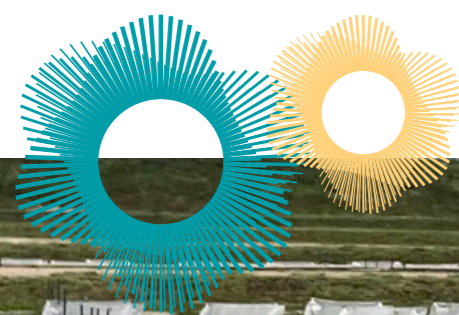
- Provide recommendations on feed strategy approach to optimize the supply of feed in the south of Mozambique for aquaculture farmers.
 - Imported feed, industrial locally made feed, and semi-artisanal local production.
 - Feed composition recommendations to adapt protein levels to extensive and semi-extensive existing models.
 - Solution with local and regional raw materials and other sources of proteins that can be used in Mozambique (blood meals, terrestrial animal meals, or others) to reduce the production costs and the feed cost for the farmers.
 - Consider transport and storage options to make the feed available to farmers in the three southern provinces.

- Provide recommendations on the fingerling strategy approach to optimize the supply of seeds in the south of Mozambique for aquaculture farmers.

- Genetic selection needs to comply with farmers' farming conditions (freshwater or brackish), farmers' expectations, farming methods, and production management.
- Logistic aspects and supply of the farms including the possibility or need to develop nursery approaches.
- Special attention will be given to the supply of fry available, their actual and maximum quantity, their level of selection and other specifications, such as monosex tilapia, sizes, price, and quality.
- For hatcheries: suggest ways to improve technical working practices to optimize performance and supply of seeds in quality and quantity.
- Identification of the fry supply demand levels for each structure will be used to draw up this map with the aim of identifying the potential for the development of hatcheries and nurseries in each region and proposing lines of collaboration between these fry-producing structures to satisfy the demand more effectively and to counteract periods of fry shortages.

- Define priorities and activities to include at the level of project actions to optimise support and capacity-building actions on feed and seed supply and to support the supply during sector development and increase of farmers' demands (in volume and quality)
- List possible phasing and related support to be considered to implement recommendations: capacity building, pre-assessment, pilot units, formulation support, material needed, and equipment.
- Define recommendations and possible roles that can be supported by public sector aquaculture services or institutions (such as CEPAQ) or by the private sector actors or Organizations.

Jorge Vieira Barbosa did this pre-study with a field visit done during the second field mission. The conclusion of its study has been incorporated in this report.



Pre-study on governance

The second study was to undertake a participatory review of the current aquaculture extension services and technical support networks in the field, with a view to optimizing sectoral growth and investment. This study was authored by William Leschen, and its findings were incorporated in this report. The review considered an analysis of technical support and flow of technical knowledge between technical services to field level, and from field levels to government and research institutions; both from public institutions (at national, regional, and field levels) and from the private sector (farmer organizations, associations, cooperatives). Special focus was given to links between private (mainly artisanal and small scale) and public sector.

The following key objectives were defined:

- Provide recommendations on extension strategy approach to optimize project action: Define and evaluate extension services and the role of the different services provincial and national and their activities on sector development. Study the link between extension services, technical training schools/institutes and the private sector, small-scale sector. Define possible private-sector governance support needs to connect to the extension network and define the technical knowledge flow (to ensure the extension service will address the developmental needs of all actors in the production sector and get back valuable information and understanding to adapt their support).
- Define priorities and activities to include at the level of project actions/activities to optimize support and capacity-building actions planned for sector development.
- Propose technical adaptation to optimize support of extension services and project activities outputs. Provide advice on potential viable improvements in governance for aquaculture field technical support and controls.

Annex B – Legislation and regulations relevant to aquaculture development

The following legislation applies to aquaculture development:

- Fisheries Act (Law 03/90, of 26th September updated in 2013 by Law no. 22/2013 of November 1st): establishes a legal framework for fishing and aquaculture activities.
- Decree No. 71/2011: Determines suitable areas for aquaculture development.
- Decree No. 3512001: Approves the General Aquaculture regulation and its annexes.
- Decree No 26/2009 of 17 August and Decree No 76/2009 of 12 November: control biosecurity measures in aquaculture.
- Law No. 16/91: controls water use and effluence discharge.
- 46/2007 of August 21 Water Policy: controls water policy.
- Decree 43/2007 of October 30 2007: regulates the private water use licensing process.

- October 072009–Regulation on small dams: Controls dam safety, construction, and maintenance of small dams.
- Water resource management strategy (approved in 22nd ordinary session of Ministry Council, August 21 of 2007): controls water management strategies.
- Decree No. 18/2004: Sets standards for effluent discharges and emissions.
- Law No. 20/97” Controls the production and disposal of toxic and polluting substances.
- Decree No. 94/2014: Establishes a framework for urban waste management, which may apply to small-scale urban fish farms.
- Decree No. 83/2014: Controls hazardous waste management.
- Resolution No. 5/95–National Environmental Policy: Establishes the basis for all environmental legislation.
- Law No. 20/97: Defines the legal basis for sound environmental use and management practices.
- Decree No. 54/2015: Outlines the framework of environmental and social impact assessments.
- Decrees No. 25/2011: Controls environmental audits
- Decree No. 11/2006: Controls the supervision and verification of environmental protection compliance.
- Ministerial Decree No. 129/2006: Standardizes the environmental impact assessment process.
- Ministerial Decree No. 130/2006: Guides the principles and methodologies of the environmental and social impact assessment consultation process.
- Resolution No. 10/95–Land National Policy: establishes certain land-use criteria for families.
- Law No. 19/1997: Outlines land-use restrictions which may impact aquaculture site selection.
- Law 20/97–Environmental Law: Controls and manages biodiversity and protected resources.
- Law No. 10/99–Forest and Wildlife Law: Controls the protection, conservation, and sustainable use of wildlife resources.
- Decree No. 12/2002: Includes a list of protected animals.
- Law 16/2014 (as amended by Law 5/2017): Controls the use of national territory, with emphasis on conservation areas.
- Law No. 10/88: Controls material and non-materials assets of Mozambiquan cultural heritage.



