Agri-Aqua Fusion: Sustainable Integration of Fish Farming and Agriculture

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Agri-Aqua Fusion is an approach gaining traction in the integration of fish farming with traditional agriculture practices. This offers a way to enhance food production and promotes resource efficiency and ecological balance. It involves the simultaneous cultivation of fish with crops in the same ecosystem. This integration harnesses natural synergies between aquatic and terrestrial environments, where waste from one component becomes valuable resource for the other leading to more efficient use of land, water, and nutrients. This Agro-Aqua fusion is also called Integrated fish farming.

It is based on the concept that "there is no waste", and "waste is only a misplaced resource which can become a valuable material for another product" (FAO, 1977). This concept represents pioneering approach to agricultural practices integrating the cultivation of aquatic. This synergy between fish farming and agriculture offers numerous benefits including enhanced productivity, efficient resource utilization and environmental sustainability.

Integrated farming and food security broader approach

Williams (1995) has defined food security as physical and economic access by all people at all times, to the basic food they need. Integrated fish farming can make a significant contribution to food security for developing countries. It eliminates the need for synthetic fertilizers, pesticides and herbicides reducing chemical inputs and maximizes the use of space by utilizing both horizontal and vertical growing surfaces. The constant flow of nutrients from fish waste accelerates plant growth resulting higher yields.

Scope of integrated fish Farming

The scope of integrated farming is considerably wide. Ducks and geese are raised in ponds, and pond-dykes are used for horticultural and agricultural crops. The system provides meat, milk, eggs, fruits, vegetables, mushrooms, fodder and grains in addition to fish. Hence this system provides better production and improves socio-economic status of farmers.

Types of Integrated Fish Farming

Pond-based Aquaculture Integration

Polyculture: Stocking multiple fish species in ponds with crops. Fish species like tilapia, carp and catfish are commonly used due to their adaptability to diverse environmental conditions.

Intensive Management: Implementing proper pond management practices, including aeration, water quality monitoring, and regular feeding, to optimize fish growth and health.

Rice-fish Culture Integration

Gher System: The fishes are cultivated in waterlogged rice fields during the monsoon season. After fish harvesting, rice cultivation is done in the same fields during the dry season.

Rice-Fish Culture: Cultivating fish in rice fields during the wet season, where fish feed on insects, weeds, and organic matter. After fish harvesting, rice is planted in the same fields.

Floating Rice Platforms: Constructing floating platforms or rafts within rice field provide shelter and foraging areas for fish.

Integrated Fish-pond and Crop Fields

Agroforestry Systems: Establishing fish ponds adjacent to agroforestry systems. Nutrient-rich water from fish ponds used for irrigation, benefiting tree crops, while trees provide shade and leaf litter.

Duck-Fish-Rice Integration: Introducing ducks into rice fields to control pests and weeds. Ducks feed on insects and weeds, and their droppings are fed by fishes.

Integrated Fish Farming with Paddy: Traditionally, paddy fields have been dedicated to rice production. However, by introducing fish into these waterlogged fields, farmers can significantly enhance the overall

productivity and sustainability of their agricultural practices. Fish culture in rice fields is done in two ways simultaneous culture and rotation culture. In this, fish species such as carp, tilapia and catfish are stocked in the paddy fields, where they feed on weeds, algae and insect larvae. The fish waste serves as natural fertilizer for the rice plants supplementing their nutrient requirements. The presence of fish helps control pests and diseases, reducing the need for chemical pesticides. This type of farming is adopted in many countries like India, USA, Malaysia, Philippines, and some African & Southeast Asian countries.

Types of Integrated Fish Farming (Examples)

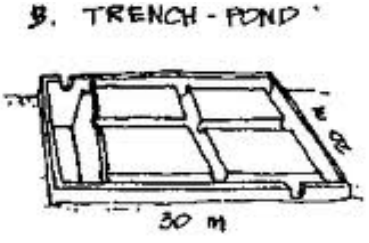
Involving two components	Involving three components	Involving four components
Fish + rice	Fish + rice + vegetables	Fish + duck + pig + vegetables
Fish + poultry	Fish + rice + fruits	Fish + duck + vegetables + fruits
Fish + duck	Fish + poultry + fruits	
Fish + pig	Fish + duck + fruits	
Fish + cattle	Fish + pig + vegetables	
Fish + vegetables	Fish + duck + pig	
Fish + fruits		
Fish + flowers		

Site and species selection

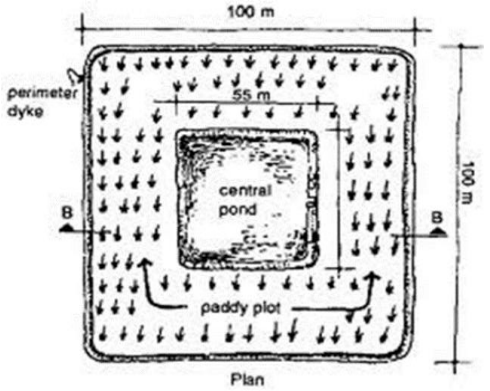
Those paddy fields retain water for 3-8 months in a year and where water remains even after the harvest of paddy. The slope of paddy and land contour. The field should have strong dikes to prevent water leakage and escape of fish. Fishes are selected having high growth rates, thrive well in shallow waters, withstand high turbidity of water and can tolerate relatively high temperatures.

Perimeter trench type

Paddy cultivation area is in the middle of the field in a zone of moderate elevation. Peripheral trenches are dug for fish culture. In 1 ha, paddy is cultivated in 0.67 ha and the fish in 0.20 ha. Perimeter trench is 6m wide at top, 3.5m at base and 1.2m deep.



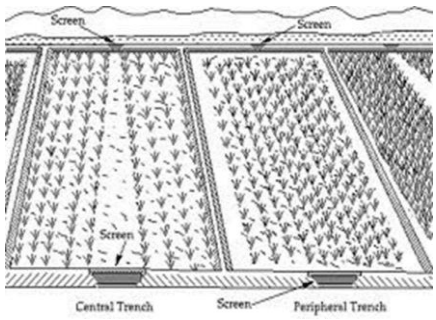
Central pond system



The fish culture area remains at the center of the plot. Paddy growing area lies surrounding the pond. In 1 ha plot, area for paddy cultivation is 0.65 ha and for fish pond is 0.35 ha.

Lateral trench type

Trapezoidal trenches are dug at the sides of the paddy plot with top width 18m, base 15m and depth 1.5m. In a plot of 1 ha area, paddy should be of 0.61 ha, fish culture area 0.27 ha and dyke area 0.12 ha.



Management measures

Fertilizers

- Compost @ 30 tons/ha
- Inorganic fertilizers @120 kg/ha

Pesticides

- No use is recommended during kharif (July to December) season.
- Can be used during rabi (winter crop) season.
- **Stocking of fish**: @4000 to 6000/ha of fry/fingerlings.

Crop and harvest

Kharif paddy crop 2800-1200 kg/ha (nov-dec) when water recedes into the fish pond or the trenches leaving the paddy plot free from water to facilitate harvesting. 4300 kg rice and 1000 kg fish can be harvested after 10 months.

Paddy Varieties

Commonly used varieties

S.no.	State	Paddy variety
1.	Andhra pradesh	PLA-2
2.	Assam	EB-2,Arl,ARC Monoharsali
3.	Haryana	BR-14,Jaispya
4.	Kerala	Ar-61,25B
5.	Manipur	Thethab
6.	Tamil nadu	TNR-1,TNR-2
7.	Uttar pradesh	Jalamagn
8.	West bengal	Jaladhi-1

Horticulture fish system

In addition to paddy cultivation, Agro-aqua fusion can also be extended to horticulture crops such as vegetables, fruits, and herbs. By incorporating fish farming into horticultural practices, farmers can maximize land use efficiency and promote ecological balance. Fish ponds or tanks are integrated with vegetable gardens or orchards. The nutrient-rich water from the fish tanks is used to irrigate the crops, providing essential nutrients for plant growth. Plants maintain water quality by absorbing excess nutrients and oxygenating the water.

The top, inner and outer dykes of ponds as well as adjoining areas can be utilized for horticulture crops. Plants should be of dwarf type, less shady, evergreen, seasonal and highly remunerative. Dwarf variety fruit-bearing plants like mango, banana, papaya, coconut and lime are suitable, while pineapple, ginger, turmeric and chilli are grown as intercrops. Plantation of flower-bearing plants like tuberose, rose, jasmine, gladiolus, marigold and chrysanthemum provides additional income to farmers. The vegetable crops include cabbage, beans, chillies, cucumber, pumpkin and tomato.

Cabbage (*Brassica oleracea var. capitata*)

It is rich in nutrients, having proteins, carbohydrates, mineral salts and vitamin C. Besides being edible, it is a very fine fodder for animals the yield being 2000-4000 kg. Optimum temperature for its growth is 14–20°C.

Chinese cabbage

The nutritive value is very high Chinese with 5.5 g of protein, 0.5 g of fat, 10 g of sugar, 2 g of crude fiber, and 4 g of inorganic salt. In general, the yield is 1,500– 2,500 kg/mu. It serves as fresh food of high quality for herbivorous fish. The optimal temperature for the growth is 15–20°C.

Mushroom fish farming

First record of mushroom cultivation is of 1630AD-1715AD. Mainly 200 species in India which are rich in proteins, essential amino acids and vitamins. Cultivation requires high degree of moisture Method of cultivation involves use of dried paddy-straw chopped into 1.2 cm bits, soaked in water overnight. Excess water is drained off. Horsegram powder (8 g/kg straw) and spawn (30 g/kg straw) are added and mixed with wet straw in alternating layers. Perforated polythene bags are filled with substrate and kept in room at 21◦C-35◦C with required light and ventilation. The mycelial growth occurs within 11-14 days. Polythene bags are cut open at this stage, water is sprayed twice a day and in a few days mushroom crop becomes ready for harvest. The paddy straw after mushroom cultivation is utilized for cattle feeding.

Three types of mushrooms being cultivated in India:

1. *Agaricus bisporus* (European button)
2. *Volvoriella* (paddy straw)
3. *Pleurotus* (oyster mushroom)

Mushroom varieties

Agaricus bisporus *Volvoriella* *Pleurotus*

Benefits and Advantages of Integrated fish farming with agriculture

Diversified Income Streams: Integrated fish farming allows farmers to diversify their sources of income by integrated farming against market fluctuations and increase overall profitability.

Increased Productivity: Fish waste serves as a natural fertilizer for crops, enhancing soil fertility and nutrient availability, which in turn improves crop yields in integrated farming of fishes with agriculture.

Resource Efficiency: Integrated farming systems utilize resources more efficiently by recycling nutrients and reducing waste. Fish waste provides organic fertilizer for crops while crops help filter and purify water for fish.

Water Conservation and Nutrient Cycling: The symbiotic relationship between fish and crops facilitates nutrient cycling within the farming system. Fish excreta and uneaten feed act as nutrients for plants, while plant residues and root exudates contribute to the aquatic ecosystem. Fish ponds or tanks can serve as reservoirs for irrigation.

Improved Soil Health: Integrating fish farming with agriculture can improve soil health. Fish waste enriches the soil with organic nutrients, promoting beneficial soil microorganisms and enhancing soil fertility over time.

Natural Pest Control: Certain fish species, such as tilapia and catfish feed on insect larvae and pests so there is no need for chemical pesticides in fields.

Success Stories of Agri-Aqua Fusion

Bangladesh's Integrated Fish Farming: In Bangladesh, small-scale farmers have successfully integrated fish farming with paddy cultivation, known as the "Gher system." This traditional practice involves cultivating fish in waterlogged rice fields during the monsoon season, followed by rice cultivation in the dry season.

China's Three-Tiered Agriculture: China has pioneered the concept of three-tiered agriculture which integrates fish farming with rice paddies and vegetable cultivation. This system utilizes the nutrient-rich water from fish ponds to irrigate rice fields and vegetable gardens, resulting in higher yields and reduced environmental impact.

Challenges in Integrated Fish Farming with Agriculture

Technical Knowledge and Skills: Adopting Agro-aqua fusion requires technical knowledge and skills. Providing training and capacity-building programs to farmers can help overcome this challenge and ensure the successful implementation of integrated farming.

Market Access and Value Chains: Integrating fish farming with crop cultivation may require establishing market linkages and value chains for diverse agricultural products. Strengthening market infrastructure and promoting collective marketing initiatives can improve market access.

Resource Limitations: Limited access to land, water, and financial resources may constrain the adoption of integrated farming systems, especially in resource-constrained or marginalized rural communities

Future Directions of Integrated Fish Farming with Agriculture

Research and Innovation: Continued research and innovation in integrated farming technologies, practices, and management strategies can help address existing challenges and unlock new opportunities for improved productivity, resource efficiency, and sustainability.

Capacity Building and Training: Investing in capacity-building programs, farmer training initiatives, and extension services to enhance the

technical skills, knowledge, and adaptive capacity of farmers and stakeholders.

Market Development and Value Addition: Developing market-oriented approaches, value-added products, and branding strategies to enhance the competitiveness and marketability of integrated fish and agricultural products.

Conclusion

Agro-aqua fusion offers a promising pathway towards sustainable agriculture, leveraging the synergies between fish farming and traditional crop cultivation. With continued innovation, policy support, and knowledge dissemination, integrated farming systems can contribute to food security, rural livelihoods, and environmental conservation on a global scale. Embracing this innovative farming model holds immense potential to address the challenges of food security, resource scarcity, and climate change, paving the way for a more resilient and sustainable agricultural future.

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