WebLog Journal of Aquaculture

Mini Review
Published: 29 Oct, 2025

Building Sustainable Aquaculture in Tunisia: Where Do We Stand and What's Next?

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WebLog Open Access Publications
Article ID : wjaq.2025.j2902
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Abstract

Tunisian aquaculture has experienced remarkable growth, increasing from 887 tonnes in 1990 to over 21,000 tonnes in 2023. This growth has been driven by mussel, oyster farming and freshwater fish aquaculture since the 1960s, as well as land-based research and development and offshore cage operations. The sector now encompasses marine hatcheries, cages for sea bass and sea bream, mussel, tilapia farms and inland fish aquaculture, as well as pilot projects for shrimp and seaweed. It contributes USD 120 million and 14.6% to the fisheries output. Key challenges, such as limited hatchery capacity, feed imports, processing gaps and disease, are being addressed through strategic plans. Emerging sustainability measures include IMTA, recirculating systems, species diversification, and certification, such as the Aquaculture Stewardship Council and Best Aquaculture Practices. This comprehensive review analyses the evolution, current status and prospects of the sector through a synthesis of official statistics and scientific literature. It examines production systems, species diversity, the governance framework and sustainability challenges, and proposes strategic directions for sustainable development.

Keywords: Aquaculture; Management; Sustainability; Diversification; Tunisia

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Received Date: *17 Oct 2025*
Accepted Date: *27 Oct 2025*
Published Date: *29 Oct 2025*

Citation:
Mili S, Ennouri R, Agrebi S, Laouar H, Hedfi A, Mahmoudi E. Building Sustainable Aquaculture in Tunisia: Where Do We Stand and What's Next?. WebLog J Aquac. wjaq.2025.j2902. https://doi.org/10.5281/zenodo.17636000

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Introduction

The history of aquaculture in Tunisia dates back to the 1960s, when private enterprises first cultivated Mediterranean mussels and Pacific oysters on fixed tables in the Bizerte Lagoon. Since the last comprehensive review in 1992, the sector has grown considerably: annual production increased from 887 tonnes in 1990 to 21,387 tonnes in 2023. Throughout this period, Tunisia's aquaculture industry has celebrated significant achievements while contending with numerous challenges, mirroring the broader evolution of aquaculture worldwide [1, 2]. What follows highlights the main successes and threats that have shaped the Tunisian experience.

Main Traits

Tunisia is located in the northern part of Africa and at the heart of the Mediterranean. It boasts over 2,290 km of coastline and a maritime jurisdiction spanning approximately 104,000 km². Its coastal lagoons cover approximately 105,200 hectares, while inland freshwater bodies account for around 20,000 hectares of surface area [7, 11]. Traditional lagoon fisheries have long been practised here as a form of extensive aquaculture. The evolution of modern aquaculture can be divided into three distinct phases.

Between 1960 and 1985, Tunisia's aquaculture sector began to develop with the establishment of the country's first freshwater fish farm in Ain Sellam, which focused on cyprinid species. During this pioneering period, an experimental shrimp farm was also established, along with the country's first marine hatcheries, which cultured sea bass, sea bream and sole, in Ghar El Melh and Monastir. Research and development were the primary drivers during this period [3, 11].

The second phase, from 1985 to 2007, saw the introduction of the first commercial land-based, intensive aquaculture operations. Three large-scale farms were constructed; however, despite an initially promising start, two of these farms eventually closed due to severe eutrophication issues, leaving only one facility fully operational [3, 11].

In 2007, the third era began with the deployment of floating cage farms offshore, a model which quickly proved to be economically viable [3, 11]. Today, Tunisia's aquaculture landscape comprises three marine hatcheries, 21 marine fish farms producing sea bass, sea bream and gilthead bream, 4 mussel farms cultivating European mussels, 4 freshwater tilapia farms, one seaweed farm, 6 microalgae farms and a pilot white-leg shrimp facility [4]. In 2023, aquaculture yielded 21,387 tonnes, accounting for 14.6% of the nation's total fishery output and generating approximately USD 120 million [4].

Strategic planning has underpinned this growth. The 1994 Master Plan for Aquaculture assessed the development potential of different species and identified suitable inland farming sites, resulting in three private sea bass and sea bream farms, two of which later faced environmental challenges. A 2006 site-selection study then identified optimal offshore zones for the cage culture of sea bass and sea bream and for the fattening of bluefin tuna [2, 11].

The National Aquaculture Development Strategy (2007–2016) accelerated progress further by offering financial and fiscal incentives and by establishing the Aquaculture Technical Centre. The latter bridges the gap between aquaculture and research, while providing training and support [3]. Subsequent policy documents, such as the Strategic Study of the Fisheries and Aquaculture Sector (2013–2016) and the 2030 Aquaculture Development Strategy, have emphasised the importance of sustainable and resilient growth through stronger governance. These documents aim to increase the share of aquaculture in national fish production to 30% and boost per capita consumption of farmed products [3, 11].

Aquaculture Models

In Tunisia, aquaculture operations are divided into marine and inland systems. Marine farms cultivate species such as finfish, seaweed, shellfish and shrimp, while freshwater facilities focus on producing fish and microalgae. In 2023, Tunisia's total aquatic yield was 164,619 tonnes, 21,387 tonnes of which came from aquaculture. This raised its share of the national fish output from 10% to 13% across 41 active farms and 30 dam reservoirs [4]. This output is valued at approximately USD 120 million. That year, the fisheries sector employed 43,847 people, only 2% of whom worked in aquaculture [4], predominantly as graduate engineers, technical staff, and scuba divers.

Offshore marine fish farms dominate the activity, accounting for 90% of total aquaculture production (19,248 tonnes in 2023), *via* 21 facilities. The four Bluefin tuna farms alone represent a further 5% of production. Shellfish farming, mainly concentrated in the Bizerte Lagoon, declined from 10 active farms in 2021 to just 4 in 2023, with annual production varying between 40 and 200 tonnes [4]. Shrimp farming remains in the experimental stage, with a pilot capacity of two tons, while freshwater aquaculture contributes around 1,000 tons to the national total [3].

Cultured Species

Tunisia's aquaculture sector currently cultivates a relatively limited range of species, but there is considerable scope for future expansion. The primary species produced in marine environments are European seabass (*Dicentrarchus labrax*), gilt-head seabream (*Sparus aurata*), meagre (*Argyrosomus regius*), Pacific white shrimp (*Litopenaeus vannamei*), red seaweed (*Gracilaria verrucosa*) and shellfish (*Mytilus galloprovincialis* and *Crassostrea gigas*), which are predominantly farmed in the Bizerte lagoon [2, 3, 11]. Spirulina (*Arthrospira platensis*), the most extensively cultivated microalgae in Tunisia, is valued for its use in nutrition, cosmetics and health supplements [8]. Although still in its early stages, macroalgae cultivation is showing promising ecological and economic potential, as demonstrated by pilot initiatives focusing on species such as *Gracilaria gracilis* and Ulva in the Bizerte Lagoon [5].

To broaden the aquaculture's species portfolio, research efforts have targeted promising candidates and sustainable production models. Integrated Multi-Trophic Aquaculture (IMTA) is one such approach, co-cultivating organisms from different trophic levels, typically finfish (seabass and seabream), bivalves (mussels and oysters) and seaweed, within the same system [1]. Nutrient effluents from fish enable shellfish and macroalgae to flourish, thereby enhancing overall resource efficiency. A recent collaborative project between the National Institute of Marine Sciences and Technologies (INSTM) and the Aquaculture Technical Centre (CTA) successfully demonstrated IMTA combinations that harnessed these nutrient synergies [3].

Inland Fish farming in Tunisian reservoirs began in the 1960s under the auspices of the National Fisheries Office (ONP), which stocked selected dams with fry of various species for subsequent harvesting. In the southern regions, where geothermal springs and earthen ponds are prevalent, Nile tilapia (*Oreochromis niloticus*) dominates. In contrast, northern reservoirs and lakes have been seeded with a broader range of species for extensive cultivation [6, 7, 9]. These introductions have included common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), bighead carp (*Aristichthys nobilis*), rudd (*Scardinius erythrophthalmus*), roach (*Scardinius erythrophthalmus*), zander (*Sander lucioperca*), catfish (*Silurus glanis*) and mullet (*Mugil cephalus* and *Chelon auratus*), with millions of fingerlings released into the water bodies [6, 10]. The strong growth performance of these species, the emergence of producer cooperatives, the deployment of young graduates to manage certain reservoirs and the production levels achieved all attest to the considerable potential of freshwater reservoirs for aquaculture. Nevertheless, the management of these fisheries still faces administrative and technical challenges. Despite sustained efforts by state agencies, technical centre, research institutes and internationally funded development projects, actual production continues to fall short of the projections set out in national economic and social development plans.

Governance

Tunisia's aquaculture sector operates within a multifaceted institutional network comprising public authorities, support agencies, research bodies and industry groups, which work together to promote sustainable growth and innovation [1].

The Ministry of Agriculture and Hydraulic Resources is at the helm, overseeing policy-making and regulation for both fisheries and aquaculture. The General Directorate of Fisheries and Aquaculture (DGPA) is responsible for formulating strategic plans, issuing licences and enforcing the regulations necessary to safeguard marine

resources and ensure long-term sectoral development. The General Directorate of Veterinary Services (DGSV) is responsible for animal health oversight, including monitoring disease outbreaks, regulating veterinary pharmaceuticals, and ensuring that aquaculture products meet food safety standards [2].

To stimulate private investment, the National Agency for the Promotion of Agricultural Investments (APIA) provides guidance, financial incentives and streamlined procedures for setting up and expanding aquaculture operations. The sector's regulatory architecture is further underpinned by a suite of laws, decrees and environmental impact requirements that collectively aim to minimise ecological footprints, protect coastal habitats and uphold rigorous health and safety norms.

The Inter-Professional Grouping of Fishery Products (GIPP) enhances the competitiveness of Tunisian fisheries and aquaculture through market development, quality assurance and export promotion. Similarly, the Agricultural Extension and Training Agency (AVFA) delivers on-the-ground training and technical support, disseminating best practices and new technologies to producers across the country.

Research and higher education institutions play a pivotal role in underpinning innovation. The Institution of Agricultural Research and Higher Education (IRESA) coordinates organisations such as the National Institute of Marine Sciences and Technologies (INSTM), the National Agronomic Institute of Tunisia (INAT) and the Higher Institute for Marine Science of Bizerte (ISSMB), which conduct fundamental and applied research ranging from marine ecosystem monitoring to the domestication of novel aquaculture species.

Finally, the Aquaculture Technical Centre (CTA) offers specialised consultancy, capacity-building workshops and technical assistance aimed at improving farm management and scaling up best-practice methodologies. Various professional associations and the Tunisian Union of Agriculture and Fisheries (UTAP) round out this framework by advocating for producers' interests, facilitating policy dialogue, and fostering collaboration across the value chain.

Challenges

Despite its rapid growth, Tunisian aquaculture continues to face several persistent challenges. These include the absence of local facilities to add value to farmed species, insufficient hatchery capacity for fry production, frequent disease outbreaks and intense competition in domestic and international markets. Investment in upgraded infrastructure, advanced technologies and specialised training is essential, as is strengthening the regulatory environment to enforce best practices [1]. Currently, around 50% of fish feed must be imported, even though there are three local feed mills, and local hatcheries supply only around 17 million larvae per year, compared to 80 million fry imported from abroad [3, 4]. Likewise, producing sufficient Artemia cysts remains a bottleneck; while over 50 Tunisian sites have been identified as suitable for development, large-scale commercial production has yet to materialise [3, 11].

Sustainability

In response to these challenges, Tunisia's aquaculture sector is placing greater emphasis on sustainability by seeking to reduce environmental impacts, lessen dependence on wild-caught fish for feed and optimise resource use. Additionally, notable advances include the adoption of integrated multi-trophic aquaculture (IMTA) and the introduction of new species and recirculating farming systems. These developments aim to improve ecological performance, economic resilience, and production efficiency. Furthermore, Tunisian producers are pursuing internationally recognised eco-certification schemes, such as the Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP) and Friend of the Sea, to validate and promote their commitment to responsible aquaculture.

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