Aquaculture Reimagined: Modern Approaches to Sustainable Fish Farming
DOI: https://doi.org/10.54083/978-81-980121-3-5_23

Chapter_23

Paddy Fish Culture: Integrating Aquaculture with Rice Farming

Virosanuo Solo[1*], Rekha Yadav[2*], Kavi Sumi[3] and Lowrence Kithan[3]

[1]*AICRP on Linseed, Medziphema Centre, School of Agricultural Science (SAS), Nagaland University, Medziphema, Nagaland (797 106), India*
[2]*Dept. of Agronomy, School of Agricultural Science (SAS), Nagaland University, Medziphema, Nagaland (797 106), India*
[3]*AICRP on Kharif Pulses, Medziphema Centre, School of Agricultural Science (SAS), Nagaland University, Medziphema, Nagaland (797 106), India*

Abstract

Paddy-cum-fish farming is an integrated agricultural practice that combines rice cultivation and fish farming in the same fields, offering a sustainable solution to increase productivity and income, particularly in North East Regions like Nagaland and Arunachal Pradesh. This system benefits both rice and fish by creating a mutually supportive environment, where fish help control pests, reduce the need for chemical inputs and provide natural fertilizer, while rice field offer an ideal habitat for fish and is noted to enhance soil fertility, boost rice yields, lowers feed costs and provides additional income streams for farmers. However, challenges such as technical training, infrastructure development and overcoming cultural barriers must be addressed for widespread adoption. With the right support, paddy-cum-fish farming has the potential to improve food security, economic resilience and sustainability especially in rural communities. As climate change impacts agriculture, this practice offers a pathway to a more environmentally eco-friendly, profitable and resilient agricultural future.

Keywords Agriculture, Economic, Fish, Food security, Paddy, Sustainable

1. Introduction

Paddy cum fish culture, also known as integrated pisciculture, is an agricultural practice that combines the cultivation of rice and fish in the same field or water body. This method is commonly used in regions prone to flooding and heavy rainfall, where both rice farming and fish rearing are prevalent. In this system, the rice plants provide shade, cover and organic material, creating a conducive environment for the fish. Paddy farming combined with fish culture is a dual farming system where paddy serves

[*]***Corresponding author's e-mail***: virosolo74@gmail.com, rekha25yadav@gmail.com

How to cite:
Solo, V., Yadav, R., Sumi, K., Kithan, L., 2025. Paddy fish culture: Integrating aquaculture with rice farming. In: *Aquaculture Reimagined: Modern Approaches to Sustainable Fish Farming.* (Eds.) Saini, V.P., Paul, T., Singh, A.K., Biswal, A. and Samanta, R. Biotica Publications, India. pp. 292-299. DOI: https://doi.org/10.54083/978-81-980121-3-5_23.

as the primary crop while fish are cultivated to provide extra income. This paddy-fish culture is common in various rice-growing regions worldwide, including China, Bangladesh, Malaysia, Korea, Indonesia, the Philippines, Thailand and India where this practice has been traditionally observed, particularly in the North-Eastern Region. Additionally, the fish contribute to pest and weed management, reducing the need for chemical pesticides and herbicides and common fish species used in this practice include carp varieties such as Rohu, Katla and Mrigal, which thrive alongside the rice crop in wet fields or ponds after planting.

2. Resources

Paddy and fish are staple foods in India, which boasts abundant natural water resources such as rivers, reservoirs, lakes, flood plains, ditches and extensive paddy fields. Paddy-fish farming entails the concurrent cultivation of both paddy and fish in irrigated paddy fields, allowing for additional fish production alongside rice.

3. Historical Context

Rice-fish culture has a long history, originating in ancient China around 2000 years ago. Over time, this practice spread to Indonesia, Vietnam, Thailand and India, among others. In India, the practice of raising fish alongside rice has been a traditional farming method, particularly prevalent in the waterlogged regions of the Northeast, where it is mostly carried out in a basic, traditional manner. Both fish and rice are staple foods for many Indians, despite the country's agricultural base and the variety of alternative food options available. Given the untapped waterlogged resources in India, there is significant potential to boost the production of both rice and fish, which could benefit many small and marginal farmers and provide livelihoods for those in need and currently, over 16 million people in India rely on this sector for their livelihoods (NFDB, 2020). It is likely that the practice of raising fish in rice fields began in the northeast alongside the advent of rice cultivation, as the flooded rice fields provide a natural habitat for wild fish.

The North-Eastern Region of India features extensive paddy fields in both valley and hill areas, benefiting from some of the highest annual rainfall in the country (averaging 2000-4000 mm) where as a result, these fields are often waterlogged throughout the year and are irrigated by numerous streams and rivers, creating favourable conditions for cultivating fish alongside rice with minimal additional cost or effort. Due to high rainfall, many paddy fields remain flooded year-round and some have become swampy and this waterlogged condition can provide an opportunity for offseason fish farming, offering farmers additional income, however, due to the hilly terrain and the demand for rice production, there is limited opportunity for constructing large fishponds in this region. The practice of paddy-cum-fish culture is straightforward, cost-effective, sustainable and environmentally friendly and can also boost rice yields through the natural nutrient input and pest control

provided by the fish, thereby increasing farmers' incomes and enhancing nutritional security.

4. Process of Setting Up the System

4.1. Site Selection

Low-lying fields with high rainfall and poor drainage are ideal for this system with good water retention and the optimal field size should be between 0.5 to 1 hectare, preferably with uniform topography.

4.2. Water Source

Water can come from precipitation, direct runoff, groundwater, or irrigation canals and the plot should be flood-free and should have abundant water that is accessible throughout the year.

4.3. Soil Quality

Medium-textured soils, such as silty clay or silty clay loam, are ideal for paddy-cum-fish farming due to their high water retention capacity. For optimal productivity, the soil should contain 50-75 mg of nitrogen, 6-12 mg of phosphorus and 1.5-2.5 g of organic carbon per 100 g of soil, with a pH range between 7.5 and 8.5.

4.4. Other Requirements

Having easy access to supplies for fish farming (like feed and fertilizers) and paddy cultivation (such as seeds, fertilizers, pesticides and tools) is very important. There should be skilled workers available for both rice and fish farming at fair prices. A reliable power supply and good roads are needed, along with nearby markets to sell fish and rice and additionally, the farm should have enough storage space for paddy.

5. Scenario of Ziro Valley, Arunachal Pradesh

In Ziro Valley, Arunachal Pradesh the practice of fish-cum-paddy farming has been passed down through generations with traditional farmers using spades for field preparation, but in recent decades, the adoption of power tillers has made land management more efficient. Farmers also regulate water levels using bunds, which they carefully construct and after the rice harvest in November, they create channels to manage water flow and from February to April, fish are introduced into these channels. Common fish species include Common Carp, while the paddy varieties typically grown are Pyaping, Miipya and Emo- local names, however, this traditional practice faces several challenges as during the dry season, droughts threaten water availability and the fish are at risk of being preyed upon by birds, moreover, annual floods are common in the region, which complicates water management.

Economically, the system yields about 40 quintals of rice per hectare and roughly 4 kilograms of fish per harvest and fishes are usually harvested in the second week of September, just before the rice, which ripens and turns yellow between September and October. While fish seedlings cost between

Rs. 1-2 per seedling, the practice is labour-intensive, requiring significant effort to maintain the fields and manage the water channels.

In recent years, there has been a shift toward commercialized farming, where many farmers now prefer to rear fish in ponds rather than in paddy fields, as ponds offer better control over fish farming. The traditional paddy cultivation, which used to include millets along the bunds, is now less common, as rice and fish cannot be cultivated in large quantities together and the fish tend to feed on the rice crop, limiting the number of fish that can be farmed in the same field, thus establishing an optimum level for both and this shift reflects the increasing commercialization of agriculture in the region.

6. Scenario of Nagaland

Paddy-cum-fish farming is an integrated agricultural practice in Nagaland that combines rice cultivation and fish farming in the same field, offering a sustainable solution to increase agricultural productivity, improve food security and provide additional income and through oral legend it has been said that paddy-cum-fish farming has been practiced since the early days of paddy cultivation where paddy fields are flooded for 3-8 months a year, offering the dual benefit of rice cultivation and fish production. This integrated farming system involves modifications to the rice-fish plot, such as creating peripheral trenches, building dykes and digging pond refuges and promising deep-water rice varieties used in this system include PLA-2 (Andhra Pradesh), IB-1, IB-2, AR-1, 353-146 (Assam), Jaladhi-1, Jaladhi-2 (West Bengal) and Thoddabi (Manipur) while the fish are stocked at a density of 4,000-6,000 per hectare and fed with rice bran and oil cakes, constituting 2-3% of their body weight.

Commonly farmed species include Indian major carps (IMC) like Rohu (*Labeo rohita*), Catla (*Catla catla*) and Mrigal (*Cirrhinus mrigala*), along with exotic carps such as Silver Carp, Common Carp and *Clarias batrachus*, as well as local species like *Labeo bata*, *Labeo calbasu* and *Puntius japonicus*. This

system enhances rice yield by 5-15%, largely due to the organic fertilization provided by fish excreta and the control of unwanted algae that might otherwise compete with rice for nutrients. Fish species are typically stocked in a ratio of 25% surface feeders (*e.g.*, Catla), 30% column feeders (*e.g.*, Rohu) and 45% bottom feeders (*e.g.*, Mrigal or Common Carp).

The fish production ranges from 300-400 kg ha^{-1} for a 3-4 month culture period, with yields of 600-700 kg ha^{-1} for a 5-6 month cycle and this practice is widely adopted across all paddy-growing districts, especially in areas like Phek (including Meluri), Tseminyu and Kohima, where the hilly terrain and ample rainfall provide favourable conditions for both rice and fish farming. During the growing season, rice is cultivated using longer-stem varieties and fields are flooded to 7-8 inches, providing a suitable environment for fish. The fish naturally forage on insects and pests in the fields, reducing the need for artificial feed and fish waste also contributes to soil fertility, reducing reliance on chemical fertilizers and boosting rice yields to about 450-500 kg ha^{-1}.

In the monsoon, when fields are ploughed for transplanting, fish are moved to separate water bodies to avoid mortality and this system preserves local biodiversity, with fish and snails helping maintain ecological balance by controlling pests and algae. Additionally, paddy-cum-fish farming reduces feed costs for fish, lowers pesticide use and provides an extra income stream through fish sales. Although challenges such as the need for technical training, infrastructure development and overcoming cultural barriers remain, the benefits of this practice, such as increased productivity, sustainability and economic resilience, make it a promising model for enhancing agriculture in Nagaland. The hilly terrain complicates infrastructure development and cultural resistance to new farming methods may slow adoption, but with continued support and proper training, paddy-cum-fish farming has the potential to transform agricultural practices, ensuring both food security and improved livelihoods for farmers.

7. Culture Procedure

Paddy fields typically retain water for 3-8 months each year and the practice of fish farming in these fields, which remain flooded even after the rice harvest, provides farmers with an off-season activity and an additional source of income. This system requires modifications to the rice fields, including digging peripheral trenches, building dykes, creating pond refuges, planting improved rice varieties, applying manure, stocking fish at a density of 10,000 per hectare and feeding the fish with rice bran and oilcakes at 2-3% of their body weight.

Five days after rice transplantation, fish fry (1 cm) are stocked at a density of 5,000 per hectare, or fingerlings (8-10 cm) at 2,000 per hectare and if supplemental feed is provided, especially when plankton levels drop after 10 days, the stocking density can be increased. To boost plankton production in the rice fields, organic manures such as cow dung or poultry droppings

can be applied. After 4-6 months, depending on whether fry or fingerlings were stocked, the rice fields are gradually drained and fish are harvested, typically about a week before the rice is ready for harvest. The fish growth rate in rice fields is moderate, as the plankton supply (which serves as food for the fish) is abundant. Under this system, individual fish can reach 500 g and fish yield can reach up to 500 kg per hectare.

8. Ecological Benefits

i) Biodiversity Enhancement: Integrating fish farming with rice cultivation increases biodiversity in agricultural systems.

ii) Natural Pest and Weed Control: Fish help manage pests and weeds, reducing the reliance on chemical pesticides and herbicides.

iii) Nutrient Recycling: Fish waste enriches the soil with organic nutrients, boosting soil fertility and crop productivity.

iv) Water Management: The practice enhances water retention and quality in fields, benefiting both rice and fish health.

v) Soil Fertility Improvement: Decomposing fish and their waste add nutrients to the soil and water, increasing overall productivity.

vi) Nutrient Release: Fish movement disturbs the soil-water interface, releasing trapped nutrients for easier absorption by rice roots.

vii) Increased Aeration: Bottom-feeding fish suspend minerals and organic particles, improving water turbidity, soil aeration and oxygen levels.

viii) Enhanced Rice Growth: Fish contribute to faster rice growth and greater solar energy fixation, increasing overall yield.

ix) Nitrogen Conversion: Fish convert insoluble organic nitrogen into soluble forms, enhancing nitrogen availability for rice plants and improving grain quality.

x) Organic Matter Contribution: Post-harvest rice roots and straw provide organic matter that supports microorganism growth and nutrient cycling, enriching the soil.

9. Economic Benefits

i) Increased Yields: Farmers can harvest both rice and fish, maximizing productivity and income from the same land.

ii) Diversified Income Sources: This integration allows farmers to diversify their income, reducing reliance on a single crop.

iii) Lower Input Costs: Reduced need for chemicals and fertilizers leads to cost savings, enhancing profitability.

iv) Sustainable Practices: By utilizing resources more efficiently, paddy cum fish culture supports sustainable agricultural practices, potentially attracting eco-conscious consumers.

10. Limitations of Paddy-Cum-Fish Farming (PCF)

i) Timing of Transplantation: Paddy seedlings must be transplanted at least one month before fish fingerling stocking. If not, fish like common carp and tilapia can uproot young seedlings that haven't had time to strengthen.

ii) Pest and Disease Management: When parasitic or microbial diseases occur in paddy fields, it can be challenging to use agrochemicals. Even small amounts of these chemicals can be harmful to fish, limiting pest control options.

iii) Water Level Fluctuations: The water level in PCF units may vary significantly, especially if water supply relies solely on rainfall. This can affect both rice and fish health.

iv) Dependency on Weather: The reliance on natural weather patterns for water supply can lead to inconsistent conditions, impacting productivity.

v) Competition for Resources: Fish and rice plants may compete for nutrients and space, potentially affecting overall growth and yields.

vi) Limited Crop Choices: Not all rice varieties may be suitable for integration with fish farming, limiting options for farmers.

vii) Management Complexity: Integrating fish farming with rice cultivation requires careful management and knowledge, which may not be readily available to all farmers.

11. Conclusion

Paddy-cum-fish farming is a promising method that combines rice cultivation and fish farming in the same fields as this approach helps increase the productivity of both rice and fish, while also providing sustainable solutions to challenges faced by farmers, especially in areas like Nagaland and Arunachal Pradesh. By growing rice and raising fish together, this system creates a mutually beneficial relationship and the fish help control pests, reduce the need for chemical pesticides and provide natural fertilizer for the rice crops. At the same time, the flooded rice paddies provide a suitable environment for the fish to grow. The practice offers several benefits, such as lowering fish feed costs, improving soil fertility, increasing food security and providing extra income for farmers, all of which help strengthen the local economy.

However, for paddy-cum-fish farming to succeed, there are challenges to

overcome including the need for proper training, better infrastructure and overcoming cultural barriers. With continued support from the government, local communities and investment in training and infrastructure, there is great potential for this practice to expand in Nagaland and other regions. As climate change continues to affect agriculture, systems like paddy-cum-fish farming, which support ecological balance and sustainability, will be important for building resilient farming systems and ensuring long-term food security. In the end, paddy-cum-fish farming offers a path toward a more sustainable, profitable and environmentally friendly future for agriculture.

12. References

Anonymous, 2024. *Prospects on Paddy cum Fish Culture (Nagaland)*. Department of Fisheries and Aquatic Resources, Government of Nagaland. Available at: https://dof.gov.in/sites/default/files/2020-07/Integrated_Paddy.pdf.

Kacha, D., 2016. The traditional way of paddy-cum-fish culture in Ziro Valley, Arunachal Pradesh. *International Journal of Innovative Research & Development* 5(5), 188-193.

NFDB, 2020. *Annual Report 2019-20*. National Fisheries Development Board (NFDB). Department of Fisheries, Ministry of Animal Husbandry, Dairying & Fisheries, Govt. of India.