

The Road to Sustainable Aquaculture

On current knowledge and priorities for responsible growth

SUMMARY REPORT



Demand for food from aquatic sources or “blue food” from the world’s ocean, rivers and lakes is growing.¹ Given the depletion of wild aquatic resources and ecosystems by overfishing and other pressures, aquaculture is playing an increasingly important role in meeting this demand, which is expected to increase from 54.7 million tonnes in 2015 to 100 million tonnes in 2050.² Aquaculture has been the fastest growing protein sector over the past few decades.³ Developed responsibly, it has the potential to deliver social, economic and environmental benefits while helping to feed a growing global population in a sustainable, nutritious and equitable way.

The [Road to Sustainable Aquaculture report](#) is a vital first step towards realizing this potential. By presenting an extensive assessment of the current state of the aquaculture sector, it aims to inform priorities toward sustainable growth, encourage widespread engagement in addressing challenges, and lead to future actions and recommendations in a global roadmap.⁴

Aquaculture production has increased by 75% per year since 1970 and its products are now some of the most traded food commodities globally.⁵ However, not all growth is sustainable. To ensure truly sustainable growth, it is critical to consider the many opportunities and trade-offs in aquaculture development. This is a complex undertaking as aquaculture involves a diversity of blue food species, production systems, and value chain actors.

The [Road to Sustainable Aquaculture report](#) highlights both the complexities and opportunities for action on local, national and global scales. It provides a foundation for the future by: (i) positioning aquaculture within global frameworks; (ii) examining different sustainability criteria and production systems; (iii) outlining existing governance strategies; and (iv) providing examples of responsible aquaculture around the world.

Aquaculture has the potential to enhance food security while having a lower impact on the environment than either beef or poultry in terms of greenhouse gas emissions, land and water use, eutrophication, etc. It is therefore well positioned to help fight climate change and provide nutrition and employment for vulnerable communities. Developing our shared understanding of the current state of aquaculture is the first step towards catalyzing a strategic vision for a dynamic, inclusive global roadmap that will ensure the sustainable growth of this vital source of blue food.

This Summary Report provides essential information and priorities to guide value chain actors, investors, nonprofit organizations, policy-makers, and regulators in the aquaculture sector and beyond. We encourage readers to consult the full [Road to Sustainable Aquaculture report](#) for further information and case studies, and hope that this work will guide the process of building a sustainable, healthy and equitable future for aquaculture.

About the Road to Sustainable Aquaculture Report

The [Road to Sustainable Aquaculture - On current knowledge and priorities for responsible growth report](#) is presented by the Sustainable Aquaculture Working Group of the Blue Food Partnership, led by the World Economic Forum’s Friends of Ocean Action platform. This work is based on both policy and science. It is framed by the ocean food priority actions related to sustainable aquaculture growth championed by 16 heads of state in the [High Level Panel for a Sustainable Ocean Economy](#). It is also informed by the findings of the [Blue Food Assessment](#), which seeks to better understand the role of blue food in global food systems and propel policies and practices accordingly. The report is designed to be an anchoring reference to support the Sustainable Aquaculture Working Group’s goal of developing a science-based global roadmap to guide the growth of sustainable aquaculture. The report was researched and produced by ThinkAqua on behalf of the Blue Food Partnership and made possible thanks to the generous support of the UK Government’s Blue Planet Fund.

¹ “Blue food” is defined by the High Level Panel for a Sustainable Ocean Economy as: All edible aquatic organisms, including fish, shellfish and algae from marine and freshwater production systems (aquaculture and fisheries).

² Naylor, R.L., Kishore, A., Sumaila, U.R. *et al.* “Blue food demand across geographic and temporal scales”, *Nature Communications* 12, 5413, 2021. <https://doi.org/10.1038/s41467-021-25516-4>

³ Bush, S.R., Belton, B., Little, D.C., Islam, M.S. “Emerging trends in aquaculture value chain research”, *Aquaculture*, Volume 498, 2019, pp. 428-434. <https://doi.org/10.1016/j.aquaculture.2018.08.0>

⁴ See box ‘About the Sustainable Development Report’ for information about the institutional framing of the global roadmap.

⁵ FAO, *The State of World Fisheries and Aquaculture 2020. Sustainability in Action*. <https://doi.org/10.4060/cag229en>

Aquaculture, and blue food more broadly, is often siloed away from wider food system dialogues on policy and business. But aquaculture has a significant impact and should be considered key to achieving sustainable development. To responsibly grow aquaculture to meet rising demand, we need to think holistically and integrate aquaculture into debates and strategies aimed at sustainable food systems, food security, nutrition, livelihoods, and environmental health. The [Road to Sustainable Aquaculture report](#) positions aquaculture in the context of two global frameworks – the Sustainable Development Goals (SDGs) and the FAO Code of Conduct for Responsible Fisheries – and draws key insights from the comprehensive Blue Food Assessment that published its first findings in 2021.

Sustainable aquaculture has the potential to play a powerful role across the SDGs. Along with supporting SDG 14 “Life Below Water” by alleviating pressure on wild aquatic resources and ecosystems, aquaculture development can contribute directly towards ending poverty (SDG 1), enhancing food and nutritional security (SDG 2), and ensuring healthy lives (SDG 3) and sustainable food production (SDG 12) through the provision of affordable, nutritious aquatic foods. Livelihood and employment opportunities across aquaculture value chains also help to empower women (SDG 5), provide millions of jobs across the world (SDG 8), and maintain communities in remote and coastal areas (SDGs 10 and 11). However, scaling up aquaculture to help meet the SDGs presents both challenges and opportunities.

Challenges related to scaling up aquaculture include:

- The knowledge gaps identified by the [Blue Food Assessment](#), such as the lack of data on dietary intake at a household level, uncertainty over the influence of urbanization, absence of information on potentially important aquatic plants and seaweed and aquatic animals (e.g., amphibians and reptiles), and the need to account for price dynamics and affordability.
- Constraints related to the costs and environmental footprint of aquaculture feed, the disease risks caused by collecting seed/spat/juveniles from the wild, and the extent of antibiotic use.
- The need for effective regulation and governance of aquaculture to ensure environmentally sustainable practices that operate within local ecosystem carrying capacities.

Opportunities created by scaling up aquaculture include:

- Ecosystem services provided by aquaculture such as wetland systems that can mitigate flood risks, increase nutrient use, and boost local biodiversity, and that could be a foundation for ethical investment in the industry and promote economic and social development in local communities.
- The location of aquaculture systems in shared spaces or dependent on shared water resources used for many different purposes, making good relations with local stakeholders vital to attain the “social licence to operate” from the surrounding communities.

The [Road to Sustainable Aquaculture report](#) considers the social, economic and environmental attributes of a wide range of aquaculture production systems. It stresses that the industry requires a rich ecosystem of both small-scale and industrial-scale actors to supply a global seafood market that spans many product categories and a diverse consumer base. Small-scale producers create resilience within aquatic animal value chains due to their ability to pivot quickly in response to dynamic markets. However, they are also the most vulnerable. People engaged in aquaculture value chains, particularly small-scale actors, face a range of threats from intensifying climate change, environmental risks, political change, and socio-economic pressures.

Considering both small and large-scale aquaculture operations holistically as part of global frameworks helps to weigh trade-offs between costs and benefits and scale aquaculture more sustainably.

Evaluating the sustainability of aquaculture development through a ‘One Health’ Approach



3

Mapping social, economic and environmental evidence programmes

A host of certification and evaluation programmes, assessing a wide range of criteria, already exist at different scales across the aquaculture sector. It is important to map these programmes in order to identify more effective ways of linking this knowledge in support of macro-scale ambitions for aquaculture development. However, most current programmes omit some of the complexity and nuance within the aquaculture sector, particularly in relation to food quality, nutrition, and sustainable livelihoods, all of which are crucial to meeting the SDGs. The expansion of sustainable aquaculture will likely build on these programmes, but will need to include this broader complexity, develop a stronger scientific foundation, and create opportunities to bring in funding systems. Identifying the strengths and shortcomings in existing certification and evaluation programmes is an essential starting point.

Much of our current understanding of aquaculture sustainability is driven by scientific evidence programmes at national, regional and global scales, and these programmes are often supported to develop the public information needed to improve aquaculture's environmental, health, and food safety impacts. The [Road to Sustainable Aquaculture report](#) examines a broad array of sustainability criteria and evaluation programmes, presents a summary of global certification systems, and reviews the research and funding systems in selected countries where aquaculture is either well established or set to grow significantly. It also considers how the aquaculture sector currently defines the criteria for sustainable production.

The assessments, programmes and reports reviewed in the report provide evidence of the sector's current performance and help identify the additional information that governments, investors and the market will need to scale future production in a responsible way. This review found that:

- Issues currently covered include regulation, certification, animal welfare, zoning, and policy development.
- None of the reports include information on food quality and nutrition, sustainable livelihoods, or the broader economy.
- Globally, third-party voluntary certification schemes are primarily targeted at meeting the requirements of buyers and consumers in North America and Western Europe.
- There are large variations in the public reporting of performance criteria by aquaculture certification bodies.
- Small-scale producers can be marginalized in export markets as they are unable to meet expensive certification requirements, but they may be better positioned to support local markets.
- The consequences of third- and second-party certification for small-scale producers have not been comprehensively studied, but some certification bodies are attempting to be more inclusive.
- More nuanced categorization is required as some small-scale production is commercially oriented and may enter certified supply chains.



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Knowledge base relating to aquaculture governance

Alongside the sustainability criteria used by businesses across the aquaculture value chain, there are different governance frameworks in place that can provide a foundation to build on and improve. Aquaculture governance strategies differ depending on their scale and how they recognize the role of both small-scale actors and large-scale industrial farms. But whatever the scale, good governance involves regulations and policies that ensure security and opportunities for all aquaculture stakeholders, social harmony, and the responsible stewardship of the environment.

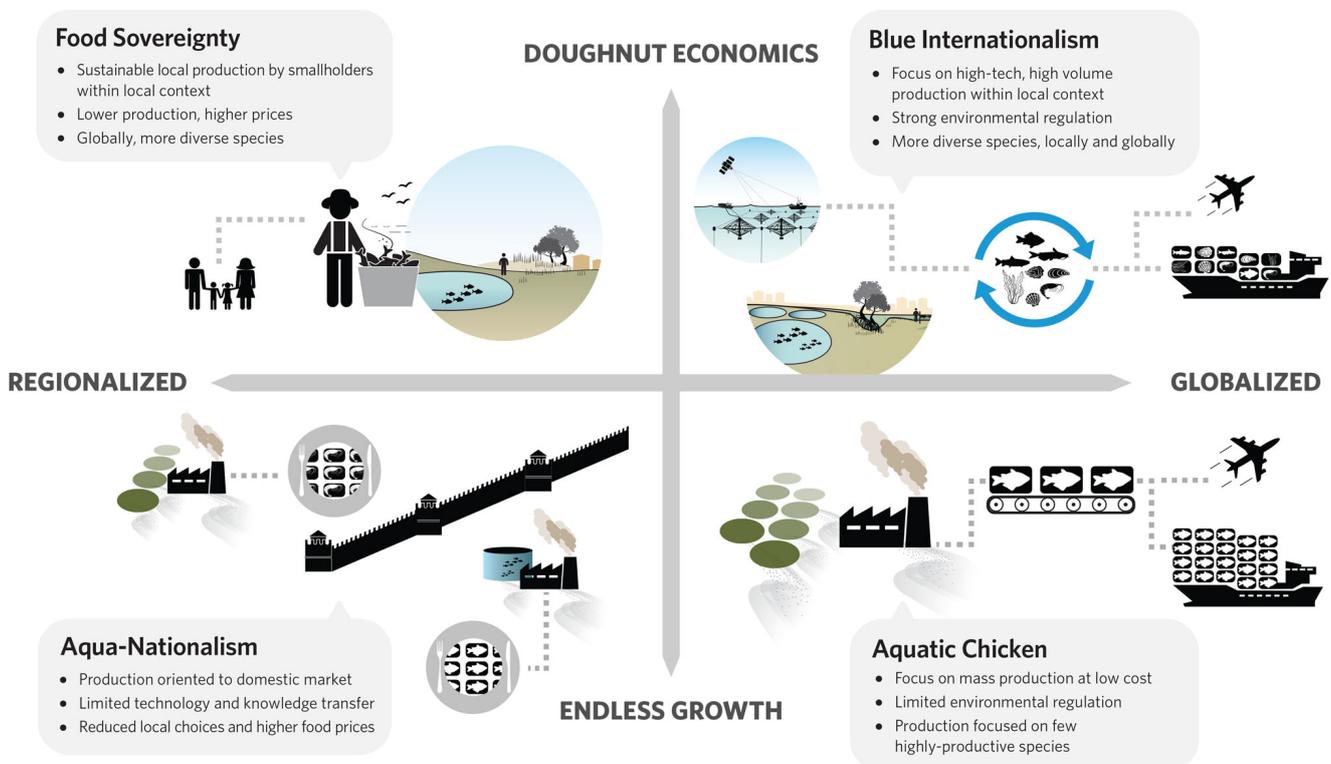
As sustainable aquaculture grows and intensifies, a key consideration is that governance should be framed around the "One Health" lens to support food safety and quality, the environment, animal health and welfare, competitive marketplaces, equitable societies, and human health.⁶ The review of current governance approaches, including legal regulations, certification schemes, and community-based governance, found that:

- Small-scale actors are essential, but large-scale industrial farms also play a critical role as their

significant economic footprint attracts substantial investment capital to the sector and their ability to deliver large volumes of seafood to international markets makes a prominent contribution to meeting the growing global demand for blue food.

- A "blue internationalism" model encourages high-tech, high-volume production across a variety of locally appropriate species under strong environmental regulations.⁷
- In order to provide equitable access to markets, property and labour rights, as well as gender responsive legislation, should be incorporated into aquaculture governance and management.
- Approximately 30-50 aquaculture certification schemes exist, driven by North American and Western European market demand. The most prevalent and value chain-oriented certification bodies for aquaculture are GlobalGAP, Aquaculture Stewardship Council (ASC), and Best Aquaculture Practices (BAP), but these only cover approximately 3.5% of total global production.

Figure 1: Four extreme scenarios for the global aquaculture trade, with indicated benefits and tradeoffs (reproduced from Gephart *et al* 2020).



6 Ste Stentiford, G.D., Bateman, I.J., Hinchliffe, S.J. *et al.* "Sustainable aquaculture through the One Health lens". *Nature Food* 1, 2020, pp. 468-474 <https://doi.org/10.1038/s43016-020-0127-5>

7 Gephart, J.A., Golden, C.D., Asche, F., Belton, B., Brugere, C., Froehlich, H.E., Fry, J.P., Halpern, B.S., Hicks, C.C., Jones, R.C., Klinger, D.H. "Scenarios for global aquaculture and its role in human nutrition". *Reviews in Fisheries Science and Aquaculture*, 29(1), 2020, pp. 122-138. <https://doi.org/10.1080/23308249.2020.1782342>

5

Opportunities for aquaculture in integrated food production systems

There are many promising integrated aquaculture systems with the potential to optimize both production and nutrient use efficiency and increase food yield from the same land area. These include aquaponics, integrated multi-trophic aquaculture (IMTA), mangrove-shrimp systems, and rice-fish systems, all of which are presented in greater detail in the full [Road to Sustainable Aquaculture report](#). The existence of this array of integrated food production systems demonstrates the diversity of the aquaculture sector. It also emphasizes the emerging opportunities to explore and grow systems able to support multiple environmental, social, health and economic goals, including the SDGs. Developing the global roadmap towards sustainable aquaculture will involve investigating

this diversity further and identifying which systems to prioritize in different contexts.

Together, value chain actors and decision-makers can guide these opportunities to develop aquaculture in integrated food production systems. This could include showcasing holistic approaches to aquaculture that combine food security, environmental sustainability, and livelihood needs. To be successful and spread further afield, these systems need to develop within an enabling policy environment and attract investments by a range of funds to support the uptake of regenerative food production practices globally.

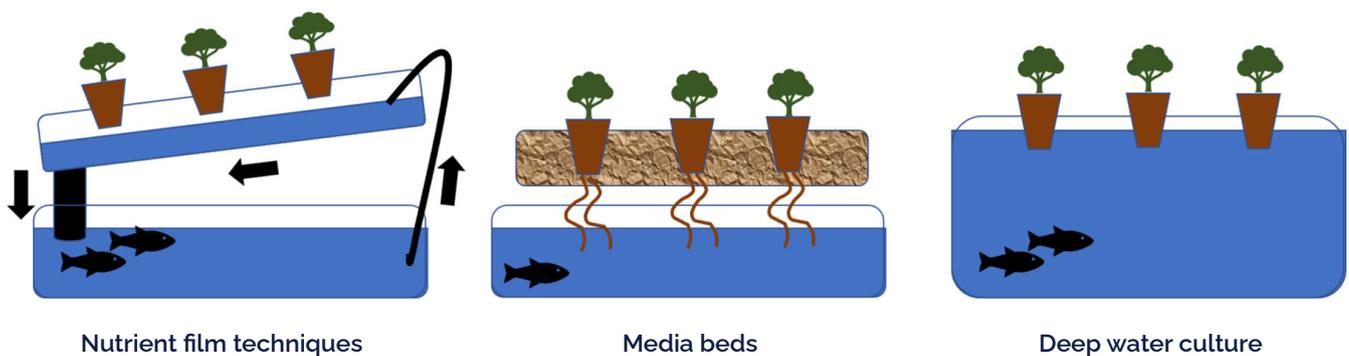


Image by: Alexandra Pounds

Case studies demonstrating lessons for aquaculture growth

The myriad aquaculture value chains already in operation across the world can provide best practices and valuable learnings that the future roadmap can build on to help stakeholders navigate challenges and transition towards sustainable practices. To showcase these prospects, the 26 case studies featured in the report reveal exciting opportunities and challenges across different production systems and geographies.

These diverse cases present real-world examples of aquaculture in all continents and highlight key areas where greater benefits could potentially be realized.

These include cases that demonstrate: critical roles for regulation and good governance; culturally sensitive ways to gain a social licence to operate through local engagement; strategies that optimize feed, nutrition, animal welfare, and biosecurity; industry-led coalitions to eliminate forced labour; and the transfer of new technology and a digital blue revolution.

Priority areas to consider towards the growth of sustainable aquaculture

The [Road to Sustainable Aquaculture report](#) explores the complexity and diversity of aquaculture value chains. There are many priority areas to consider for the future. By identifying some of the most promising avenues for development, the report aims to highlight opportunities for a wide range of actors to get involved in the process and contribute to future roadmap efforts. The below list of 12 priority areas is not exhaustive but presents a set of potential pathways that could form the basis of a global roadmap towards the growth of sustainable aquaculture.

- **Conducive regulatory environment** – encouraging fit-for-purpose, efficient, evidence-based regulatory frameworks built on transparency, accountability and participation, and including “beyond-compliance” social, environmental and economic performance measures.
- **Access to markets** – including successful investments based on credible market assessments, group certification schemes enabling producers in emerging economies to access commodity export markets, improved physical networks and transportation, and more durable opportunities for small-scale participation.
- **Access to finance** – supporting sustainable growth through investments, loans, credit, and financial services that match producer needs, timelines, and risk profiles, while ensuring the availability of competitive, transparent, secure markets and modes of transaction to strengthen investor confidence.
- **Insurance** – increasing access to insurance for aquaculture producers, which currently trails behind agriculture in its effectiveness.
- **Value chains** – optimizing product quality and opportunities for employment, value addition, and local social development through proximity of primary processing capacity, facilitating technology transfer, and the reuse of by-products to ensure nutrients are not lost to the biosphere.
- **Access to technology/innovation** – supporting innovative tech start-ups (e.g., in precision farming, diagnostics, and selective breeding) to provide solutions known to improve productivity and efficiency, and scaling established technologies and systems that offer high potential for replicating responsible aquaculture growth in new regions.
- **Social inclusion and community engagement** – promoting responsible interaction and engagement with neighbouring communities and local stakeholders, including through certification schemes, to support social sustainability goals and increase the social licence to operate within shared environments.
- **Disease management** – developing biosecurity measures and preventive management plans to minimize the risk of transmitting pathogens, introducing commercial vaccines to reduce the use of antimicrobials, and enhancing access to diagnostic services and rapid testing.
- **Feed supply** – ensuring access to reliable, nutritionally complete, sustainable and affordable feeds that are formulated to match the requirements of the species and life-stages being cultured, and the nutritional profile demanded, and using new approaches and digital solutions to improve environmental impact quantification and traceability of feed materials and aquafeed production.
- **Seed supply** – delivering dependable and timely supplies of good quality seed that optimize survival, yields, and disease prevention, and ensuring good broodstock selection and management programmes that support farmed stock with traits desired by producers, buyers and consumers.
- **Conducive environment/water quality** – establishing ecosystem-based management systems that take cumulative environmental impacts into account in site licensing and farm management in order to support better water quality, animal health welfare, and site operation longevity, and ensure that growth remains within ecosystem carrying capacities.
- **Efficient use of natural resources** – optimizing the use of fish-derived ingredients to ensure their most appropriate use in feed, adopting technologies and design principles that maximize water efficiency, and introducing certification standards that encourage producers to adopt practices that use fewer natural resources per unit of production.

The [Road to Sustainable Aquaculture report](#)'s exploration of sustainability goes beyond the conventional review of aquaculture's impacts on the environment to touch on its reverberations in communities, livelihoods and economies. It also positions aquaculture within a “One Health” framework that links animal, environmental and human health. By shedding light on a range of dimensions and issues related to aquaculture now, more informed decisions can be made about the levers of change that could bring about a more socially just, economically viable, and environmentally sound aquaculture sector in the future.



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