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Modern Trout Culture Systems

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Aquaculture being one of the fastest growing food production sectors with an annual growth rate of around 7% in the past two decades, can be considered as a cash generating activity and plays an important role in addressing the issues of food insecurity particularly for a country like India, the economy of which is agriculture based. Rainbow trout Oncorhyn chus my kiss has established itself as prime cultivable coldwater species in the Indian Himalayan regions and now farmed on commercial scale. Its production has increased markedly in last ten years (2004 - 2016) from 147.0 to 842.0 tonnes, with a growth rate of 31 percent per annum. Availability of technical know-how of trout farming, breeding and artificial diets has immensely helped in promoting aquaculture of trout in the country. Rainbow trout has an annual global production of around 8,14,000 tons contributing around 2% of the world total aquaculture production and it is the seventeenth widely cultivated commercially important finfish in the world (FAO, 2018). So far, rainbow trout is widely being cultured in open cement raceways; however, the recent popularity of RAS system, with high density water and land intensive system has made its culture more profitable with huge potential of expansion.

Jammu and Kashmir is a hilly region with the country's largest fresh cold water resources. The majority of J&K's cold water resources pass through snow-covered mountains. Because of good environmental circumstances, the Kashmir region is a key contributor to trout production, since the fish has adapted both in the wild and in captivity. The current trout fish production in J&K is anticipated to be around 697tonnesand the trout seed production is 147. 80 lacs (J&K Fisheries department, 2022).

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Rainbow trout, scientifically known as Oncorhynchus mykiss, is a species of freshwater fish native to North America. It is a popular game fish and is also extensively raised in fish farms for commercial purposes. Rainbow trout have a streamlined body with a silvery coloration on their sides and a metallic rainbow-like stripe running along their lateral line, which gives them their name. Their back can range from olive-green to bluish-black, and they have scattered black spots on their body, dorsal fin, and tail. Rainbow trout are found in various freshwater habitats, including rivers, lakes, and streams. They prefer cold and clear waters with high oxygen levels. They are native to the Pacific Coast of North America, from Alaska to Mexico, and have been introduced to many other regions worldwide.

Rainbow trout are opportunistic feeders and have a diverse diet. They primarily feed on aquatic insects, crustaceans, small fish, and fish eggs. In some cases, they may also consume terrestrial insects that fall into the water.Rainbow trout usually spawn in the spring or fall, depending on the population and environmental conditions. They typically select gravel-bottomed streams or lake shores to lay their eggs. After hatching, the fry feed on small invertebrates until they grow larger and begin to consume other fish or larger prey.Rainbow trout are highly sought after by recreational anglers due to their strong fight and good taste. They are known for their acrobatic jumps and fast swimming. In addition to wild populations, rainbow trout are extensively raised in fish farms for food production, making them one of the most commercially important freshwater fish species.

Culture practices:

Trout culture in raceways has traditionally been used for fish production, with a flow-through system maintained to maintain the needed degree of water quality. Raceways make it easier to regulate environmental and water quantity characteristics than pond

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systems. Flowing water washes wastes from the culture units and also causes the fish to exercise, which aids in the fish's survival. The shallow water in raceways enables for visual monitoring of the fish, allowing for quick correction of food and/or illness issues. with general, feeding and harvesting are easier with raceway systems. Raceway systems make feeding and disease control easier than open systems or ponds.A trout raceway should be 17 m x 2 m x 2 m in size, with an entrance and an outlet for overflow of water secured with wire mesh screws to prevent stocked species from escaping.A drain line should be installed at the bottom of the raceway to permit harvesting and tank cleaning on a regular basis.With a total volume of 50 cum./raceway, the water depth may be kept at 1.5m. Water should be provided to trout raceways via a filter bed/sedimentation tank.

The physico-chemical parameters

- Optimum temperature: 5^{o}C to 18^{o} C
- DO: 5.8 to 9.5 mg/l
- pH: 7-8
- Turbidity: <25 cm in the Secchi disc.

Feeding:

Feeding at 4-6% of body weight is important for fingerling growth, although the water temperature must be taken into account while following the feeding plan. When the water temperature is between 10 and 12 degrees Celsius, a feeding schedule of 6% is optimal; however, when the temperature rises to 15 degrees Celsius, the feeding schedule should be reduced to 4%. The ideal monthly growth rate is 30-40 g.

Recirculatory Aquaculture System

Recirculating aquaculture systems (RAS) are advanced fish farming systems that use water recirculation to maintain high water quality and reduce environmental impacts. In RAS, water is continuously recycled within the system, minimizing the need for large volumes of water and preventing the release of waste into the surrounding environment. This makes RAS a more sustainable and efficient method of aquaculture compared to traditional open-net systems.

They are closed or semi-closed systems; a battery of ponds or raceways, interconnected with each other in such a way that the same water is used over and over again with minimum wastage of water as outflow, with not more than 10% of water exchange. The water is reconditioned by clarification, biological filtration, and re-aeration so that most of the water is reused and only a fraction of the total daily flow is made up of new water. The productive capacity of this system depends on the filtration system's ability to remove wastes, as well as on the volume of replacement water used to improve water quality. Water quality should be monitored frequently in such a system because without high rates of water exchange, toxic metabolites may accumulate rapidly if the biological filtration system is not sufficient to handle the wastes.

Circulatory Aquaculture System (RAS) is a technology where zero water exchange takes place. In this system, the water is recycled and reused after mechanical and bio filtration and removal of suspended metabolites. This method is used for culturing various species of fish at high density using minimum land area and water.

It is an intensive aquaculture production system where fishes are stocked at high density. Unlike other aquaculture production systems (ponds and raceways), this system employs the use of rearing fish in indoor tanks under controlled environmental conditions. Recirculating systems filter and clean the water by recycling it back to the culture unit. Filtration is done mainly by mechanical and biological filters. RAS are environmentally sustainable, they use 90-99% less water than conventional aquaculture systems, less than 1% of the land, area and provide for environmentally safe waste management treatment. New water is added to culture units only to make up for that has been splashed out or lost through evaporation or used to remove waste materials. The reconditioned water circulates through the system and not more than 10% water is replaced daily

The management of RAS system mainly depends on the type of feed used, quantity of feed used and type of filtration system employed in the unit as the filtration units play an important role in removing the organic wastes and ammonia.

RAS offer a high degree of environmental control. It allows to mitigate the risks of natural disaster, pollution, and disease and also allows optimized species growth on a year-round basis. Recirculatory systems should maintain uniform flow rates, fixed water levels and uninterrupted operations to provide a suitable environment for intensive production.

Here's how a typical recirculating aquaculture system works:

1. **Water Filtration:** The system starts with the removal of solid waste and particulate matter from the water. Mechanical filters such as screens, settling tanks, and drum

filters are used to remove larger particles, while biofilters are employed to break down ammonia and other harmful substances.

2. **Biological Filtration:** In RAS, beneficial bacteria are used to convert toxic ammonia, produced by fish waste, into less harmful nitrate through a process called nitrification. This is typically achieved using biofilters, which provide a surface for the bacteria to colonize and perform their functions.
3. **Oxygenation:** Fish require oxygen to survive, so adequate oxygen levels must be maintained within the system. Oxygen is often supplied through diffusers or aerators, which help to ensure that fish have enough oxygen for respiration.
4. **Water Treatment:** Additional water treatment steps may be included in the system to maintain water quality. These may include processes such as ozonation, ultraviolet (UV) sterilization, or chemical treatments to control pathogens, parasites, and other waterborne diseases.
5. **Monitoring and Control:** RAS often incorporates sophisticated monitoring and control systems to maintain optimal water conditions. Parameters such as temperature, dissolved oxygen levels, pH, ammonia, nitrate, and water flow rates are continuously monitored, and adjustments can be made as needed.
6. **Fish Culture:** Fish are raised in tanks or enclosed systems within the RAS. The tanks provide a controlled environment where water temperature, lighting, and feeding can be optimized for the specific fish species being cultivated. The tanks are designed to provide suitable space for fish growth and minimize stress.

The benefits of recirculating aquaculture systems include:

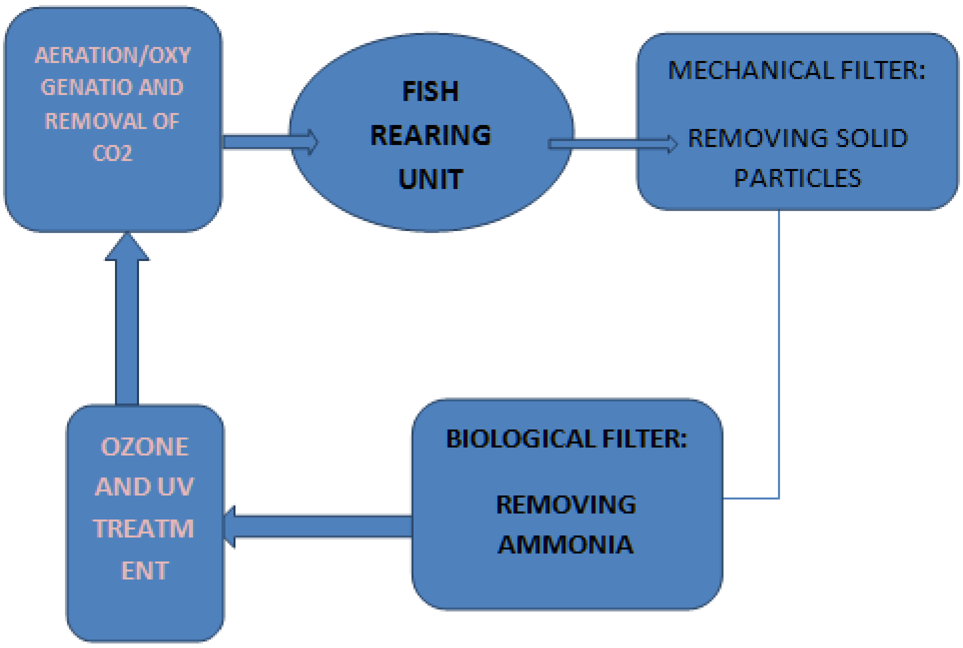
1. **Water Conservation:** RAS uses significantly less water compared to traditional aquaculture systems because water is continuously recirculated within the system.
2. **Waste Reduction:** The advanced filtration and water treatment processes in RAS reduce the release of waste into the environment, minimizing the impact on natural ecosystems.
3. **Disease Control:** RAS offers better disease control due to the closed and controlled environment, which helps to prevent the introduction and spread of pathogens and parasites.

4. **Location Flexibility:** RAS can be established in various locations, including urban areas, where land availability for traditional aquaculture may be limited.
5. **Increased Production:** RAS allows for higher stocking densities, leading to increased production in a smaller footprint.

However, recirculating aquaculture systems also have some challenges. They require higher initial investment costs compared to traditional aquaculture systems, and the energy required to run the system can be substantial. Additionally, maintaining water quality parameters can be technically demanding and require skilled operators.

Despite these challenges, RAS has gained popularity in recent years due to its potential to produce fish sustainably and efficiently. It offers a promising solution to meet the increasing global demand for seafood while minimizing the environmental impact of aquaculture.

Working of RAS



Components of RAS

1. Insulated indoor facility
2. Water pump shed
3. Grow out tanks with inlet, outlet and central drainage system
4. Sedimentation tanks for sludge
5. Sump tanks

6. Overhead supply tanks
7. Mechanical filters
8. Motors, Generators and pumps
9. Biofilters and UV units
10. Aeration system
11. Degasser system
12. Uninterrupted water supply

Advantages of RAS

1. Sustainable use of water and land areas.
2. Enhanced feed management.
3. Enhanced fish production compared to traditional systems.
4. Advantage of production of high quality fish.
5. Market flexibility.
6. Reduction in operational costs associated with control of predators and parasites.

Disadvantages

1. Uninterrupted power supply is required
2. Capital cost of RAS is higher than that of pond and raceway systems.

Candidate species for RAS

1. Rainbow trout (in cold hilly areas)
2. Asia sea bass
3. Silver pompano
4. Pearl spot
5. Cobia
6. Tilapia
7. Pangasius

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