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OPEN OCEAN AQUACULTURE – NEXT FRONTIER FOR SUSTAINABLE MARINE FISH FARMING

- Ramji B, Aanand S and Sudarshan S

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editorsabujeema@gmail.com
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OPEN OCEAN AQUACULTURE – NEXT FRONTIER FOR SUSTAINABLE MARINE FISH FARMING

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Ramji, B
Fisheries College and Research Institute, Thoothukudi

Aanand S
Erode Bhavanisagar Centre for Sustainable Aquaculture, Bhavanisagar, Erode

Sudarshan S
Dr. MGR Fisheries College and Research Institute, Thalainayeru, Nagapattinam

INTRODUCTION

Aquaculture is the fastest-growing food production sector globally and is increasingly seen as an important solution for feeding the growing global population in the coming decades sustainably. Presently, much aquaculture is in land-based ponds in raceways or cages and net pens; however, sustained growth is limited. Limitations in development are primarily due to lack of land bank for traditional land-based systems, limited availability of fresh water, and high disease incidences. The coastal aquaculture is also constrained by lack of space, competition with other sectors, such as wild capture fisheries, and anthropogenic and natural impacts on coastal ecosystems. On the contrary, open-ocean aquaculture, where fish production unit is located away from the coastal zone and in the open ocean, has been identified as one of several technologies that can help increase aquaculture production while avoiding these constraints. However, the potential for open-ocean aquaculture to contribute to seafood production is poorly understood, especially in terms of changes in the state of key physical-ocean parameters, driven by climate change.

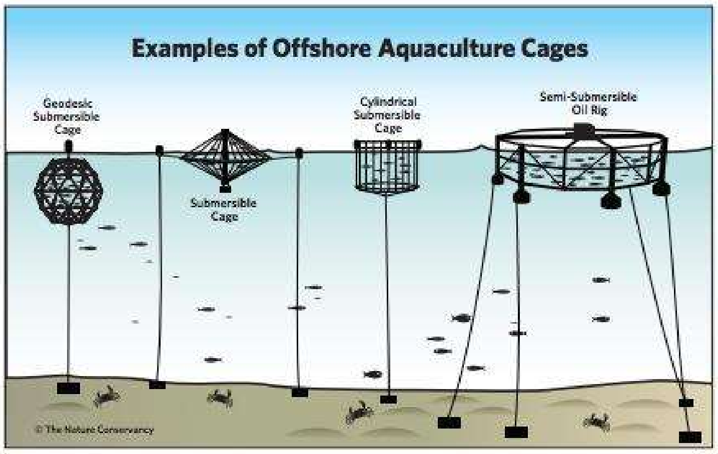

Fig 1. Examples of offshore aquaculture cages (Source: The Nature Conservancy)

Inshore aquaculture concerns that discarded nutrients and faeces from cages can blanket the seafloor, damaging the benthic ecosystem. However, it is anticipated that the wastes from offshore aquaculture would be swept away from the site and diluted due to underwater currents. Moving aquaculture offshore also is advantageous concerning more space available for aquaculture production; it can be extended more depending on the increasing demand for fish.

Fig 2. Open ocean aquaculture practice in EU. (Source: https://horizon-magazine.eu/)

AQUACULTURE IN THE OPEN OCEAN

Open ocean aquaculture or offshore Aquaculture is emerging in mariculture or marine farming, where fish farms are moved offshore. Open Ocean farming is conducted in areas not sheltered by land and exposure to extreme sea conditions., which includes sites located 10 km or more from shore, in depths over 50 m, tidal currents > 0.50 m / sec, and seas > 9 m.

The ocean farms are systems of underwater vertical gardens, able to grow 10 to 30 tons of sea vegetables and 250,000 shellfish on each acre per year. Using these crops, food, fertiliser, animal feed, and biofuels can be produced. Until recently, marine aquaculture has primarily been located close to shore and sheltered coastal waters (areas with high environmental sensitivity also already crowded with other ocean uses). Consequently, nearshore mariculture can have a high potential for conflicts (e.g., with wild-capture fisheries) and higher risks of environmental impacts (e.g., on the marine benthos and coastal habitats such as mangrove forests). Thus, offshore aquaculture is defined here as farming beyond the nearshore and inshore coastal zone, which typically refers to waters greater than about 20 m in depth—as the most promising option for expanded sustainable seafood production. It avoids conflicts that occur with other marine resource users in the more crowded coastal waters, although there are possibilities of user conflicts offshore. Aquaculture critics are more concerned about the possibilities of using antibiotics, other drugs and diseases spread to the wild by the escape of cultured species.

TECHNOLOGY

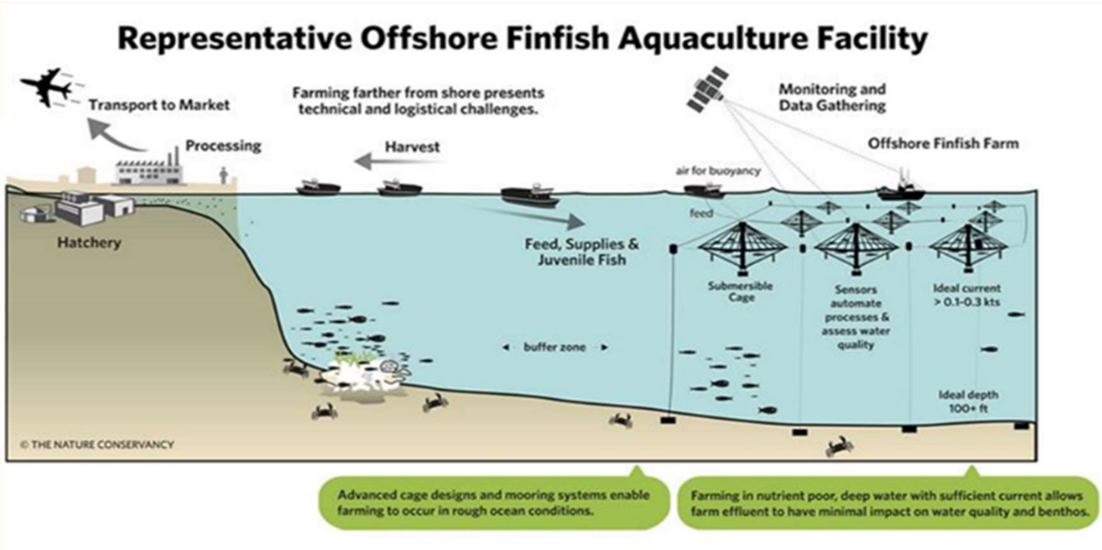

Fig 3. Offshore Finfish Aquaculture Systems (https://www.nature.org)

Offshore farms must be built to be more robust than those inshore to withstand the high-energy offshore environment. There is a rapid development of offshore technology, with the main objective of the reduced initial investment. Presently tuna are housed in open-net cages at the sea surface for ranching systems. However, offshore technology generally employs submersible cages. These submerged are rigid with the capacity to hold many thousands of fish and anchored on the seafloor. However, provision for moving up and down in the water column is provided with the help of buoys. The feeding mechanishm is usually housed in the bouy, along with storage for equipment. This technology is already being implemented in waters near the Bahamas, China, the Philippines, Portugal, Puerto Rico, and Spain. By submerging cages or shellfish culture systems, the effects of waves are minimised, and hindrance to boating and shipping can be avoided. Offshore farms would be more efficient and safer with the development of automatic feeders and health monitors.

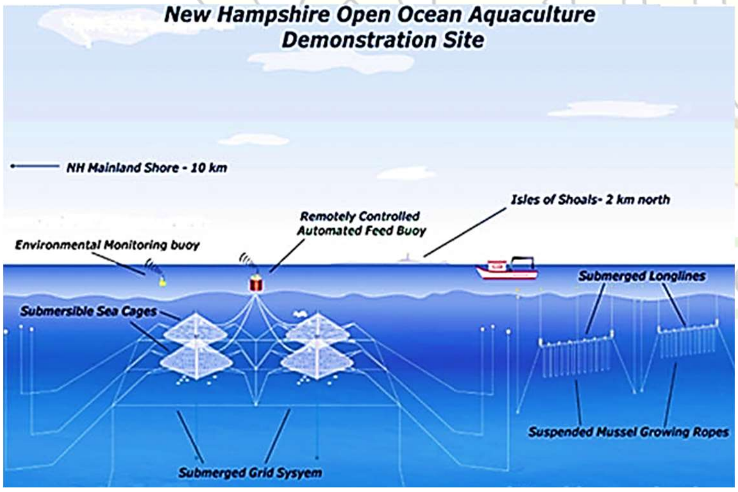

Fig. 4. Design and plan for the University of New Hampshire Open Ocean Aquaculture site located 12 km offshore New Hampshire, USA

(Source: http://ooa.unh.edu)

Integrated multi-trophic aquaculture - Integrated multi-trophic aquaculture (IMTA), or polyculture, occurs when finfish are cultured alongside suspension feeders and deposit feeders. Pioneered in Spain and Canada, this method could sustainably solve several problems with offshore aquaculture.

Roaming cages - Roaming cages have been planned as the "next-generation technology" for offshore aquaculture. Mobile cages have thrusters and move in tow with ocean currents. One idea is that juvenile tuna, starting in mobile cages in Mexico, could reach Japan after a few months, mature and ready for the market. However, the implementation of mobile cages requires regulatory and legal implications.

Space conflicts - As oceans industrialise, conflicts are increasing among the users of marine space. Competition for marine space develops in a context where natural resources can be publicly owned. There can be a conflict with the tourism industry, game fishing, wild harvest fisheries, and the fixing of marine renewable energy installations. The problems can be aggravated by many marine areas' remoteness and difficulties with monitoring and enforcement. Alternatively, remote sites can be chosen to avoid conflicts with other users and allow large-scale operations with economic benefits.

ECOLOGICAL IMPACTS OF OFFSHORE AQUACULTURE

The ecological impacts arising from offshore aquaculture operations are yet to be understood as it is still largely in the research stage.

1. POLLUTION:

One major concern in coastal farming is the fate of discarded nutrients and faeces, which could disturb the benthos. An anticipated dilution of nutrients in deeper water is one strong possibility to move coastal aquaculture into the open ocean. The extent of nutrient discharge and possible deposition on the seafloor depends on the FCR of the cultured species, flushing rate, and overall aquaculture operation size. However, the possibility of dissolved and particulate nutrients released into the environment does always exist. In the future large scale, offshore culture units will expand to an even larger unit; therefore, it is poised to generating waste. The limitations or prescribed specifications for setting up open ocean aquaculture must be ascertained before promoting such ventures.

2. WILD-CAUGHT FEED

It is common practice in coastal aquaculture that predatory fish are fed wild-caught trash fish. Offshore aquaculture is predominantly focused on high-value predatory fish, and any dependence on wild-caught fish could make it ecologically unsustainable.

3. FISH ESCAPES

Fish escapes into the wild in any offshore culture units is unavoidable as the offshore industry expands. The consequences exist for native species, even though native fish species are farmed. Such escape risks are minimal in submersible cages as they are fully closed, and any escape can occur only in case of structural damage. Offshore cages must be strong enough to withstand the high energy of the environment and attacks by predators such as sharks. Spectra – a super-strong polyethene fibre has been developed as the outer netting that does not leave any slack for predators to grip. However, the fertilised eggs of some species can pass through the cage mesh into the ocean.

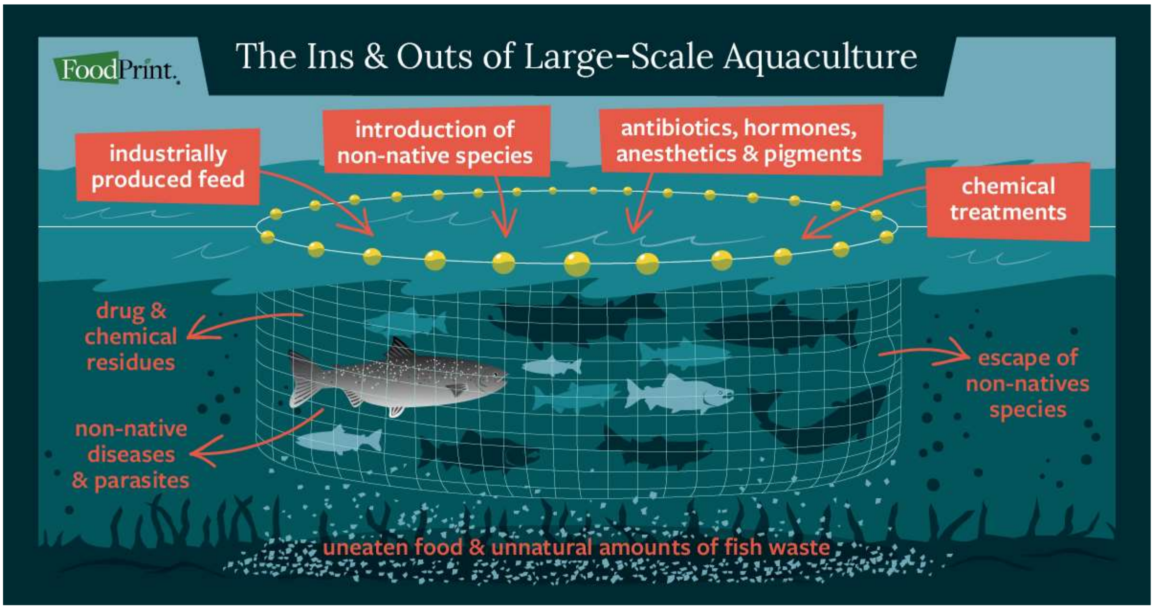

Fig. 5. Main environmental risks of marine aquaculture (Source: https://foodprint.org/)

4. DISEASE PROBLEM

Offshore farming has less risk of diseases when compared to coastal aquaculture. Incidence of parasitic infections of mussels cultured inshore would be more than when cultured offshore. The spreading of pathogens between fish stocks is another major issue in disease control. Static offshore cages can minimise direct spreading due to greater distances between aquaculture production areas. However, the roaming cage technology could transfer disease and spread it to different regions. The dependence on baitfish, wild trash fish as feed for the culture of predatory species can result in the spread of disease across species barriers.

5. EMPLOYMENT

Aquaculture is promoted by many nations as a means of livelihood and income, particularly wherever capture fisheries is stagnated. Such promotion for offshore aquaculture is not possible owing to high equipment and supply costs. Offshore aquaculture can indirectly increase employment vide processing industry that may develop due to the increased production.

PRO's

1. Increased space for expansion
2. High water quality
3. Fewer user conflicts
4. Less visual concern
5. Greater dispersion of nutrients

CON's

1. High wind and wave energies
2. Difficult to feed and monitor
3. Increased capital investment
4. Increased risks
5. Need new farming technologies
6. Video telemetry
7. Icing

PROSPECTS

Presently Norway and the United States are currently making the main investments in the design of offshore cages. The world's first 'offshore' aquaculture development project received the green light from the Norwegian government - Kongsberg Maritime.

CURRENT SPECIES CULTURED IN OFFSHORE AQUACULTURE

Twenty-five countries have offshore aquaculture, both as experimental and commercial farms, by 2005. Market demand has pushed most offshore farming efforts towards raising finfish. Two commercial operations in the US and one in the Bahamas are submersible cages to raise high-value carnivorous finfish, such as Pacific Threadfin, cobia, and mutton snapper, which are also experimental systems for halibut, haddock, cod, summer flounder in New Hampshire waters; amberjack, red drum, snapper, pompano, and cobia in the Gulf of Mexico.

The offshore aquaculture of shellfish grown in suspended culture systems, like scallops and mussels, is gaining ground. Suspended culture systems include methods where the shellfish are grown on a tethered rope or suspended from a floating raft in net containers. Mussels, in particular, can survive the high physical stress levels which occur in the volatile environments that occur in offshore waters. Finfish species must be fed regularly, but shellfish do not, which can reduce costs. Research in the farming of blue mussels in submerged cages is under progress at the University of New Hampshire in the US. Farming of blue mussels in less polluted offshore waters produces mussels with more flesh with lighter shells.

CONCLUSION

Open Ocean Aquaculture is the "Next Frontier" of marine aquaculture. It is one food production sector that is growing within aquaculture. Every coastal nation can utilise this significant potential to farm its oceans. It can be an economically efficient way to grow fish in an environmentally sustainable way. Aquaculture could feed the world and protect the planet if done right.