



Fish Farming in Cities: Bringing Aquaculture Closer to Consumers

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Cities are expanding rapidly, while the demand for fresh, nutritious food continues to increase. Fish is an important source of high-quality protein, essential fatty acids, vitamins and minerals, but conventional fish farming generally requires ponds, reservoirs, coastal areas or other large spaces. This creates an interesting question: can fish actually be farmed inside or close to cities? The answer is increasingly yes. Urban fish farming refers to the production of fish within cities or in the immediate surroundings using systems designed for limited land and water availability. Instead of relying on large ponds, urban farmers can use tanks, recirculating aquaculture systems (RAS), biofloc technology and aquaponics. These systems allow fish to be produced in relatively small areas and, in some cases, inside buildings, rooftops, backyards or other unused urban spaces. RAS is particularly suited to urban environments because water can be treated and reused rather than continuously discharged and replaced. Researchers have specifically identified urban aquaculture as an application of RAS technology (Schreibman & Zarnoch, 2009). The idea is not simply about putting fish tanks in a city. Urban aquaculture represents a different way of thinking about food production: produce food closer to consumers, use resources more efficiently, recover nutrients and make use of spaces that cannot support conventional agriculture.

Why bring fish farming into cities?

Traditional aquaculture is often associated with rural and coastal landscapes. Fish ponds require considerable land, and water exchange can become a challenge in densely populated regions. At the same time, transporting fish from rural production areas to large cities adds distance between the place of production and the consumer. Urbanization therefore creates both a challenge and an opportunity. A city may have limited agricultural land but considerable demand for fresh fish. It may also contain unused rooftops, warehouses, commercial buildings, institutional premises and small plots that cannot accommodate conventional ponds. Intensive aquaculture systems can potentially convert some of these spaces into food-production units. This is where RAS becomes particularly interesting. In an RAS, water from the fish tank passes through mechanical and biological filtration before returning to the culture tank. Fish continuously add metabolic wastes to the water, including ammonia. Beneficial microorganisms in the biofilter convert toxic ammonia into less toxic nitrogen compounds, while other treatment components remove suspended solids and help maintain suitable water quality. The same water can therefore circulate repeatedly. Modern RAS technology can provide high production efficiency while reducing water requirements and allowing close control of temperature, dissolved oxygen and nitrogenous wastes. These characteristics make RAS particularly relevant where land and water are limited. India is also developing indigenous RAS technologies. ICAR-CMFRI, for example, developed and standardized an RAS for nursery rearing of marine fish seed, with the system designed to operate with minimum water use. ICAR institutions have also developed RAS facilities for broodstock development and other production stages (Ranjan et al., 2019).

Not every urban fish farm needs a huge building

When people hear “urban fish farming,” they may imagine a large commercial indoor facility filled with hundreds of tanks. That is only one possibility. Urban aquaculture can occur at different scales. A small entrepreneur might operate a few tanks in a backyard or unused space. A restaurant could potentially integrate a small fish-production unit with its food business. A commercial enterprise could operate a sophisticated indoor RAS facility. Institutions and educational centres can use small systems for training and demonstration. Biofloc technology offers another possibility. Instead of removing all nitrogenous waste from the culture water, biofloc systems encourage microorganisms to capture nitrogen and convert it into microbial biomass. The resulting microbial aggregates can contribute to water-quality management and may also provide supplemental nutrition to cultured animals. This makes biofloc attractive for intensive production where water availability is limited. However, the system is not maintenance-free. Continuous aeration, careful feeding, control of solids and close monitoring of water quality are essential. Thus, urban aquaculture should not be viewed simply as “fish farming in a tank.” It is a controlled biological system in which fish, microorganisms, water and technology have to work together.

From fish tanks to fish-and-vegetable systems

One of the most interesting developments in urban aquaculture is aquaponics. Aquaponics combines aquaculture with plant production. Fish are raised in tanks, while plants grow in a connected hydroponic system. Fish feed provides nutrients to the system, and microbial processes transform nitrogenous wastes into forms that plants can utilize. The plants, in turn, remove nutrients from the water before it is returned to the fish culture system. This creates a biological connection between two forms of food production. Recent research has demonstrated the potential of integrating fish production with vegetable cultivation. A 2025 study integrating vegetables with biofloc-based tilapia culture reported that the presence of vegetables helped reduce nitrogenous compounds and increased nitrogen and phosphorus retention within the system (Martins et al., 2025). Another recent study examining aquaponics in an urban food-system context found that rooftop and ground-based aquaponics can provide substantial water-use efficiency, although the systems may require more energy than conventional greenhouse production (Yuan et al., 2025).

What happens to fish waste?

In conventional systems, fish waste can become an environmental problem if it is discharged without adequate treatment. In controlled systems, however, that same waste can become a resource. Fish excreta and uneaten feed contain nitrogen, phosphorus and other nutrients. RAS technology captures and transforms these materials through filtration and biological treatment. Aquaponics can take the concept one step further by directing nutrient-rich water toward plant production. This concept changes the question from “How do we dispose of fish waste?” to “How can we recover the nutrients contained in fish waste?” That shift is central to the idea of circular aquaculture. Future urban systems could potentially combine fish, vegetables, algae, microorganisms and other biological components so that the waste stream from one component becomes an input for another.

Could rooftops become fish farms?

Urban rooftops offer valuable but underused space for food production. While conventional fish ponds are unsuitable because of their weight, small, well-designed tanks can support aquaculture or aquaponics when building strength, drainage, electricity and safety are properly assessed. However, rooftop aquaculture requires reliable power for pumps and aeration. Backup power, alarms and regular monitoring are therefore essential to prevent fish losses during equipment or power failures.

The importance of technology

Technology is what makes intensive urban fish production possible. A modern urban aquaculture unit can use sensors to monitor temperature, dissolved oxygen, pH and other

water-quality parameters. Automated feeders can control feeding frequency and quantity. Pumps circulate water between tanks and filters, while aeration equipment maintains oxygen availability. More advanced systems can incorporate automated alerts, remote monitoring and data logging. The benefit is not simply convenience. Continuous monitoring can help farmers identify changes before they become serious problems. For example, a sudden decline in dissolved oxygen can indicate equipment failure, excessive stocking, excessive feeding or other system disturbances. The greater the stocking density, the greater the dependence on technology and management. This is why urban aquaculture requires technical knowledge. A tank filled with fish is not automatically a fish farm. Successful production depends on understanding fish biology, water chemistry, microbial processes, feeding, biosecurity and equipment operation.

Can urban aquaculture produce enough fish?

Urban aquaculture is not intended to replace conventional pond, cage or coastal farming but to complement these systems by producing fish closer to consumers and utilizing limited urban spaces. Technologies such as RAS enable intensive fish production with efficient land and water use. Studies have also demonstrated the potential of RAS for maintaining marine fish broodstock and supporting year-round maturation and spawning. However, successful urban farming depends on selecting suitable species and production systems. Factors such as temperature, water availability, tank size, market demand, electricity, investment and technical expertise must be considered when designing urban aquaculture systems for different locations.

Benefits of Urban Aquaculture

Urban aquaculture can bring fresh fish closer to consumers, potentially reducing transport distances and supporting shorter food-supply chains. However, its environmental benefits depend on electricity use, feed, infrastructure, water consumption and overall production efficiency. In India, limited urban land, increasing fish demand and water constraints create opportunities for compact systems such as RAS, biofloc and aquaponics. ICAR has demonstrated RAS technologies for intensive fish production and homestead-scale applications. Such systems could provide opportunities for entrepreneurs, self-help groups and small businesses. With appropriate infrastructure, technical knowledge and market demand, decentralized urban fish farms could contribute to India's future food-production systems.

Challenges behind the idea

- **High initial cost:** RAS requires tanks, pumps, filters, aeration, biofilters, monitoring devices and backup systems.
- **Electricity dependence:** Continuous pumping and aeration require reliable power, as failures can quickly affect fish health.
- **Technical expertise:** Regular water-quality monitoring and proper management of feeding, stocking density and microbial processes are essential.
- **Biosecurity risks:** High stocking densities can facilitate rapid disease transmission if pathogens enter the system.
- **Profitability:** Feed, electricity, labour, seed, maintenance and equipment costs can significantly affect economic returns.
- **Proper management:** Successful urban aquaculture requires careful planning, technical knowledge and efficient resource management.

A glimpse of the future

Imagine a city where an unused warehouse contains a compact fish farm. Tanks occupy several levels, water circulates through filtration units, sensors continuously monitor water quality and automated feeders deliver precise quantities of feed. Nutrient-rich water is directed to a vegetable-growing section. Solid waste is collected separately and converted into useful products. Solar energy supplies part of the electricity requirement.

Such a system would not eliminate conventional aquaculture. Instead, it would become another component of the wider food-production network. The most promising urban systems may therefore be those that connect multiple activities rather than simply raising fish in isolation. This is the concept of a circular urban food system.

Conclusion

Fish farming is traditionally associated with ponds, rivers, reservoirs and coastal areas, but the future of aquaculture does not necessarily have to remain outside cities. Recirculating aquaculture, biofloc technology and aquaponics are making it possible to produce aquatic food with much smaller land requirements and controlled water use. The real opportunity lies not simply in placing fish tanks inside cities, but in designing systems where water, nutrients, energy and biological resources are used efficiently. Urban aquaculture will not replace India's ponds, reservoirs, cages and coastal farms. Instead, it can complement them by bringing a portion of fish production closer to consumers and by creating new opportunities for small-scale entrepreneurs and technology-driven businesses. The fish farm of the future may not always be beside a rural pond or along the coast. Some of it may be on the edge of a city, inside a warehouse, on a carefully engineered rooftop, or even within a compact urban food-production facility. The city itself could become part of the aquaculture landscape.

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