

# Workshop report

## **PREAMBLE**

With the global human population expected to reach 9 billion by 2050, demand for food and feed will substantially increase. The manner in which food and feed production is increased to meet the demand of the world's growing population is a major challenge. Increasing production from the sea through expanded aquaculture may be a better alternative to further land development, which could involve clearing more rain forests, draining more aquifers or using more fertilizers and pesticides as agriculture spreads to marginal lands. Current overexploitation in wild fisheries means that fisheries cannot provide a solution. Expansion of land-based aquaculture and coastal aquaculture faces constraints because of an increasing lack of suitable land and water sites, a dependence on reliable supply of good quality water and, particularly in the coastal zone, the potential for conflicts with other users.

For these reasons, it is believed that the expansion of aquaculture into deeper and farther offshore marine waters is a high priority and should be facilitated through research, development and appropriate regulatory management.

Offshore mariculture offers significant potential for increasing world food production in an environmentally sustainable way. Its expansion is important to achieving the goal of world food security, providing alternatives to wild stock fisheries, and fostering economic development, particularly in coastal regions of the world.

There are potentially significant environmental, economic and food security benefits from the sustainable expansion of mariculture of finfish, shellfish and macroalgae in marine sites that are located farther offshore. However, the achievement of this potential will require, among other things, governments and developmental agencies to work together with the offshore aquaculture industry to develop policy and regulatory frameworks that enable mariculture to move farther off the coast in an environmentally sustainable way. The achievement of this goal also requires policies to facilitate appropriate technological developments.

## **OBJECTIVES AND APPROACH**

The main objective of this technical workshop was to assess the current situation and future prospects for offshore mariculture development around the globe through eight expert reviews. The main output of this workshop was the identification of activities and intervention areas (covering technical, environmental, spatial and governance issues) to be included as components of an FAO action programme in support of offshore mariculture development. The workshop was organized in five main sessions covering technical, environmental, spatial, economics/marketing and policy/governance issues related to offshore mariculture development and focusing on the following themes:

- discussion and agreement on a working definition for offshore mariculture;
- presentation and discussion of the reviews commissioned on offshore mariculture development;
- proposal, discussion and drafting of a series of actions by FAO, coastal States/governments and the industry to address the main issues identified in support of offshore mariculture development.

## **DEFINITION OF OFFSHORE MARICULTURE**

The term offshore mariculture is understood differently among nations and stakeholders, although it clearly refers to farming farther off the coast and in more exposed locations

be it in archipelagic waters or the high seas. Nevertheless, the great diversity of coastal waters makes it difficult to define “typical” conditions and it may be challenging to distinguish a farming site that is beyond “coastal”.

To facilitate discussions at the workshop, mariculture activity was operationally classified in three categories based on site location (coastal, off the coast and offshore) and then described according to general criteria according to the distance from the coast, water depth, degree of exposure, access to the site and the operational requirements for a farm. However, even these criteria give only a preliminary idea of feasibility, the actual sites, with the prevailing conditions, should always be considered individually.

According to the criteria agreed at the workshop, mariculture is considered “offshore” when it is located > 2 km or out of sight from the coast, in water depths > 50 m, with waves heights of 5 m or more, ocean swells, variable winds and strong ocean currents, in locations that are exposed (open sea, e.g.  $\geq 180^\circ$  open) and where there is a requirement for remote operations, automated feeding, and where remote monitoring of operating system may be required.

## **WORKSHOP RECOMMENDATIONS**

After initial presentations and discussions on a wide variety of topics related to offshore mariculture (see Annex 1), the workshop participants identified eight key issues (not listed in rank order) for the expansion of mariculture offshore. After identifying the issues, the workshop participants were divided into two working groups (WGs), with WG-1 focusing on technical, economic and marketing issues and WG-2 focusing on environmental, policy and governance issues. The two WGs then identified opportunities and challenges and the corresponding actions for FAO to support the development for offshore mariculture for each of the eight issues. The experts’ findings are summarized below.

### **WORKING GROUP 1: TECHNICAL, ECONOMIC AND MARKETING ISSUES**

#### **1. Need for enabling governance to facilitate development of aquaculture technologies**

*Opportunities and challenges* – The global increase in fish consumption tallies with trends in food consumption in general. Per capita food consumption has been rising in the last few decades. A self-sustaining mariculture, driven by feed resources mainly taken from outside the human food chain, may increasingly contribute to food supply. Mariculture can also contribute to a reduced pressure on wild stocks. Different coastal States have widely varying plans for developing aquaculture in their coastal waters, and enabling governance can facilitate technological development, leading in time to a realization of mariculture’s full potential.

However, there is a general lack of understanding on the potential for offshore aquaculture to contribute to fish output, food security and nutrition in the coming decades. Furthermore, there appears to be a misunderstanding regarding offshore mariculture as if it were equivalent only to farming in areas beyond national jurisdiction (ABNJ), while the potential in areas of national jurisdiction has yet to be fully exploited.

*Actions* – FAO has a very important role to play in the process of enabling governance that may facilitate development and dissemination of technology among its Members. FAO should give a clear recommendation to Members that, because of global food security, food safety concerns and human nutrition benefits, there will probably be a need to expand mariculture to more exposed waters to increase seafood production. FAO should, in this regard, take the initiative to conduct a cost–benefit analysis of

current coastal mariculture versus offshore alternatives considering both farming in the areas of national jurisdiction, where most farming will take place in the coming decades, and in ABNJ.

There is also a need to strengthen national policies and develop international principles for offshore mariculture development, and to include all main stakeholders in this process. Governments of Members should be urged to create and enable policies and regulations to support mariculture and provide other incentives for commercial development.

## **2. Economic and technological issues associated with a transition from coastal to offshore aquaculture**

*Opportunities and challenges* – The current development of mariculture of species such as salmon (*Salmo salar*), seabream and seabass and experimental/pilot farming of other species such as cobia (*Rachycentron canandum*) and amberjacks (*Seriola* spp.) provides excellent and promising technological advances for moving mariculture farther offshore. However, the economic viability of offshore mariculture is a major challenge and better technologies still need to be developed. There are also concerns about the availability of capital for investments in research and development (R&D) and for the development of commercial farms. Moreover, there is no clear candidate species of finfish available that has proved both economic and physiological feasibility for offshore production and, while species of shellfish and aquatic plants are better identified, the economic viability of their production is still questionable. A transition from coastal to off-the-coast and offshore mariculture will demand the development of new or suitably adapted technologies throughout the value chain, with obvious scientific challenges. This is what is needed if global seafood supply is to be increased in a way that minimizes impacts on benthic and pelagic ecosystems as demanded by society.

*Actions* – Good access to information on the economics of offshore mariculture can help would-be investors and coastal States in developing economically feasible technologies for offshore mariculture, and FAO can help to provide this. FAO can also help Members by funding demonstration and pre-commercial projects including a variety of species. Member government actions are also needed to create conditions for increased investment in mariculture and to allocate funds for R&D. Governments should also encourage international cooperation and technology transfer among stakeholders.

## **3. Inadequacy of information on coastal States' interest and opportunities in mariculture development**

*Opportunities and challenges* – The increasing pressure on the use of coastal zones from alternative activities such as tourism and urban development provides strong impetus for aquaculture to move off the coast. However, the interest and capacity of coastal States for developing mariculture in general, and offshore mariculture in particular, is not well known. There may indeed be more interest than generally believed, and access to accurate information on technology, markets and economic potentials may help to clarify the situation. This will require innovations in tools and methods to collect the relevant information from Members, and may contribute to global interaction in general.

*Actions* – FAO should collect information through surveys to gauge the interest among its Members for developing offshore mariculture. FAO should also assist its Members by identifying logistics and infrastructure that may facilitate developments, provide

advice for conducting spatial analyses to estimate potential for offshore mariculture, and also for zoning and selection of sites for development.

#### **4. Ensuring offshore aquaculture sustainability and expansion**

*Opportunities and challenges* – As noted earlier, the growing global human population will require more food, and sustainable and scalable food production in the sea is becoming increasingly important. Aquaculture production, both inland and in coastal zones, is increasingly threatened by pollution and user conflicts, thus opening up an opportunity for offshore mariculture. One of the challenges in doing this is to develop new sources of raw materials for feed that should be, as far as possible, from a lower trophic level than is currently often the case and, preferably, not from sources that serve the existing human food chain. This is necessary if mariculture is to increase its net contribution to the human food supply and not simply to substitute fish for animal products that are now produced on land. A related challenge and benefit in doing this is to ensure that more people can take advantage of the nutritional benefits of seafood production.

*Actions* – The major recommendation is for FAO to provide advice and guidance to stakeholders and a forum for discussion among them on issues related to global food security, the increasing importance of the sea in future food production and the challenges related to more mariculture activity. Furthermore, FAO should review the sustainability of different food production options, especially offshore mariculture, to set the agenda in terms of research challenges to improve performance of offshore mariculture, but also to guide Members as to relative merits of offshore mariculture in relation to alternative food production options such as forest clearance for agricultural production. This requires participation by both public and private sectors and the creation of conditions that facilitate investments and technology transfer.

### **WORKING GROUP 2: ENVIRONMENTAL, POLICY AND GOVERNANCE ISSUES**

#### **5. The negative image of mariculture (environment and products)**

*Opportunities and challenges* – Aquaculture, in particular mariculture, in some areas of the world has triggered environmental and social concerns, which have influenced the way the public perceives aquaculture. The image of aquaculture is frequently negative across countries and regions, and very often based on the negative impacts of very few commodity species. Moving aquaculture offshore would probably diminish many environmental and food safety risks, if properly conducted. To counteract the negative image of aquaculture, there must be more proactive rather than reactive communication with society. The aquaculture industry and its stakeholders must be more visible and be seen to be socially and environmentally responsible. Removal of negative perceptions takes time, and a paramount premise is transparency and the avoidance of environmental and food safety scandals. The ultimate challenge is to tackle this negative image by clarifying responsibilities with public and political stakeholders, and to make mariculture a prioritized activity in most coastal nations.

*Actions* – The aquaculture industry and relevant international organizations such as FAO must strive to improve the reputation of the industry among the general public, regulators and policy-makers. The sea will be needed to feed humanity in centuries to come, and it is paramount that this message of global food security and environmental sustainability is clearly communicated to governments by all stakeholders involved. Important aspects in this regard are environmental interactions, use of resources and

marine space and food safety. It is also important to communicate that mariculture can help to reduce pressure on commercial fishing and that, by increasing the production of macroalgae as raw material for feed, it may well become a self-sustaining industry.

To improve the image of aquaculture, it is recommended that FAO, through the Committee on Fisheries (COFI) and its Sub-Committee on Aquaculture (SCA), place mariculture on its agenda. Elements of a possible strategy should include the dissemination of widely proven and recognized facts to all involved stakeholders, interaction and discussion with interest groups, be they non-governmental organizations (NGOs), associations or other stakeholder groups, and establishment of frameworks for certification of processes and products. These involve, for example, questions related to feed resources, emission of wastes, species introductions and problems of mariculture escapes.

Governments should promote the sustainable development of mariculture, giving unbiased transparent information to the public and supporting well-managed mariculture actions and actors. It is also vital to establish and fund R&D programmes and to stimulate and support the implementation of education programmes at all levels.

## **6. Improved understanding of negative and positive interactions between offshore mariculture and the environment**

*Opportunities and challenges* – All food-producing activities and natural resource industries have environmental impacts, and some level of impact must be accepted for mariculture. Furthermore, the fact that aquaculture can have much less impact than other terrestrial sources of protein is a relevant opportunity for the expansion of this sector. It is also important to recognize that mariculture is affected by environmental degradation of coastal and open ocean waters, for example by toxic pollution, which can harm aquatic animals and lead to concerns about food safety. There is generally a poor understanding in society that it is the aquaculture industry itself that becomes the primary victim of environmental degradation. Expansion of mariculture to open waters may reduce this vulnerability because of the greater capacity of such waters to dilute pollutants. For example, the pollution from other sources (including the spreading of disease) becomes less and the impact of aquaculture is more effectively mitigated by natural processes in the benthic and pelagic offshore ecosystems.

There is a general lack of environmental data for potential offshore mariculture locations and of resources for research to provide them, and yet they are essential if offshore mariculture is to be able to validate its promise. This is especially the case in many developing countries, and, therefore, the development and implementation of education and training programmes that can increase the human capacity to undertake environmental assessments is important in all of them.

*Actions* – FAO must play an active role to inform Members and society in general that mariculture depends on a clean and unpolluted environment, which means, in turn, that a sustainable mariculture industry itself must be environmentally responsible. This calls for action to build awareness of the “two-way” environmental interactions in mariculture.

It is important to develop methods and indicators for estimating carrying capacity of open marine ecosystems, to identify limiting factors and to contribute to establishing guidelines for best environmental practices. Due to the general gap in data from offshore locations, it is important to gather together what data there are and to draw on relevant experience from coastal mariculture. Governments must adopt and implement an ecosystem approach to aquaculture governance and allocate funds to establish the knowledge and build the competence needed to implement it. FAO should strive to

promote global sharing of knowledge and experiences gained about the responsible development and management of offshore mariculture among Members.

## **7. Limited guidance for development of offshore mariculture**

*Opportunities and challenges* – Although there are some useful experiences in culturing finfish, shellfish and macroalgae in exposed off-the-coast and offshore waters in some countries, there is still very little offshore mariculture undertaken anywhere in the world. Therefore, systematic expansion of offshore mariculture around the world still presents many challenges. These include engineering of systems to be able to withstand and be operable in exposed waters, and the identification of suitable areas and species, especially finfish species, that can thrive in offshore conditions and meet consumers' demands for quality and value. These challenges will be particularly large in developing countries.

*Actions* – Gathering experience and sharing of knowledge is paramount to finding solutions for these challenges, and FAO can play an active part in these processes. Activities may include regional workshops, initiatives in capacity building and provision of guidelines for best practices in offshore mariculture. FAO must also inform and motivate Members to take part in the development of offshore mariculture. A major source of motivation is the importance that mariculture can have for future global food security. Governments need to develop national strategies and work together with FAO on this important issue, and to provide the resources needed to do it. In turn, it is important for the mariculture industry to participate from the very beginning, and to be encouraged to farm shellfish and marine plants by incentives that recognize the environmental benefits of doing so.

## **8. Enabling policy and regulatory frameworks for offshore mariculture**

*Opportunities and challenges* – Mariculture has relatively limited space for development in most of the world's coastal waters; therefore, there is a growing interest in moving mariculture farther offshore where there is vast potential, fewer competing uses, and space availability is not an issue. Expansion of the mariculture industry can help to meet the growing demands for seafood that cannot be met by fisheries alone. However, at present, there is a general absence of effective governance and regulatory structures to allow for offshore mariculture development, although many countries have suitable locations for offshore mariculture in their national waters. Policy and law-making are sovereign acts, and it may be a challenge in many countries to convince policy-makers of the importance of developing mariculture offshore and to support it, especially in those countries that lack the human and financial capacities for monitoring, control and enforcement.

*Actions* – FAO should encourage governments to prioritize mariculture as an important food production sector and to create the policies and laws needed to make it happen. Coastal States must take responsibility for leasing space for and monitoring and enforcement of mariculture activities as well as providing incentives for education, research and technology transfer. In addition, there should be incentives to industry for investment in offshore mariculture, including financing, insurance and creation of secure property rights. The industry should be involved in the creation of policy and laws to encourage private development. FAO should also facilitate the establishment of governance instruments needed to enable offshore mariculture development, and ensure that governance becomes ecosystem-based while complying with laws of the sea.

## STEPS FOR BROADER ACTIONS

It is clear that production of more food from the sea is needed to feed humanity in the future, so it is of paramount importance to inform governments and all stakeholders about the potential value of off-the-coast and offshore mariculture to address this need. In the same vein, it is also important that they recognize that the expansion of mariculture worldwide will be challenging and, if it is to supplement food from agriculture in a significant way, production must increasingly come from the lowest trophic levels, i.e. filter feeders, aquatic plants and plankton, or through their utilization as feed components for fed aquaculture species. Furthermore, feed sources for fed mariculture must be sustainable and preferably come from the lowest marine trophic level. Specific actions recommended by the workshop participants are as follows:

### FAO actions

1. The FAO Committee on Fisheries (COFI) and the COFI Sub-Committee on Aquaculture (SCA) must place mariculture on their agendas.
2. There is a need to expand mariculture offshore to increase seafood production, and FAO must inform and encourage Members to take part in its development. A major motivating factor is the vital role that mariculture will have in addressing global food security in the future. This situation is little understood and recognized in society today, especially in developed countries.
3. FAO should provide a forum through which the potential importance of the sea in future food production can be communicated to the public and specific groups of stakeholders.
4. FAO must guide and support Members and industry in the development needed to expand mariculture to offshore locations, including the provision of the following services:
  - spatial analyses studies to estimate the potential for sustainable offshore mariculture development, including zoning and site selection;
  - development of funding mechanisms for pre-commercial projects and demonstrations farms;
  - cost-benefit analysis of current coastal mariculture versus the open ocean alternatives;
  - gathering of relevant experience and sharing of knowledge to support the engineering and environmental innovations needed;
  - production of technical publications and other information to support commercial development;
  - provision of technical guidelines for best practices of offshore mariculture;
  - organization of regional offshore mariculture workshops, initiatives for capacity building, and creation of databases to share data and information.
5. Expanding mariculture to offshore locations has major technical and biological challenges. FAO must encourage Members to undertake and guide the research and development that is needed. Available knowledge and expertise from current exposed mariculture activities can be of immense value, especially for those countries that are starting offshore mariculture.
6. FAO must advise governments to consider, whenever technically possible, establishing environmental incentives for integrated multitrophic aquaculture (IMTA) to combine the cultivation of fed aquaculture species (e.g. finfish) with organic extractive aquaculture species (e.g. shellfish / herbivorous fish) and inorganic extractive aquaculture species (e.g. seaweed) to create balanced systems for environmental sustainability (biomitigation), economic stability (product diversification and risk reduction) and social acceptability (better management practices).

7. The real and perceived environmental impacts of mariculture are a major concern to society. FAO must communicate that mariculture depends on a healthy and unpolluted environment and should lead a process to improve the negative image of mariculture in society. Appropriate means for communicating this message are:
  - dissemination of facts to FAO Members, society, and to active groups of involved stakeholders;
  - interaction and discussion with active interest groups;
  - communication of challenges related to the provision of sustainable feed resources, waste emissions, species introductions and problems of escapes;
  - communication of the benefits of mariculture, including the comparative trophic efficiency of aquatic animals and the environmental services that extractive aquaculture can provide.
8. FAO should involve all main stakeholders in developing methods and indicators for estimation of the carrying capacity of different bodies of water and establish guidelines for best environmental practices in open ocean ecosystems that include protocols for food safety and biosecurity.
9. Governance of mariculture must become ecosystem-based while complying with national and international laws of the sea. FAO should initiate a process to establish international principles and governance instruments needed for undertaking offshore aquaculture in international waters when and if this may take place, although it is recognized that many countries have suitable locations for offshore mariculture in their national waters.

#### **Actions of coastal States/governments**

1. Before any progress can be made, governments must be convinced to prioritize mariculture as an important food sector and develop national strategies together with FAO if the organization can be of help. Prioritizing mariculture has to be justified by assessments showing favourable potential. This is needed before moving into more comprehensive policy- and law-making to create and enable policies and regulation regimes to support mariculture.
2. The environment for investment in mariculture, including financing, insurance and creation of property rights in marine waters, must be met by appropriate incentives. Government must create conditions for increased investment in mariculture, and stimulate international cooperation and technology transfer among the stakeholders, i.e.:
  - provide incentives to enable and stimulate domestic and foreign investments in offshore mariculture;
  - direct support to well-managed offshore mariculture activities, including the culturing of shellfish and plants offshore;
  - contribute together with FAO to give unbiased transparent information to society;
  - facilitate technology transfer among producers and supporting industries.
3. Expanding mariculture to offshore locations will require major national and international research, development and innovation efforts, and governments must plan and implement research programmes covering the main challenges in engineering, natural science and social science, i.e.:
  - promote the entire mariculture industry as a cluster for active research;
  - private commercial actors should be encouraged to contribute to the funding;
  - stimulate and support the implementation of education programmes at all levels;
  - support technology transfer.

### **Actions of the industry**

1. The industry must drive the process of expanding mariculture from the very beginning, and should be involved in all aspects of policy-and law-making as far as possible to facilitate the development of sustainable offshore mariculture.
2. The industry must build awareness of both the beneficial and adverse environmental interactions of mariculture while more actively disseminating their activities to society.