J Krishi Vigyan 2018, 7(1) : 187-191 DOI : 10.5958/2349-4433.2018.00130.7

Rice-Fish Cultivation of Apatanis: A High Altitude Farming System in Arunachal Pradesh

Deepjyoti Baruah and N D Singh*

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal-263 136, Nainital (Uttarakhand

ABSTRACT

Rice-fish farming has been a heritage practice for the Apatanis in the Ziro valley of Arunachal Pradesh sustaining upon natural resources *viz*., land, water, rice varieties, fish species and indigenous knowledge. This paper reviewed the traditional expertise in the management of inimitable rice-fish farming of the valley and analyses the principles underlying the success of this system in fragile eastern Himalayan region of India. A survey conducted to collect data from randomly selected farmers of 7 villages of Ziro. The rice-fish farming system as part of integrated ecosystem holds distinctive for its wet rice terraces with intrinsic fish trenches, dyke raised finger millets and finely apt bamboo plantations and pinewood thicket at the periphery to avoid soil erosion and conservation of forest together with intricately linked irrigation channels. Common carp (Cyprinus carpio) was the most preferred fish in the system cultivated with 16 indigenous landraces of rice varieties. The system assures improved rice and fish productivity than rice mono-crop, yielding 3-5 tons of rice and 200-500 kg fish/ha/yr. Furthermore, conserving this indigenous agro-culture has been meaningful to exploit rice-fish farming as eco-tourism resources for the mountainous farmers.

Key Words: Integration, tradition, indigenous, hill farming, Ziro valley, Arunachal Pradesh.

INTRODUCTION

Arunachal Pradesh is well-known for its ethnic diversity and a happy home of 26 major tribes and 110 sub-tribes (Nimachow *et al*, 2010). The state, once described as the 'Hidden Land' by virtue of its geographical position, climatic conditions and altitudinal variations, is a land of lush-green forests, deep river valleys, snow clad mountains, plateaus, numerous wetlands, natural lakes, snow-fed streams and falls. The people of the state are mostly agrarian and restore a wealth of traditional knowledge. Among the major tribes of the state, the Apatani tribe is popular for their heritage old practice of wet rice with fish in the Ziro valley of Lower Subansiri district. The efficient management and sustainable use of the agricultural land for rice-fish by the Apatanis in the plateau is unmatched when compared to the other tribes of the entire northeastern states, and henceforth the name of the plateau as 'Apatani Plateau'.

Background of Apatani Plateau

The Apatani Plateau of Ziro valley is geographically located at the altitude of 1572 meters above mean sea level and between 26º50´-98º21´N latitude and 92º40´ and 94 º 21´E longitudes (Kacha, 2016). The valley is surrounded by high hills interspersed with unique and a highly developed ingenious integrated rice and fish farming (locally called Aji-Ngyii) and bamboo with pine home garden agroforestry systems. The Ziro valley is bifurcated by the Kele river and lies between the river valleys of Kamla and Khru on the north and Palin on the south. All these rivers eventually drain into the Subansiri river, a tributary of the river Brahmaputra. It receives a mean rainfall of about 1,500 mm, concentrated during May-August with relatively little or no rains from November to February (Dollo *et al*, 2009). The temperature varies from 6.3°C and 28.1°C in summer and 1.0°C and 18.4°C in winter shows wide fluctuations

Corresponding Author's Email:deep_baruah@rediffmail.com

*KVK, West Kameng, Santi, Dirang 790101 (Arunachal Pradesh)

favoring both warm and coldwater fisheries. The cool summer weather makes the valley a major tourist destination as well. Rice-fish farming of the Apatanis in this part of the country is an integral part of the ecosystem blended by their rich traditional knowledge, culture, environment and socio-economic conditions. This paper reviews this traditional culture and analyses the expertise in the management of this inimitable rice-fish farming of the Apatanis in this fragile eastern Himalayan region of India.

MATERIALS AND METHODS

The field study was conducted during 2015-2016 in 7 villages of the Ziro valley of Lower Subansiri district of Arunachal Pradesh namely Bulla, Dutta, Hari, Hija, Hong, Bamin Michi and Mudang Tage. Personal interaction with the farm women and men of the villages enabled to understand the technique of cultivating fish with rice. On field observations in rice-fish plots comprising land preparation, transplantation and sowing of rice, stocking of fish, periodical weeding and water management and harvesting of crops were recorded to understand the actual action of work. Digital camera (Sony Cyber-shot DSC T77) was used to store the photographs. Physical parameters of water were estimated in situ by electronic digital multiprobe (Hanna model HI 9828) in each of the visited sites. Water samples collected from the sampling sites in wide mouth PVC bottles were brought to laboratory for analysis of chemical parameters following standard methods outlined by Merck Spectroquant Multy (SN 072414) kits. Fish identification was done based on the identifying keys mentioned by Talwar and Jhingran (1991), Jayaram (1999), Nath and Dey (2000) and Eschmeyer and Fong Catalogue of Fishes (2016).

RESULTS AND DISCUSSION

The plot preparation and components

The Apatani Plateau or Ziro valley has a total water area of 715.7 ha and the long established practice of rice-fish culture covers approximately 592.0 ha (Das, 2002). The preparation for rice-fish plots starts just after the final harvest of rice in November. The paddy straw is left on the field to decompose while the other left overs are taken out and burned. For land preparation during December-January, the farmers neither make use of animal power, machines nor any advanced tools to plow their fields. Instead, they prepare the rice-fish fields with economically and ecologically viable conventional daos (a chopping implement) and spades (Fig. 1).

The major components identified in this traditional system featuring its uniqueness were (a) the terraces (b) the irrigation system and (c) the trenches. The Apatanis practice mono crop of wet rice in the terraces (Fig. 2) once in a year integrated with fish and associated production of various vegetables on dykes of rice terraces. The terraces are uniformly leveled and the dykes (Agher) are raised to ensure retention of water during the entire period of cultivation. The irrigation system for supply of water in these terraces are highly organized which are vastly webbed with water feed channels (Fig. 3) and are well linked to each and every rice plot of the plateau. The trenches are most distinctively dug for 30-45 cm depth which are prepared within the rice-fields for facilitating movement and refuge to fish during warmer hours of the day. The trenches are either dug perpendicular to one another or at times irregularly webbed. These trenches are provided with two outlets (hubur) – one at the surface side to release excess water and at the bottom side for drying up of the field water for harvesting the fish. Both the outlets are strictly guarded with bamboo screens (Fig. 4) to prevent escape of fishes during the culture period. Water level of 25-35 cm is maintained in the rice-fish plots during the season. In the event of water scarcity or in a hot weather, the water in the deep trenches provides cool hideouts for the fishes. Water is generally flowed into the plots by diverting a part of the nearby stream in the form of a primary channel which in turn is connected to numerous secondary channels which flows water through each and every plot of rice. The water is conveyed from one terrace to another through a bamboo or wooden pipe installed at a height of 15 – 25 cm above the bed to ensure proper water depth in each of these plots. In order to contain soil erosion, bio-fencing is installed alongside of the primary canals.

The fish and rice varieties for integration

Fish rearing in the field involve one batch or two batches in a year depending upon the field condition. Generally in soft field one batch of fish and in hard fields two batches of fishes were reared in a crop season (Nimachow *et al*, 2010). The most favoured fish species are the strains of common carp, scientifically known as *Cyprinus carpio* specularis (Mirror carp), *C. carpio* communis (Scale carp) and *C. carpio* nudus (Leather carp). Young ones of 5-8 cm size fish (Fig. 5) are stocked in the rice plots after 10-15 days of transplantation of seedlings during April-May. Apart from the common carp, species such as grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), Labeo gonius, *Barbonymus gonionotus* etc. are also stocked in the plots. But unfavourable climatic conditions of the Ziro valley have led to poor production for these varieties of fish. 16 indigenous landraces of local rice varieties are sown (Fig. 6) for integration under the major groups Ampu, Mipye, Pyapu and Eylang. Millets (*Eleusine coracana* Linn. Gaertn.) and other grains are also grown on the dykes. Sequential weeding operation is carried out by mechanical means during the rice-growing season. Both men and women share their work in rice-fish cultivation.

Nutrient management in rice-fish environment

Efficient water management by utilizing water from natural streams in well planned manner is one of the major grounds for making the Apatani system highly organized for rice and fish cultivation together. The irrigation channels not only optimize the water use but also provide nutrient wash-out to the paddy field. Good management practices are followed in this system since older time by using cow dung as organic manure at the time of field preparation and incorporating Azolla and Lemna in rice plots as nitrogen fixer (Fig. 7). Soil nutrient levels are also retained in the plots by allowing self decompose of agricultural wastes, paddy straw, rice husk, ash, weeds, etc. Subsequent to harvest, cattle are grazed in the plots to add manure. It has been reported that, the decomposed leaf litter leached from the forest land is gathered in separate channels and are washed to one of the primary canal so that it exits on to the cultivated plots. The fishes get sufficient food in the form of planktons and periphytons (Saikia and Das, 2008) from the system and need not to be supplemented with external feed. Das *et al* (2007) recognized it as Self-Subtracting Periphyton Based Aquaculture (SSPBA) system for the role played by rice plant as a surface for periphyton growth. Chaudhary *et al* (1993) advocated rice-fish system as an ideal integration in any rice ecosystem having fertile water even with lower depth. These fishes also feed on small insects like water beetle and larvae, which are harmful to the paddy. The waste material voided by fish works as manure to the rice plant.

Water quality in rice-fish fields

The agro-climate conditions of the Ziro valley make rice-fish farming very favourable in the state. The water temperature ranges between 12-28OC, pH (6.2 to 7.1), dissolved oxygen (8.11±0.13), alkalinity (20.33±4.13 NTU), hardness (19±3.21 NTU), ammonium (<0.01 mg/l), nitrate (3.8±0.3 mg/l), nitrite (9.88±1.84 mg/l), phosphorus (0.20±0.16 mg/l). The water quality parameters in the rice-fish environment as indicated above represent a clear indication of favourable conditions for growing fish together with rice at this altitude in Ziro valley of Arunachal Pradesh.

Production and benefits

Common carp (Fig. 8) generally grow up to 250-500 g within a period of 3-4 months. The production rate is reported for 500 kg/ha/season by Saikia and Das (2008). The harvest is usually sold in the local markets of Ziro valley at a rate of Rs. 150/kg fish over the initial cost of Rs. 1.00 – 5.00 per fingerling at the time of stocking. Thus, the net profit for the

Fig.1: Preparation of dykes and trenches in rice-fish plots

Fig.2: Typical rice-fish terraces of Apatani Plateau.

Fig.3: An irrigation channel to the rice-fish plots

Fig.4: Earthen bundhs with guarded bamboo screens in rice-fish plots.

Fig.5: Apatani women with common carp fingerlings for stocking.

Fig. 6: Transplanting rice plants in rice-fish plots

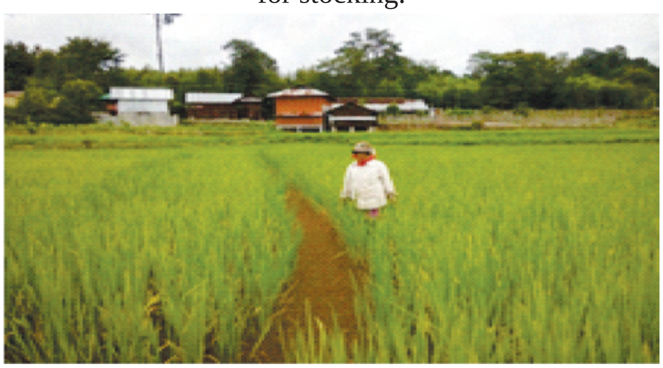

Fig. 7: Incorporating Azolla in rice plots as nitrogen fixer

Fig. 8: Harvesting of fishes from rice plots

farmer stands more than 50 per cent earning in addition to their regular crop of rice. The system assures improved rice productivity than rice mono-crop yielding 3-5 tons of rice (Sarma and Goswami, 2015). It can be said that, integration of rice with fish is a low-cost sustainable practice for the rural mass to obtain high value protein and nutritional security. Rice-fish farming reduces the usage of fertilizer, pesticides and herbicides in the rice field and zero input of artificial feed to fish. Such reduction of input costs lower farmer's economic load and increases their additional income from fish sale. Having such additional income, the net productivity from rice-fish integrated farming is reported to be higher up to 65per cent than monoculture of rice (Halwart, 1998).

CONCLUSION

It was observed that the rice-fish has its own ancient legacy among the Apatanis, and this rightly proves UNESCO for proposing Ziro valley as a World Heritage Site for its primordial traditions. The present investigation revealed that rice-fish farming is a viable, environment friendly, economic, low-risk activity with a source of higher income and can play a crucial role in food security, nutrition, human health and livelihood of the rural folk. Therefore, this low input self-supporting system of traditional rice-fish culture of Apatani Plateau can be very well extended as a farmers' friendly enterprise in other parts of Arunachal Pradesh with necessary location specific refinement is made in the technology. However, establishment of a few private fish seed hatcheries and strengthening the existing Departmental fish hatcheries in the Ziro valley will be an added advantage for ready availability of quality and quantity fish seeds for self sufficiency among the rice-fish growers. Furthermore, the valley may be facilitated with a few maintained fish brood banks and the present strains of cultivable fish species may be replaced with improved strains of fishes for faster growth and enhanced productivity.

References

Choudhuri R G, Dwivedi R N, Dutta K K and Sharma B K (1993). Rice based farming of Apatani- An efficient indigenous system of hill farming. *Indian J Hill Farming* **6** (1): 93-102.

Das D N (2002). Fish farming in rice environments of north-east India. *Aquacult Asia* **2**: 43-47.

Das D N, Saikia S K and Das A K (2007). Periphyton in rice–fish culture system: A case study from Arunachal Pradesh, India. *Renewable Agri Food Systems* **22**: 316-319.

Dollo Mihin, Samal1 Prasanna K , Sundriyal R C and Kumar Kireet (2009). Environmentally Sustainable Traditional Natural Resource Management and Conservation in Ziro Valley, Arunachal Himalaya, India. *J American Sci* **5** (5): 41-52.

Saikia S K and Das D N (2008). Rice-Fish Culture and its Potential in Rural Development: A Lesson from Apatani Farmers, Arunachal Pradesh, India. *J Agric Rural Dev* **6** (1&2): 125-131.

Halwart M (1998). *Trends in rice fish farming*. FAO Aquaculture News-letter **18**: 3-11.

Kacha D (2016). The traditional way of paddy cum fish culture in Ziro valley, Arunachal Pradesh (India). *Int J Innovative Res and Dev* **5**(5): 188-193.

Talwar P K and Jhingran A G (1991). *Inland fishes of India and adjacent countries*, Vol. 1&2, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Jayaram K C (1999). *The freshwater fishes of the Indian Region.* Narendra Publishing House, New Delhi.

Eschmeyer W N and Fong J D (2016). Catalog of fishes: genera, species, references, (http:// research archive.calacademy.org/ research/ ichthyology/ catalog/ fishcatmain.asp), Electronic version accessed 02 June 2016.

Nath P and Dey S C (2000). *Fish and fisheries of north eastern India (Arunachal Pradesh)*. Narendra Publishing House, New Delhi.

Nimachow G, Rawat J S , Dai O and Loder T (2010). A sustainable mountain paddy-fish farming of the Apatani tribes of Arunachal Pradesh, India. *Aquaculture Asia* **XV**(2): 25-28.

Sarma Angkita and Goswami D C (2015). Sustainable agricultural practices and the methods of traditional water harvesting in North East Region of India. *Arch Appl Sci Res* **7**(4): 23-30.

Received on 1/3/2018 *Accepted on 25/6/2018*