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Editorial: Blue foods security and sustainability

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Editorial on the Research Topic
Blue foods security and sustainability

Blue foods, encompassing aquatic foods sourced from marine and freshwater environments, serve as a cornerstone of global nutrition and food security. They offer an accessible and affordable supply of protein and essential micronutrients to over 3.2 billion people worldwide, while also sustaining the livelihoods of 600 million individuals and providing employment to 58.5 million workers (FAO, 2022). As such, blue foods are intrinsically linked to the achievement of several Sustainable Development Goals (SDGs), particularly those focused on ending hunger, ensuring healthy lives, and promoting sustainable economic growth. The remarkable surge in blue food production, from 19.9 million tons in 1950 to 214 million tons in 2020 (FAO, 2022), further underscores their growing significance within the global food landscape. Despite this growth, however, persistent hunger remains a significant global issue. Adding to the problem is the fact that 28.9 percent of the global population remained moderately or severely food insecure in 2023 (FAO et al., 2024), highlighting the need for continued expansion of blue food production to meet future demands.

The rapid expansion of aquaculture and fisheries, however, has introduced significant ecological and environmental challenges including biodiversity loss, pollution, and habitat degradation. These issues are compounded by the impacts of climate change, ocean acidification, and other environmental stressors, which threaten the sustainability of blue food systems. Despite these challenges, blue foods remain a critical component of sustainable food systems and offer a lower environmental footprint compared to terrestrial animal-sourced foods. Addressing the ecological and environmental impacts through innovative practices and sustainable management is essential to ensure that blue foods can continue to contribute to global food security and environmental resilience.

1 Current research landscape

The articles in this Research Topic explore various aspects of blue food security and sustainability, ranging from environmental impacts and climate change to innovative management strategies and technological advancements.

1.1 Impact on and by the environment and ecology

Several articles provide key data on how blue food production can both contribute to and be affected by ecological and environmental change. The study on atmospheric CO_2 emissions from bottom trawling (Atwood et al.) highlights the impact of fishing practices on carbon release and ocean acidification, emphasizing the need for sustainable management strategies. Another article (Bu et al.) examines the eutrophication effects of mariculture in Sansha Bay, demonstrating how nutrient management practices can influence ecosystem health. More importantly, a long-term observation on Fukushima-derived radiocesium (Lin et al.) provides critical insights into the persistence and distribution of radiocesium in marine ecosystems. It highlights the importance of ongoing monitoring to assess the impact of environmental contamination (especially nuclide content) on blue food safety.

1.2 Climate change and adaptation

Climate change poses a significant threat to blue food production. The impacts of climate events on fish life history parameters (Hong et al.) underscore the need for adaptive management strategies to ensure the resilience of fisheries. Similarly, the study on Pacific oyster mortality (Mackenzie et al.) explores nature-based solutions to enhance resilience to environmental stressors, offering insights into sustainable aquaculture practices. The research by Shang et al. also indicates that by simply modulating the temperature could help to optimize the utilization of diatoms as an aquatic feed source. The findings underscore the potential of diatoms as a high-quality aquafeed and lay the foundation for its success in ocean warming scenarios.

1.3 Technological innovations and sustainable practices

Technological advancements and innovative management practices are crucial for enhancing the sustainability of blue foods.

1.3.1 Breeding and hatchery technologies

The work on hatchery release frameworks (Zhang et al.), and mass production of mola seed (Rajts et al.) offers valuable insights into improving the sustainability and nutritional value of aquaculture systems. These studies suggest that enhancing broodstock management and developing standardized breeding techniques are essential for promoting sustainable aquaculture practices that can meet the growing demand for blue foods.

1.3.2 Genetic or molecular approaches

The development of a controllable fertility switch in zebrafish (Shi et al.) offers a promising tool for managing the genetic aspects of aquaculture, supporting both productivity and sustainability. Zheng et al. also identified numerous differentially expressed genes (DEGs) related to immune function that can serve as the basis for subsequent immune response analysis of allotransplantation and xenotransplantation. *In situ* labeling technology, such as calcein (Gao et al.), can act as a promising and low-hazard method to monitor the proliferation, release, and resource conservation of shellfish in tidal flats.

1.3.3 Integrate macro-scale monitoring and management approaches

The use of Geographic Information System (GIS) and remote sensing to evaluate aquaculture suitability (Li et al.) highlights the potential of technology integration in optimizing production and minimizing environmental impacts. Integrating large-scale monitoring techniques into the surveillance of field aquaculture activities has also helped to address the challenge of quantifying plastic loads in aquaculture (Tian et al., 2022).

1.3.4 Nature-based solutions

The development of nature-based solutions to enhance the resilience of aquaculture species is another key area of research. It has been highlighted in several studies, particularly in relation to population connectivity (Close et al.), mitigation of eutrophication (Bu et al.), natural aquafeed production, and intertidal farming (Mackenzie et al.). The connectivity study on scallops in the Irish Sea demonstrates how understanding larval dispersal and population dynamics can inform more effective fisheries management strategies. The research by Bu et al. on Sansha Bay shows how mariculture can exacerbate eutrophication, suggesting that integrated management approaches are necessary to balance production with environmental health. Mackenzie et al. demonstrates how intertidal farming can improve the resilience of Pacific oysters to summer mortality syndrome, suggesting that partial culture in the intertidal zone could be an effective strategy for mitigating the impacts of environmental stressors on aquaculture species.

1.4 Socioeconomic and policy dimensions

Ensuring that the benefits of blue food security are equitably distributed is another significant challenge. The research on shellfish mariculture in China (Gu et al.) and the suitability of oyster aquaculture (Li et al.) suggests that market demand and socio-economic factors play a crucial role in the sustainability of blue food systems. Policymakers must consider these factors when designing and implementing regulations to support sustainable blue food production.

2 Challenges and opportunities

2.1 Balancing growth with environmental sustainability

The rapid expansion of blue food production presents challenges related to biodiversity loss, environmental pollution, and habitat degradation. Addressing these issues requires a comprehensive understanding of the interactions between blue food systems and their environments. Further research should focus on developing sustainable practices that balance production growth with environmental conservation.

2.2 Climate change adaptation and mitigation

The impacts of climate change on blue food systems necessitate adaptive management strategies to ensure resilience. This includes developing climate-resilient species and practices, as well as exploring the potential of blue foods in carbon reduction and sequestration. Collaborative efforts across disciplines are essential to address the complex challenges posed by climate change.

2.3 Technological advancements and innovations

Technological innovations offer significant opportunities to enhance blue food security and sustainability. Advances in breeding techniques, genetic manipulation, ecosystem modelling, and integrated resource management approaches can improve production efficiency and reduce environmental impacts. Continued investment in research and development is crucial to harness the potential of technology in blue food systems.

2.4 Policy and governance

Effective governance and policy frameworks are essential for promoting sustainable blue food systems. This includes implementing regulations that address overfishing, habitat protection, and pollution control. Collaborative governance models that involve stakeholders at all levels can foster sustainable practices and ensure equitable access to blue food resources.

3 Conclusion

The research on blue foods security and sustainability highlights the critical role of aquatic foods in addressing global food security challenges. The articles in this Research Topic provide valuable insights into the environmental, technological, and policy dimensions of blue food systems. By advancing our understanding of these issues, we can develop strategies that promote the sustainable growth of blue foods, to ensure their continued contribution to global food security and environmental sustainability.

Author contributions

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Conflict of interest

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

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