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THE STATE OF WORLD FISHERIES AND AQUACULTURE

SUSTAINABILITY IN ACTION

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fishing areas should be closed. Truly adaptive fisheries management strategies responding to signals from the field could become the norm. The enforcing of regulations will become more data-driven, and monitoring agencies should considerably improve their understanding of the sector.

High-tech and big-data approaches have the potential to improve sustainability and working conditions for fishers and fish farmers, and help society to understand better the interdependences that aquaculture and fisheries have with the environment. However, new technologies can infringe on privacy, run the risk of breaking established monitoring and management frameworks, and may not automatically result in efficient controls on activities. Here, FAO has a role to play in promoting the use of standards, in ensuring that fishers' rights and livelihoods are improved in the future by fostering international collaboration on data management and privacy, and in encouraging the development of appropriate regulations, guidelines and best practices for information systems. ■

AQUACULTURE BIOSECURITY

Disease emergence

Aquatic animal disease is one of the most serious constraints to the expansion and development of sustainable aquaculture. Globally, a trend in aquaculture is that a previously unreported pathogen that causes a new and unknown disease will emerge, spread rapidly, including across national borders, and cause major production losses approximately every three to five years (FAO, 2019o). Such serious transboundary aquatic animal diseases are most often caused by viruses, but occasionally a bacterium or a parasite may be the causative agent. A long time lapse (usually years) then ensues, from the time that a serious mortality event is observed in the field, to the subsequent identification and confirmation of its causative agent, to global awareness, and to the establishment and implementation of surveillance and reporting/notification systems and effective risk management measures. In this regard, as stated in the previous edition of this publication (FAO, 2018a), "a paradigm shift is needed in dealing with aquaculture biosecurity risks." By the time the pathogen has been identified and its host range determined, it may have already become widespread globally (including to wild populations), through the movement of live animals of uncertain health status, most often for aquaculture development.

In recent years, the understanding of the drivers for disease emergence in aquaculture has increased, and the factors and pathways involved can be grouped in four general categories (FAO Committee on Fisheries, 2019a), namely:

- Trade and movement of live animals and their products: Fish, shrimp and other cultured aquatic animals (and aquatic plants) have become food commodities, traded globally as live aquatic organisms (e.g. eggs, larvae, fry and adults) and products (fresh, frozen, dried, salted and smoked), often in huge volumes. When adequate national biosecurity is lacking, pathogens (and invasive aquatic species) may be transferred at the same time.
- Knowledge of pathogens and their hosts: Due to their unique aquatic medium, the health of cultured populations of aquatic animals is not readily apparent. The large number of species reared under a variety of aquaculture systems (more than 600 species are farmed globally) means that knowledge on new diseases and the range of susceptible host species often lags behind aquaculture development. Moreover, there is often a slow collective awareness of new threats among relevant stakeholders and entities responsible for maintaining biosecurity. Basic knowledge on the pathogen (e.g. pathogenicity and transmission routes) and its host(s) (e.g. species, life stages infected, immunity and genetics) is often lacking, as are sensitive, specific, and rapid diagnostic tests for identification.
- Aquatic animal health management: A lack (or insufficient number and quality) of institutional and technical capacities limits the application of effective biosecurity measures. Some of the more important ones are: (i) weak regulatory frameworks, enforcement and implementation of international standards

and guidelines for biosecurity best practices; (ii) weak coordination between the multiple institutions involved in aquaculture production and aquatic animal health management (i.e. fisheries, aquaculture and veterinary authorities); (iii) a lack of adequate and well-implemented biosecurity strategies at the farm, sector and national levels; and (iv) absent or insufficient capacity for response to emergencies;

- Ecosystem changes: Aquatic ecosystems are dynamic, changing through both direct human activity (dams, community expansion, pollution, shipping, tourism, new species introductions, etc.) and non-human impacts (climate change, hurricanes, algal blooms, etc.). In these evolving situations, achieving successful aquaculture is complicated by the physiology of the animals (e.g. poikilothermic constraints to adaptation), emergence of pathogens, and changing geographical ranges of wild stocks, and microbes and parasites as environmental factors change near the tolerance levels for hosts and disease agents.

The environmental, social and economic impacts of disease outbreaks in aquaculture are many, and can be very substantial. They can include: direct costs of lost production due to mortalities and slow growth; temporary or permanent closure of aquaculture facilities, causing loss of employment in aquaculture and related upstream and downstream industries; and decreased trade and loss of markets due to bans on exportation, and loss of domestic sales due to public concerns over the safety of consuming fish and shellfish (with spillover into capture fisheries). A recent study (Shinn *et al.*, 2018) estimated the economic losses in Thailand due to acute hepatopancreatic necrosis disease in the period 2010–2016 at USD 7.38 billion, with a further USD 4.2 billion in lost exports. Also for Thailand, losses due to *Enterocytozoon hepatopenaei* could be up to USD 180 million per year. According to the China Fisheries Statistics Yearbook, disease outbreaks caused a direct production loss to Chinese aquaculture of 205 000 tonnes, worth USD 401 million (CNY 2.6 billion), in 2018. In the questionnaire for the Census of Aquaculture 2018 carried out by the Department of Agriculture in the United States of America, disease was listed ahead of all other causes of production losses.

Biosecurity has been challenging the aquaculture sector for the last three decades. Stakeholders from national competent authorities, producer and academic sectors, regional and international entities and development institutions as well as donors agree that actions need to be taken, and they have exerted great efforts in addressing biosecurity. However, very often, such actions have been reactive and costly because less-costly preventative approaches based on international biosecurity best practices have not been implemented. Is there something else that can be done?

Challenges and solutions

To assist its Members in supporting the goals of FAO's BGI, in particular that of promoting sustainable aquaculture development for food security and economic growth, the COFI Sub-Committee on Aquaculture endorsed the Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB) at its tenth session held in Trondheim, Norway, August 2019 (FAO Committee on Fisheries, 2019b). This new paradigm, introduced in *The State of World Fisheries and Aquaculture 2018* (FAO, 2018a), focuses on building management capacity through combined bottom-up and top-down approaches with strong stakeholder engagement, leading to co-management of biosecurity and promotion of long-term commitment to risk management.

Using the PMP/AB platform, a participating country or enterprise may progress through four stages, as appropriate to its specific situation:

1. Biosecurity risks identified and defined.
2. Biosecurity systems developed and implemented.
3. Biosecurity and preparedness enhanced.
4. Sustainable biosecurity and health management systems established to support the national aquaculture sector.

As countries and aquaculture enterprises advance along the biosecurity pathway, the following outcomes can be expected: reduced burden of diseases; improved aquatic health at the farm and national levels; minimized global spread

of diseases; optimized national socio-economic benefits from aquaculture; attraction of investment into aquaculture; and achievement of One Health goals. These outcomes will provide benefits at the enterprise, national, regional and global levels.

This process will include the development of PMP toolkits to support its implementation, for example: governance and national application guidelines; risk-based surveillance; decision trees for investigating aquatic animal (including plant) mortality events; emergency preparedness and response system audits; aquatic animal disease burden; public–private-sector partnerships; and biosecurity actions plans specific to farms and commodities (sectors).

Another milestone decision reached at the tenth session of the Sub-Committee on Aquaculture was the recommendation to COFI to consider the development, as part of FAO's global aquaculture sustainability programme, of a multidonor-assisted, long-term component on aquaculture biosecurity and its five pillars:

1. Strengthening disease prevention at the farm level through responsible fish farming (including reducing antimicrobial resistance in aquaculture and application of suitable alternatives to antimicrobials) and other science-based and technology-proven measures.
2. Improving aquaculture biosecurity governance through implementing the PMP/AB, enhancing interpretation and implementation of international standards and strengthening the One Health approach by bringing together state and non-state (producers and value chain stakeholders) actors, international and regional organizations, and research, academic, donor and financial institutions to design and implement mandated biosecurity measures.
3. Expanding understanding of aquaculture health economics (burden and investments).
4. Enhancing emergency preparedness (early warning and forecasting tools, early detection, and early response) at all levels.
5. Actively supporting Pillars 1–4 with several cross-cutting issues such as capacity and competence development, disease intelligence and risk communication, education and extension, targeted research and development and innovation (FAO Committee on Fisheries, 2019b).

The PMP/AB emphasizes the need to understand aquaculture health economics (burden and investments, costs and benefits). With respect to Pillar 3, FAO is collaborating with the University of Liverpool and partners to address diseases in aquaculture within the Global Burden of Animal Diseases programme. This programme, coupled with guidance for the estimation of losses due to aquatic diseases, is expected to support more consistent and accurate estimates of the cost of diseases at the national, regional and global levels. This information will demonstrate the potential economic benefits to be gained by implementing the PMP/AB.

The need for long-term biosecurity management strategies, including implementation of international standards on aquatic animal health of the World Organisation for Animal Health (OIE, 2020), has long been emphasized, including in the previous edition of this publication (FAO, 2018a). Among such strategies, the mandatory development of domesticated, specific pathogen-free (SPF) stocks for aquaculture species targeted for sustainable industrial production is becoming essential. It is now timely to optimize the use of SPF stocks. While the use of SPF shrimp stocks varies greatly between regions and farming practices, evidence is increasingly showing that they have reduced the introduction of pathogens and disease expression in farms, and provided a means for the safe introduction of *Penaeus vannamei* around the world – the species of choice and the dominant species in shrimp farming. Moreover, SPF shrimp has become an important asset in laboratory-based studies such as disease challenges and other nutritional and biochemical studies (Alday-Sanz *et al.*, 2018). The use of infected broodstock perpetuates disease problems all along the production cycle.

In conclusion, to meet the ever-growing demand for fish and seafood for human consumption, aquaculture systems must become more efficient by increasing production and profitability through prevention and long-term biosecurity

management strategies that can greatly reduce the economic and environmental losses caused by diseases. Creating healthy and resilient hosts through good biosecurity – in combination with good genetics and nutrition – is needed for a maturing aquaculture industry. It is now time to pursue multi-stakeholder commitment and multidonor support towards a coherent, cooperative and coordinated aquaculture biosecurity component of the global aquaculture sustainability programme. ■

TOWARDS A NEW VISION FOR CAPTURE FISHERIES IN THE TWENTY-FIRST CENTURY

The capture fisheries sector is at a crossroads. On the one hand, fish and fish products make a crucial and increasing contribution to economic growth, food, nutrition and livelihood security. For example, of the 34 countries where fish contributes more than one-third of the total animal protein supply, 18 are LIFDCs. Moreover, per capita fish consumption has doubled in the last 50 years (see p. 65); and dietary recommendations include a significant increase in fish consumption (Willett *et al.*, 2019). On the other hand, 34 percent of assessed fish stocks are fished at levels that exceed biological sustainability (see p. 47). Furthermore, the fish stock status in developed countries is improving, while many developing countries face a worsening situation in terms of overcapacity, production per unit of effort and stock status (see Box 4, p. 55). The capture fisheries sector is therefore in need of significant management action in some regions, particularly in the context of the expected impacts of climate change in coming decades.

Navigating this crossroads demands a vision that outlines how the sector can respond to the complex and rapidly changing challenges facing society. This vision needs to recognize the crucial role of fisheries in future economic development, food, nutrition and livelihood security, in the context of the multiple environmental impacts that humans have to address, on land and in water, in order to place humanity on a more sustainable footing. To develop this vision, FAO hosted the International Symposium on Fisheries Sustainability, on 18–21 November 2019 in Rome (FAO, 2020f). The event attracted almost 1 000 attendees from more than 100 countries, including academia, the private sector, governments, and intergovernmental, non-governmental and civil society organizations, to discuss a number of strategic questions addressed in eight topical sessions. The recommendations emerging from the debates are summarized below, by topic, for information and consideration by all stakeholders. These recommendations do not constitute a set of necessary steps agreed by all, and they are not geographically or temporally explicit or prioritized in any way. They represent a collective set of views on issues that need consideration in order to drive sustainability forward.

TOPIC 1. On the challenges to achieving ecological sustainability of global and regional fisheries:

- Promote assessment and monitoring of individual stocks and improve transparency at the stock and country level to better understand the status of fisheries at relevant geographical scales.
- Encourage the development and implementation of simpler stock assessment methods that require less-detailed data and less technical expertise to reduce the proportion of unassessed stocks around the globe.
- Improve the monitoring of inland fisheries and the collection of biological, fishery and habitat information in a cost-efficient and rigorous manner.
- Mobilize resources and provide financial support for continued capacity development programmes aimed at strengthening stock and fisheries assessment and monitoring systems, particularly in developing-world, small-scale and inland fisheries.
- Consider adoption of a new global target for sustainable management that would be more conservative or precautionary in data-limited situations and/or where governance is weaker.
- Data-poor does not always mean information-poor. Develop and implement better mechanisms to incorporate multiple

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The 2020 edition of *The State of World Fisheries and Aquaculture* has a particular focus on sustainability. This reflects a number of specific considerations. First, 2020 marks the twenty-fifth anniversary of the Code of Conduct for Responsible Fisheries (the Code). Second, several Sustainable Development Goal indicators mature in 2020. Third, FAO hosted the International Symposium on Fisheries Sustainability in late 2019, and fourth, 2020 sees the finalization of specific FAO guidelines on sustainable aquaculture growth, and on social sustainability along value chains.

While Part 1 retains the format of previous editions, the structure of the rest of the publication has been revised. Part 2 opens with a special section marking the twenty-fifth anniversary of the Code. It also focuses on issues coming to the fore, in particular, those related to Sustainable Development Goal 14 and its indicators for which FAO is the "custodian" agency. In addition, Part 2 covers various aspects of fisheries and aquaculture sustainability. The topics discussed range widely, from data and information systems to ocean pollution, product legality, user rights and climate change adaptation. Part 3 now forms the final part of the publication, covering projections and emerging issues such as new technologies and aquaculture biosecurity. It concludes by outlining steps towards a new vision for capture fisheries.

The State of World Fisheries and Aquaculture aims to provide objective, reliable and up-to-date information to a wide audience – policymakers, managers, scientists, stakeholders and indeed everyone interested in the fisheries and aquaculture sector.

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