Sustainable farm management practices for rice-fish co-cultivation in Arunachal Pradesh, India

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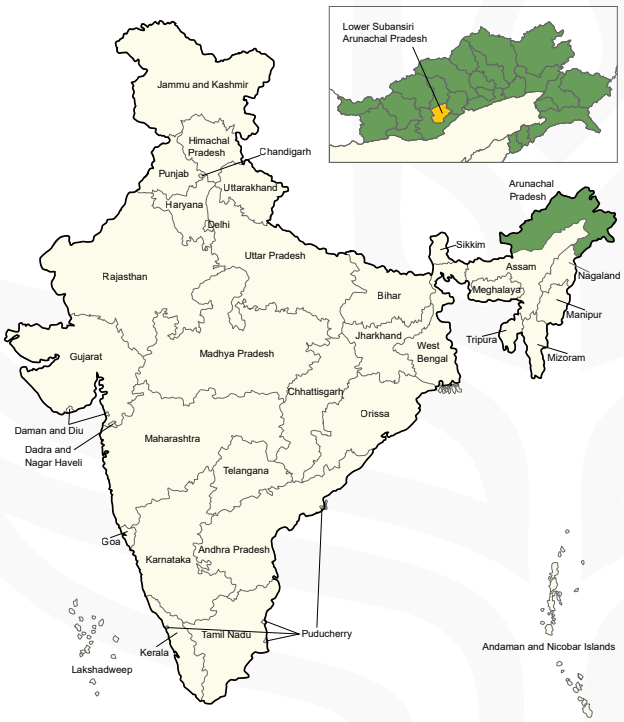
The Apatani Valley, commonly known as the Ziro Valley (N27.32 – 27.37, E93.48 – 93.52), is in the district of Lower Subansiri in the state of Arunachal Pradesh. Located within the sub-Himalayas climatic region, it is a farming zone in northeastern India where cultivating rice and fish together is very popular. At 1524 m above sea level, the area covers more than 500 ha of effective rice-fish systems, surrounded by hills and mountains in forest lands. The state government first piloted integrated rice-fish systems (IRFS) here in 1964–1965 by introducing common carp into rice fields. The technology became remarkably successful and was quickly adopted by the Apatani tribes. It has since become part of their tradition, as almost every Apatani, especially women, practice IRFS using their indigenous knowledge and techniques. The principal rice crops in these IRFS are three indigenous tall rice (*Oryzae sativa*) varieties (Figure 1): Emo, Pyaping and Mipya. These are cultivated with common carp (*Cyprinus carpio*) and indigenous millets, wheat and vegetables (optional) as companion crops. Some farmers also cultivate grass carp (*Ctenopharyngodon idelea*), silver carp (*Hypopthalmiclthys rodepix*), rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*).

Figure 1. Map of Lower Subansiri District in Arunachal Pradesh.



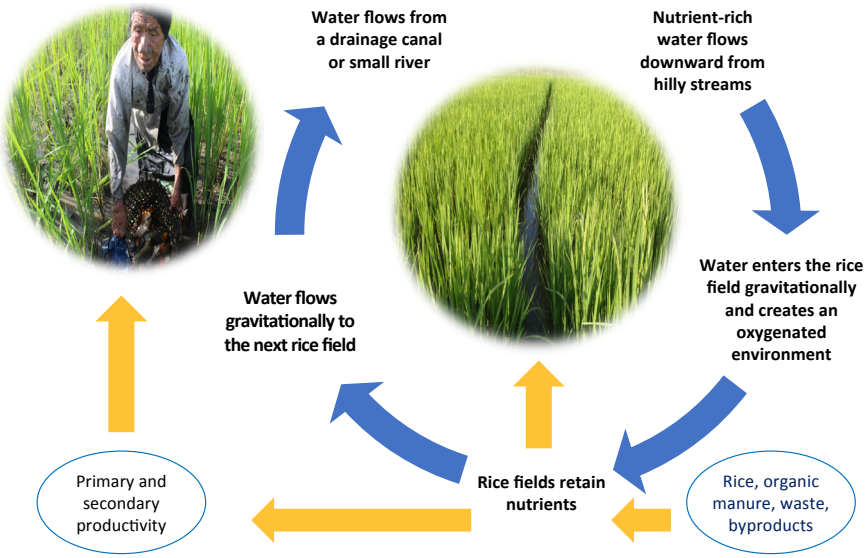
Practices

By cultivating rice and fish following well-designed land-use planning (Figure 2), local farmers in the Apatani Valley are able to maintain the natural resources available to them in their rice fields. The valley receives a rich supply of water from surrounding hilly streams, which are diverted to rice fields through community irrigation channels. The water flows downward through terraced rice fields, from where a network of artificially prepared earthen channels distributes it throughout the rest of the rice fields. At the lowest elevation, excess water pours into major streams. Bamboo nodes are fitted as inlets or outlets for the water to pass through, and fencing made of sliced bamboo prevents fish from escaping out of the rice fields. In these fields, deep trenches serve as a shelter for stocked fish during low water or warm periods. These trenches are 40–50 cm deep and are built irregularly or, in most cases, perpendicularly to each other. Inlets and outlets are connected to most of the trenches. The top one regulates the water level by allowing water to flow into the system, while the bottom one allows water to drain. Across the terraced fields, the upper dike is generally built 30–35 cm higher than the lower dike and creates staircase-like configurations in the valley, where each terraced plot can dry completely and separately before harvesting.

Techniques

Farmers normally prepare their fields during the winter and spring months, from the end of harvest until transplantation. The dikes are raised all along the fields, while bamboo fences are built along the cultivated area to keep unwanted humans and animals out of the fields. During the preparation period, the Apatani tribes use organic fertilizers such as cattle dung, pig manure, domestic food waste, poultry manure and plant waste, including rice husks and ashes from burned household waste. When preparing the fields, they mix the decomposed remnants of the preceding crop manually with the soil. Beginning in mid-April, they then start transplanting tall healthy rice seedlings (30–40 days old) into the main plots, maintaining an average distance of 11–23 cm between the crop rows. This process continues for up to a month. Before or after transplantation, depending on their experience and

Figure 2. Key beneficial features of integrated rice-fish production.



preference, generally farmers stock 600–5000 numbers of common carp seeds (fry or fingerlings) per hectare. Most buy their fish seed, at INR 1–6 per fish, from vendors coming from neighboring states or from local producers. Other farmers produce seed themselves from their previous stocks. Some farmers also receive fish seed from the government.

During cultivation, farmers remove weeds and pile them in the field, where they are left to decompose. Only panicles are collected during harvesting. Some farmers also grow small aquatic weeds like *Azolla* sp. and *Lemna* sp. in the field water as nitrogen fixers and leave post-harvest residues in the field to decompose. Generally, farmers perform two types of fish harvests: single and multiple. Single harvests are done 3–5 months after stocking, when the fish reach 220–350 g in weight, while multiple harvests begin 2–3 months after stocking and last up to 5–6 months, when the fish reach 60–300 g in weight. During the harvesting period, fish are captured almost daily. Depending on when the rice was transplanted, farmers harvest their paddies in September and October, usually following the final fish harvest. Depending on the soil fertility and management practice, annual production from rice-fish terraces ranges between 0.1 and 3 t/ha for rice and 0.06 and 0.4 t/ha for fish.

> “ Proper water quality management provides nutrients through a constant gravitational flow of water. This creates an ideal environment for pisciculture.

Nutrition

Households consume most of the rice harvests. Additional crops grown on the dikes, such as millet harvested in August and September, are used as food and for preparing local wine. Similarly, the vegetables grown on the dikes are periodically harvested from July to October. Vegetables are primarily used for household consumption, and the surplus is sold in the market. Fish are harvested continually for 2–3 months and are kept for household consumption, while any surplus is sold.

Economics

After harvesting their fish, farmers clean them in fresh water and then transport them to the fish market in bamboo baskets. There they sell their fish live at the local market in Hapoli in the district headquarters of Lower Subansiri. At the market, farmers keep their fish in water in bamboo troughs overlaid with a polyethylene sheet. No middlemen are involved. The live fish are sold at INR 300–600/kg. Some of the farmers also sell their excess rice at this market for INR 40–100/kg.

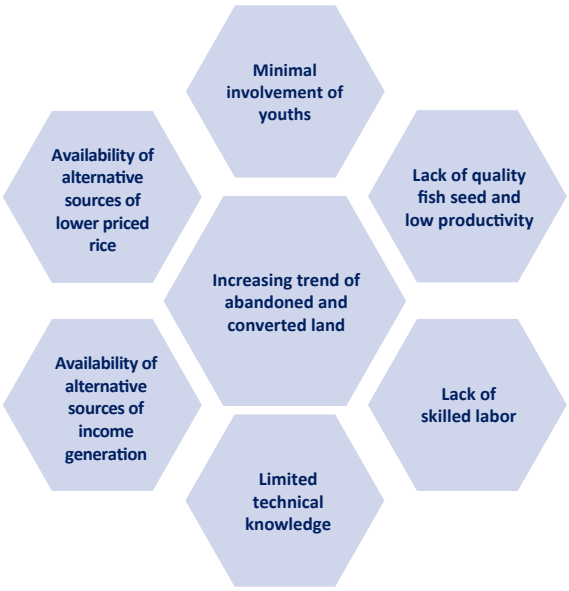
Environment

Apatani rice fields mostly rely on nutrients brought in by runoff from the hills, while recycled organic waste and decomposed crops help sustain soil fertility and crop productivity.

Our initial observations reveal numerous features of the Apatani rice-fish system in adherence to several agroecological principles: recycling, input reduction, soil health, biodiversity, synergies between the rice and fish production system, connectivity, economic diversification, participation, social values and diets, as well as co-creation of knowledge, land and natural resource governance. In addition, the characteristic features of the system have the capacity to influence almost every agroecological principle and could help researchers understand agroecological transitions involving rice-fish based agroecosystems.

Major challenges and constraints

Figure 3. Issues hindering the adoption of IRFS among Apatani tribes.



Strategies adopted by local authorities

- Establish local hatcheries to promote common carp seed production.
- Promote Amur carp cultivation as a new candidate species for IRFS.
- Provide fish seed to Apatani tribes to promote IRFS.
- Provide training and capacity building to Apatani tribes to promote IRFS.

Future research scope

- ✓ Assess the pattern of abandoned land through GIS and determine the reasons.
- ✓ Assess both soil and water quality to optimize land fertility.
- ✓ Assess agroecological features and functioning mechanisms.
- ✓ Promote and optimize cultivation processes for new candidate fish species and rice varieties for the Apatani rice-fish culture system.

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