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Sustainable Freshwater Aquaculture and Resource Management in Sarampalli Pond, Kamareddy, Telangana, India: A Community-Based Approach for Ecological Conservation and Livelihood Improvement

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Abstract

Freshwater aquaculture plays an important role in enhancing food security, improving rural livelihoods, and promoting sustainable utilization of aquatic resources. The present study evaluates the sustainable aquaculture practices and resource management strategies adopted in Sarampalli Pond, Kamareddy District, Telangana, India. The study focuses on fish production systems, water quality management, environmental protection measures, institutional support, and socio-economic benefits to local fishing communities. Sarampalli Pond, situated at Latitude 18.30115°N and Longitude 78.33724°E has a water storage area of about 251.25 ha and is supporting community based fisheries activities with 252 members. The major fish species stocked in the pond are Rohu (*Labeo rohita*), Mrigala (*Cirrhinus mrigala*), Catla (*Catla catla*) and Tilapia (Oreochromis spp. A total of 3,77,840 fingerlings ranging between 80-100 mm were released, including 1,88,920 Rohu, 37,784 Mrigala and 1,51,136 Catla fingerlings. Regular monitoring of physicochemical parameters of water quality like temperature, pH, dissolved oxygen, turbidity and alkalinity creates suitable condition for fish growth. The pond ecosystem has a natural green water color due to plankton productivity, i.e., good primary productivity. Environmental management practices include the prevention of pollution, reduction of pesticide runoff, controlled fertilizer application, removal of plastic waste, prevention of overfishing and active community participation. The estimated gross revenue from fish production was ₹6,49,38,309 and after allowance for about 30% mortality the expected revenue was calculated to be ₹4,54,56,816. The technical development, training, subsidy and market support has been contributed with the support from Fishermen Cooperative Societies Limited, Kamareddy, District Fisheries Office and the Pradhan Mantri Matsya Sampada Yojana (PMMSY). The study shows that integrated resource management and community-based approaches can enhance the sustainability of freshwater aquaculture while contributing to rural livelihoods.

Keywords: Freshwater aquaculture, sustainable fisheries, pond management, fish production, water quality, community participation, Sarampalli Pond, resource management

1. Introduction

Freshwater ecosystems provide key ecological services including biodiversity conservation, food production, nutrient cycling and livelihoods. Freshwater pond aquaculture is one of the many aquatic food production systems that have become very important in contributing to the global fish production, especially in developing countries where inland fisheries provide the livelihood for millions of rural households.

India is blessed with plentiful freshwater resources such as ponds, tanks, reservoirs and wetlands that have a great contribution to the development of inland fisheries. However, increasing population growth, intensification of agriculture, pollution and climate variability has brought about challenges for the maintenance of sustainable aquatic production systems. (Naylor *et al*., 2021; FAO, 2024) [11, 6].

Sustainable aquaculture is the combination of biological productivity, environmental protection, economic efficiency and social participation. Appropriate water quality, compatible fish species, controlled nutrient inputs, prevention of pollution, and stronger community-based management are all essential to long-term fisheries sustainability.

Composite fish culture with Indian major carps like Catla

(*Catla catla*), Rohu (*Labeo rohita*) and Mrigala (*Cirrhinus mrigala*) are widely practiced because of their complementary feeding behavior and efficient utilization of the pond resources. These species are in different feeding zones and reduce competition, resulting in better production efficiency. (Jhingran, 1991; Boyd and Tucker, 2012) [8, 4].
Sarampalli Pond in Kamareddy District, Telangana, is an example of a community managed fresh water aquaculture system where sustainable fisheries development is being achieved through scientific stocking practices, water quality management and institutional support.

2. Materials and Methods

2.1 Study Location

The study was conducted at Sarampalli Pond, Kamareddy District, Telangana, India. The geographical coordinates of the pond are:

- **Latitude:** 18.30115°N
- **Longitude:** 78.33724°E

The pond has a total water storage area of approximately: 251.25 hectares

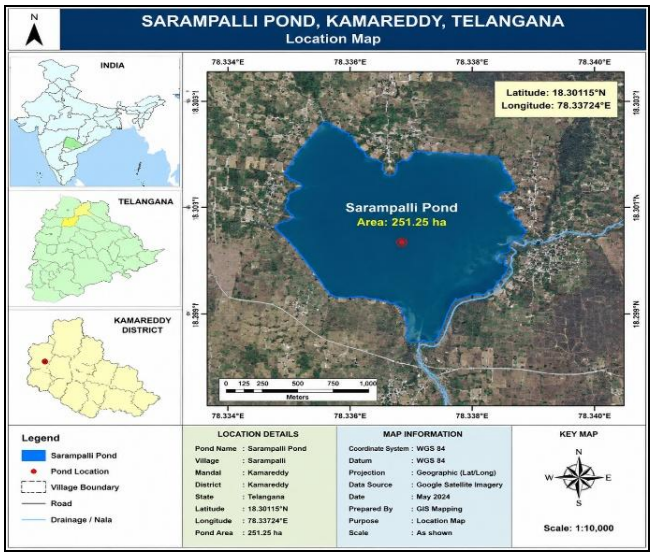

Fig 1: Showing the site

Fig 2: Showing the details of the pond

2.2 Fish Stocking Management

Four commercially important freshwater fish species were stocked.

Table 1: Fish stocking composition

Species	Scientific name	Ecological zone	Number stocked
Rohu	*Labeo rohita*	Column feeder	1,88,920
Mrigala	*Cirrhinus mrigala*	Bottom feeder	37,784
Catla	*Catla catla*	Surface feeder	1,51,136
Tilapia	*Oreochromis* spp.	Omnivorous feeder	Included in culture system
Total			3,77,840

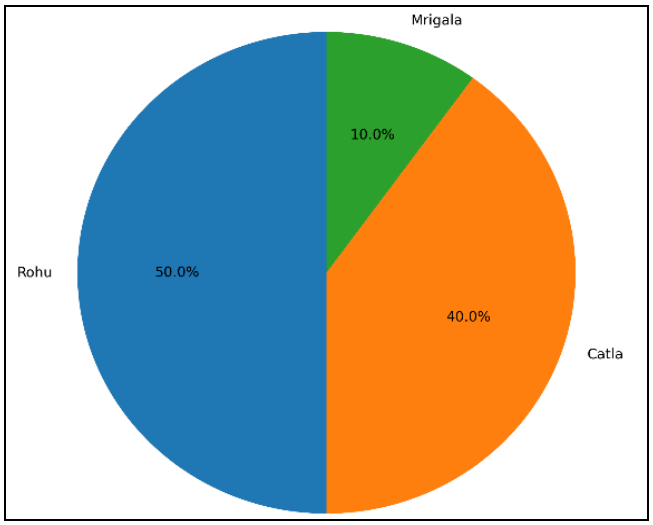

Fig 3: Fish stocking composition in Sarampalli Pond

Fig 4: Collection of water samples

The fingerlings introduced were approximately 80–100 mm in size, providing better survival potential and adaptation after stocking.

3. Water Quality Management

Water quality monitoring is essential for maintaining fish health and productivity. Regular testing was conducted for important physicochemical parameters.
The green colour of Sarampalli Pond water indicates the presence of phytoplankton, which contributes to natural food availability.

Table 2: Optimum water quality requirements for freshwater aquaculture

Parameter	Optimum range
Temperature	25±0.5 °C
pH	6.5–8.5
Dissolved Oxygen	5–8 mg/L
Turbidity	25–50 NTU
Total alkalinity	75–150 mg/L $CaCO_3$
Total hardness	50–150 mg/L $CaCO_3$
Ammonia	<0.05 mg/L
Nitrite	<0.10 mg/L
Transparency	25–40 cm

Fig 5: Growth performance observation

All measured parameters remained within suitable ranges for freshwater fish culture. (Boyd, 1998; Hargreaves & Tucker, 2004) [3, 7].

4. Fish Production and Economic Assessment

The estimated gross revenue from fish production: ₹6,49,38,309
Considering 30% mortality: Survival = 100 - 30 = 70%
Final Revenue = 6,49,38,309 x times 0.70
Final estimated revenue: ₹4,54,56,816

This indicates that sustainable pond management provides significant economic benefits to local fishermen communities.

5. Sustainable Resource Management Practices

5.1 Pond Environmental Protection

The following practices are implemented:

5.1.1 Pollution Prevention

- Regular removal of plastic and waste materials.
- Prevention of domestic waste disposal.
- Maintaining clean pond surroundings.

5.1.2 Nutrient Management

- Controlled fertilizer application.
- Avoidance of excessive nutrient loading.
- Prevention of algal imbalance.

5.1.3 Agricultural Runoff Management

- Reduction of pesticide contamination.
- Awareness among nearby farmers.
- Protection of water quality.

5.1.4 Sustainable Harvesting

- Prevention of overfishing.
- Monitoring fishing activities.
- Avoiding immature fish harvesting.

6. Community-Based Fisheries Management

Sarampalli Pond supports:

Total community members involved: 252 persons.
Community participation enhances:

- Resources protection. Sustainable harvesting.
- Maintenance activities.
- Sharing knowledge.

The cooperative strategy guaranties that fishermen benefit on an equal footing. (Béné *et al*., 2016; Kittinger *et al*., 2013).

7. Support System of Institution

7.1 Kamareddy Fishermen Co-Operative Societies Ltd Awards

- Assistance with fisheries management.
- Co-ordination among fishermen.
- Assist with harvesting

7.2 District Fisheries Office, Kamareddy

Provides:

- Technical guidance.
- Scientific aquaculture recommendations.
- Training programs.
- Awareness activities.

7.3 PMMSY Support

Provides:

- Subsidies.
- Infrastructure development.
- Skill development.
- Fisheries modernization support.

8. Sustainability Framework Analysis of Sarampalli Pond Aquaculture System

Sustainable aquaculture requires a balanced approach integrating ecological protection, economic development, and social welfare. The management practices followed in Sarampalli Pond demonstrate a combination of these three sustainability dimensions.

Table 3: Sustainability indicators of Sarampalli Pond

Sustainability dimension	Management indicators	Current practices in Sarampalli Pond	Expected benefits
Ecological sustainability	Water quality management	Regular monitoring of pH, temperature, DO, turbidity, and alkalinity	Maintains healthy aquatic environment
	Nutrient management	Controlled fertilizer application	Prevents eutrophication and oxygen depletion
	Pollution control	Plastic waste removal and prevention of waste dumping	Protects aquatic biodiversity
	Fish diversity	Composite culture of Catla, Rohu, Mrigala and Tilapia	Efficient resource utilization
	Sustainable harvesting	Prevention of overfishing	Maintains fish population balance
Economic sustainability	Fish production	Stocking of 3,77,840 fingerlings	Enhances commercial production
	Revenue generation	Estimated final revenue ₹4.54 crore after mortality adjustment	Improves rural income
	Market support	Fisheries department assistance	Better price realization
Social sustainability	Community participation	252 fishermen/community members involved	Strengthens local resource ownership
	Capacity building	Training and awareness programs	Improves technical knowledge
	Institutional support	Cooperative society, Fisheries Office, PMMSY	Long-term fisheries development

9. Discussion

9.1 Need of Composite Fish Culture in Sarampalli Pond

Composite fish culture is one of the most effective ways of managing freshwater ponds. This is because several species of fish with varying feeding habits can live together. Catla, Rohu and Mrigala stocked in Sarampalli Pond constitute a scientifically proved combination of surface, column and bottom feeders.

Catla consumes phytoplankton from surface water layer, Rohu eats plant materials and plankton from the middle water column and Mrigala eats organic matter lying at the bottom of the pond. This complementary feeding behavior reduces interspecific competition and increases the conversion of available natural resources into fish biomass. Tilapia are fast growing, tolerant to environmental variation and in demand in the market, therefore further productivity enhancement. But it needs constant monitoring to prevent overpopulation which may disturb the ecological balance of the pond.

9.2 Role of Water Quality Management in Fish Productivity

Water quality is considered the foundation of successful freshwater aquaculture. Poor water quality can reduce growth performance, increase disease susceptibility, and cause mass mortality events.

Physico-chemical parameters of Sarampalli Pond are regularly monitored to maintain suitable environmental conditions. The green color of the water of the pond is indicative of the development of plankton, which is an important indicator of natural productivity.

Plankton communities are natural food sources of cultured fish and enhance productivity efficiency. However, too much plankton growth can cause fluctuations in oxygen, especially from respiration annite. Therefore, regular monitoring is required to ensure that sufficient dissolved oxygen levels are maintained.

For freshwater fish culture, the recommended dissolved oxygen concentration is generally above 5 mg/L and pH values are between 6.5 and 8.5 to support physiological functions of most cultured species.

9.3 Environmental Conservation and Sustainable Resource Utilization

Aquaculture development must be achieved without damaging surrounding ecosystems. Sarampalli Pond follows several environmental protection measures that contribute to long-term sustainability.

Important conservation approaches include:

9.3.1 Reduction of Pollution Pressure

Plastic waste and other pollutants can negatively affect fish health by reducing water quality and introducing toxic substances. Regular cleaning activities help maintain pond ecosystem integrity.

9.3.2 Controlled Use of Fertilizers

Although fertilizers enhance plankton production, excessive application can increase nutrient loading and create harmful algal blooms. Controlled fertilizer management helps maintain ecological balance.

9.3.4 Prevention of Chemical Contamination

Agricultural runoff containing pesticides and chemical fertilizers can affect aquatic organisms. Reducing pesticide entry into the pond protects fish biodiversity and maintains water quality.

9.3.5 Sustainable Fishing Practices

Avoiding overfishing ensures continuous recruitment of fish populations and prevents depletion of aquatic resources.

9.4 Socio-economic Importance of Sarampalli Pond Fisheries

Freshwater aquaculture contributes significantly to rural livelihood improvement by generating employment and income opportunities. The involvement of 252 community members demonstrates the social importance of Sarampalli Pond.

9.4.1 The fisheries system provides benefits through

- Fish harvesting activities.
- Employment opportunities.

- Marketing and transportation services.
- Cooperative-based resource management.

Community participation also increases responsibility toward environmental conservation because local stakeholders directly depend on the sustainability of pond resources.

9.5 Role of Institutional Support in Fisheries Development

Government support plays a major role in strengthening freshwater aquaculture systems. In Sarampalli Pond, assistance from Fishermen Cooperative Societies Limited, Kamareddy District Fisheries Office, and PMMSY contributes to improved production efficiency.

Technical guidance helps fishermen adopt scientific practices related to:

- Stocking density.
- Water quality management.
- Fish health monitoring.
- Harvesting techniques.

Financial assistance and subsidies reduce economic barriers and encourage adoption of improved aquaculture technologies.

Training programs and awareness campaigns further enhance knowledge among fishermen and promote environmentally responsible fisheries practices.

10. Conclusion

The Sarampalli Pond is a successful model of sustainable management of freshwater aquaculture integrating scientific fish production, ecological conservation and community-based resource management. The stocking of 3,77,840 fingerlings of Rohu, Catla, Mrigala and Tilapia has enhanced the utilization of available pond resources through complementary feeding strategies.

Regular monitoring of key water quality parameters such as pH, temperature, dissolved oxygen, turbidity and alkalinity has kept conditions favorable for fish growth. The natural green color of the pond indicates sufficient productive plankton and encourages ecosystem-based fish production.

Environmental protection practices such as pollution prevention, controlled fertilizer application, plastic waste removal, pesticide runoff reduction and overfishing prevention help maintain ecological stability.

The fisheries system offers a good deal of socio-economic benefits to the 252 members of the community. Institutional support from Fishermen Cooperative Societies Limited, Kamareddy, District Fisheries Office and PMMSY has strengthened technical knowledge, financial assistance and fisheries development.

Estimated revenue (after 30% mortality) was around ₹4.54 crore, which underscores the economic potential of sustainable pond aquaculture.

Sarampalli Pond is an example of how ecological conservation, scientific aquaculture practices and community participation can be integrated as a sustainable freshwater fisheries model to ensure environmental protection and rural livelihood development.

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