ISBN: 978-81-19149-98-8

4. Aquaculture's Vital Role in Sustainable Food Production

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Abstract:

The world's fastest-growing food production industry is aquaculture. In practically every part of the planet, it is growing, spreading, and becoming more intense. The global population growth is driving an increase in aquatic food demand, with capture fisheries production leveling off and most of the main fishing areas reaching their maximum potential.

The diverse ecosystem is primarily dominated by shellfish and herbivorous and omnivorous pond fish, which utilize natural productivity or partially. Aquaculture, primarily developed in fertile coastal areas, has led to significant land use changes, destruction of wetlands, and pollution of waters and soils. This chapter presents an overview of aquaculture, and depicts its key environmental impacts.

Keywords:

Aquaculture, Fisheries, Ecosystem, Shellfish, Environmental

4.1 Introduction:

Aquaculture is the process of producing fish, shellfish, algae, and other organisms in a variety of aquatic habitats by breeding, growing, and harvesting.

Particular types of aquaculture include fish farming, prawn farming, oyster farming, mariculture, pisciculture, alga culture (including seaweed farming), and fish raising for ornamental purposes.

Aquaculture systems consisting more than 600 different animal species of finfish (e.g., catfish, trout, carp, tilapia, salmon), crustaceans (shrimp, prawn, crabs, freshwater crayfish), and molluscs (Troell et al., 2014).

Aquaculture production has significantly increased globally over the past four decades, contributing significantly to the global supply of fish for human consumption. Aquaculture now accounts for nearly half (45%) of the world's food fish (Subasinghe et al., 2008).

With an annual growth rate of more than 7%, aquaculture is one of India's fastest-growing fisheries sectors. India, a global aquaculture leader, hosts over 10% of the world's fish biodiversity and has increased production for freshwater fish and prawns. Although new methods of seaweed, and marine fish production, like seabass, have been developed but have not yet been commercialized.

The utilization of diverse marine resources along India's extensive coastline is crucial to bridge the production gap between China and other Asian countries for aquaculture production.

The aquaculture sector's rapid expansion raises sustainability concerns, including climate change, eutrophication, antibiotic use, biodiversity loss, non-indigenous species introduction, parasite spread, genetic pollution, and socio-economic dependence.

The global expansion of aquaculture has been contributed by number of factors such as population growth, food changes, and technological advancements in aquaculture.

The natural supply of ocean resources is being depleted, which has led to an increased role for aquaculture in meeting the rising demand for fish and shellfish.

A. Advantages:

- Aquaculture is the important source of excellent quality protein and healthy oils
- Aquaculture is the important source of employment
- Due to production of fish at lower cost, it can be supplied at an affordable price even to poorer peoples
- Future of fish is dependent on the aquaculture
- Aquaculture decrease impacts on wild stock

B. Disadvantages:

- Large inputs of land, feed and water need
- Destroys coastal ecosystem like mangrooves
- Fish can be contamininated or killed from pesticide runoff
- Areas become too contaminated to use after approximately 10 years

4.2 Different Types of Aquacultures:

Freshwater farming - Aquaculture practices are classified based on many elements and conditions. The following classifications are useful for understanding the various aspects involved in aquaculture. Cultivation of aquatic life in completely salinized water; often, this type of farming is done inland. The primary fish raised in fresh water include Catla, Rohu, Mrigal, Silver carp, Grass carp, Common carp, and Freshwater Prawn (FAO, 2002)

Brackish water Farming- Aquatic species are raised in brackish water, a type of coastal aquaculture where the salinity of the water is a mixture of freshwater and seawater.

Coastal marshlands and river mouths that flow into the ocean are home to this kind of environment (FAO, 2002). Marine water farming- Mariculture, also known as marine farming or marine aquaculture, is the process of cultivating marine organisms for food and other animal products.

It is a specialized part of aquaculture, which also includes freshwater aquaculture. Fish farms located on littoral waters are known as inshore mariculture, while artificial tanks, ponds, or raceways filled with seawater known as offshore mariculture (FAO, 2002)

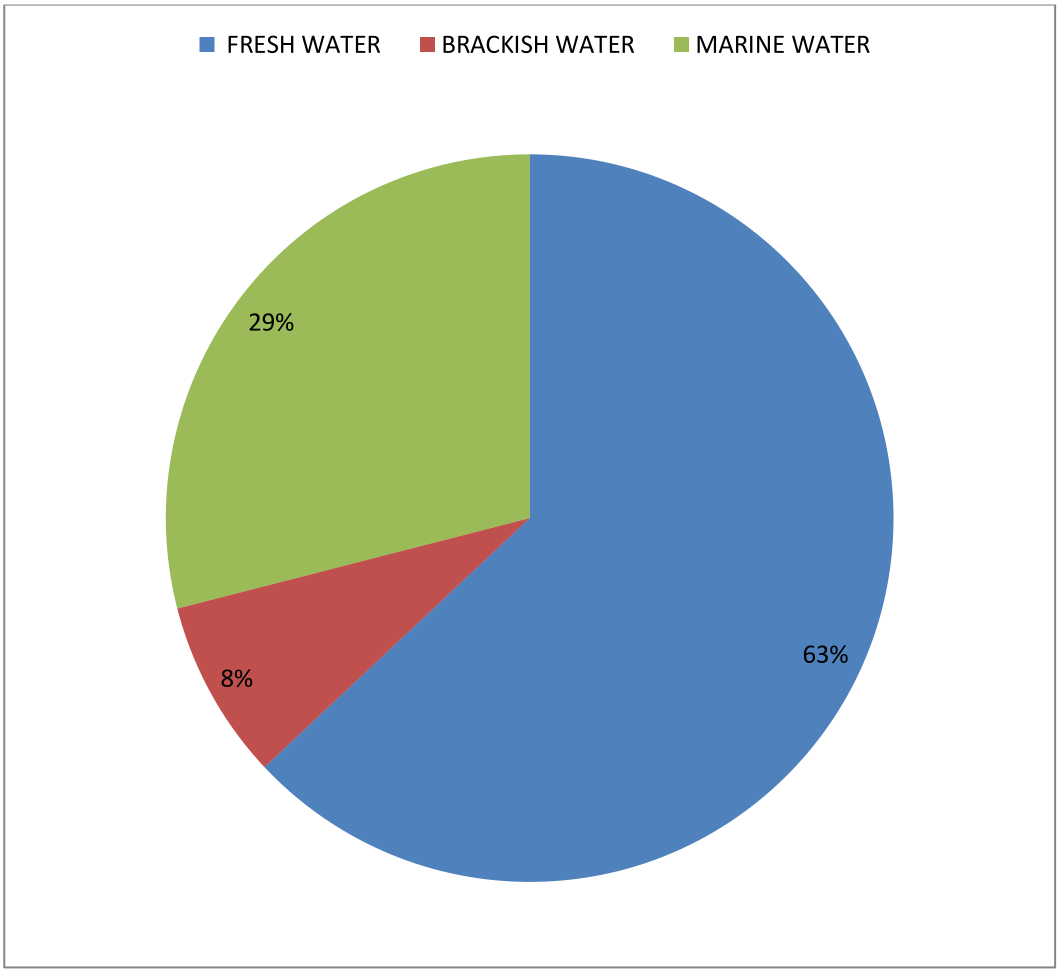

Figure 4.1: Various aquaculture habitats and their contributions to the total aquaculture production worldwide.

4.3 On the Basis of Number of Species Stocked for Farming:

A. Monoculture:

When only one fish species gets farmed in a single pond or tank, it gets referred to as a monoculture farming method. Common Monoculture types of fishes are trout, catfish, and carps.

B. Polyculture:

The technique of cultivating multiple types of aquatic organisms in one pond is known as Polyculture.

The guiding idea is that breeding a variety of species with various feeding preferences will maximize fish production in ponds.

Grass carp, common carp, mrigal, rohu, catla are the common Polyculture types of fishes.

4.4 On the Basis of Enclosure used for Culture:

A. Pond Culture:

Pond culture, includes cultivating aquatic creatures in ponds, including fish, prawns, prawns, and shellfish. With a history spanning thousands of years, it is among the most established and extensively used types of aquacultures. Ponds with freshwater, brackish, or saltwater can all be used for pond aquaculture.

Advantages:

- It is easy to construct
- It is cheap and easy to operate
- Low production cost for algal biomass

B. Cage Culture:

Fish raised in cages, from juvenile to commercial size, are surrounded by water on all sides, including the bottom, and yet are allowed to circulate freely. Cage culture is simple to adapt to non-drainable water environments.

Advantages:

- Occupy the small area of river, canal, and reservoir.
- Reduced startup cost as compare to land- bases farms.
- Yield and profit are high.

C. Pen Culture:

Fish raised in tank of water that is enclosed on all sides except the bottom and allowing water to flow freely from one side.

Water to flow freely at least from one side is known as pen culture. Fish can be raised in pen/enclosures made of net or wooden materials, primarily in shallow areas along the banks and coastlines of lakes and reservoirs.

Advantages

- Greater production is assured in a limited space with rich food and oxygen supply
- It is a continuous process due to continous supply of water.
- Ease of harvest.

D. Raceway Culture:

Raceway also called flow through system; man-made channels used to cultivate aquatic which are manmade channel used to cultivate aquatic life.

A raceway typically consists of rectangular concrete basins or canals with an entrance and an exit. (Ottinger et al., 2015)

Advantages:

- Can grow lot of fish in a small space
- Can have multiple sizes of fish
- Labour efficient

E. Main Species:

Aquaculture is one of the most complicated and diversified food production sectors, requiring a wide range of different systems and technology input due to wide variety of culture conditions, farming intensities, and spectrum of cultivated species.

Freshwater fish comprise 56% of the overall production output through aquaculture and are the most produced aquatic animal category globally.

With 23 percent and 10 percent of the total, mollusks and crustaceans are the second and third largest group, respectively.

Marine fish (3 percent) and diadromous fish (7 percent) are next in line. The top ten aquaculture species are distinctly dominated by production in Asia, and China in particular. (Troell et al.,2014)

F. Trade:

Aquaculture has become a highly globalized industry due to the rise in global demand for fish and the expansion of international trade in food items.

Aquaculture products, valued at $150.5 billion in 2013, are among the most traded sectors in the global food economy, with developing nations exporting more than their coffee, rubber, cocoa, tea, tobacco, pork, and rice exports. (Smith et al., 2010)

G. Value Chain:

Aquaculture interacts with various economic sectors in an increasingly globalized and complicated value chain that spans from production through distribution and consumption, just as other high-intensive terrestrial animal production systems (Deutsch et al., 2007).

Aquaculture's evolution as a highly international food industry has given rise to intricate networks of suppliers for services and inputs, whose operations span the entire value chain from farmers to consumers. Through the creation of income and jobs, the aquaculture sector has also had a significant positive socioeconomic impact on a number of other industries, including hatcheries, the feed industry, trade, transportation, and energy (Belton and Little, 2011; Meaden and Aguilar-Manjarrez, 2013). Depending on the commodity and market value, it has also positive effect on related pre- and post-harvest processing procedures like slicing, sorting, quality control, and ice packaging, gutting.(Ahmed and Troell, 2010)

4.5 Environmental Impacts of Aquaculture:

A. Footprint of Aquaculture in the Landscape:

Since the middle of the 1970s, the production of aquaculture has greatly increased and intensified in coastal areas, leading to the extensive conversion of coastal wetlands, primarily mangroves, coastal lakes, and lagoons (Bostock et al., 2010; Troell et al., 2013).

Rapid growth of highly export-oriented commodities like prawns and pangasius catfish has been driven by rising demand for aquatic products from international markets, but it also puts pressure on ecosystems as more land-based (ponds, tanks) and water-based (fish cages or mussel farms) systems must be built (Belton et al., 2011; Genschick, 2011).

B. Surface and Ground Water Pollution, Water Withdrawal:

Aquaculture has a significant impact on the quantity and quality of water resources, requiring a lot of water (Troell et al., 2013). The growth of the aquaculture business has led to water contamination, which had detrimental ecological effects on the surrounding environment.

One of aquaculture's biggest environmental concerns is wastewater dumped into nearby coastal waterways without treatment, which is mostly the result of poorly run fish and shrimp farms. This results in the subsequent discharge of suspended solids, high concentrations of nutrients (phosphorus and nitrogen), and estuaries, lagoons, and coastal waters nearby (Cao et al., 2007).

C. Land Use Change and Ecosystem Degradation:

Due to the conversion of farming practices into more successful aquaculture systems and their extension towards coastal and marine areas, there have been substantial changes in land use during the past few decades (Peng et al., 2013; Spalding et al., 2014). Wetland habitats have been severely lost and fragmented along the South China Sea coast as a result of aquaculture's quick expansion due to land reclamation and conversion. (Peng et al., 2013)

D. Food Chain Pollution:

Aquaculture heavily uses fertilizers, disinfectants, and pesticides to control organisms such as water weeds, insects etc. This can lead to toxicities, irreversible damage, and harm to humans and wild biota. (Primavera, 2006)

4.6 Conclusion:

It is anticipated that aquaculture would become primary source of food for aquatic animals in the next years due to its rapid expansion, surpassing even catch fisheries.

In many nations, aquaculture has already become a valuable alternative for animal protein, and it has enormous potential to increase food security worldwide.

Global climate change, however, poses a serious threat to coastal aquaculture's viability. The consequences of climate change, such as storms, flooding, and droughts, rising sea levels, and salt intrusion, could have a serious influence on aquaculture in the future.

Possible increasing strain on freshwater availability and water quality due to eutrophication might result in decreased aquaculture productivity, which would have a detrimental impact on food security and export revenue.

Aquaculture, despite its economic benefits, poses environmental challenges such as habitat loss, degradation, and water and soil pollution, threatening sustainable natural resource use.

Spatial assessment of aquaculture is crucial for determining potential effects and developing environmental protection measures, using earth observation for standardized inventory at local, national, regional, or global levels.

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