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A sustainable mountain paddy-fish farming of the Apatani tribes of Arunachal Pradesh, India

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Efficient land utilisation.

Integrated paddy-fish farming systems can be found in parts of China, Japan, Indonesia, Philippines, Vietnam, Malaysia, Thailand, Myanmar and India. In some cases these systems date back virtually to when man started paddy cultivation. These systems generally involve some form of on-farm waste recycling technique or multiple usage of resources that enhance production capacity, helping to improve farmer's socio-economic conditions and often benefiting the ecology as well. Integrated paddy-fish systems can aid intensive production of rice and fish protein with greater efficiency than they can be grown in isolation, as the by-products of one system component becomes the input for other¹.

With 26 major tribes and 110 sub-tribes, Arunachal Pradesh is well-known for its ethnic diversity and a wealth of traditional ecological knowledge. The efficient management and sustainable use of agro-ecosystems by the Apatani tribe of the Ziro Valley in lower Subansiri District is unmatched when compared to the other adjacent tribes of Arunachal Pradesh, which largely depend on a low productivity slash-and-burn economy. Apatanis are well known for their integrated system of rice and fish culture (Aji-nyyii) in the valley², which has become an additional source of income and important economic avenue of the Apatani farm families³. At the same time fish culture in paddy field may sometime cause health risks if the input of pesticides in the paddy crop is not properly

managed⁴. Similarly, although common carp culture in rice fields is quite advanced in Japan⁵, it has had serious setbacks because of pesticide use in paddy cultivation¹.

The paddy-fish culture of the Apatani, however, is a purely an organic farming practice and is distinctly characteristic of Apatani agro-ecosystem². UNESCO has, therefore, proposed Ziro valley as a World Heritage Site for it's for its ancient custom, forming the basis of the eco-preservation efforts. This article describes the integrated paddy-fish farming of the Apatani Tribes of Arunachal Pradesh.

Background of Ziro Valley

Located at the altitude of 1572 meters Ziro valley has about 32 km² of cultivable area, the rest being covered with hills and mountains unsuitable for wet rice cultivation. As per the 2001 census, the total population of Apatani tribes was about 26,650 with a density of 948 person km⁻². The annual rainfall fluctuates from 2,240mm – 2,910 mm with the maximum rainfall during the months of June and July. The minimum and maximum temperature during summer is 6.3°C and 28.1°C respectively and that of winter is 1.0°C and 18.4°C³ respectively. The air has mountainous soils with high water holding capacity suitable for paddy cultivation.

The land and water resource utilisation system developed by Apatanis is essentially necessitated by the limited land resource available for large population base. The Apatanis are densely concentrated in the Ziro valley. The population density of the Ziro valley, as shown in Table 1, is more than hundred folds than that of state's density and also much higher than the average for the country. In the year 1961 it was 415 persons km⁻² against 4 persons and 142 persons km⁻² of the state and country respectively. The population density of Ziro valley had doubled by 1991 where as that of state and country doubled by 1981. Interestingly, the 0.03% area of the Ziro Valley to the total geographical area of Arunachal Pradesh is supporting 2.26% population of the state.

Looking at the distribution scenario of landholding size and number of farmers, as evident in Table 2, farmers with marginal (very small) holdings make up almost half of the farming population in Ziro Valley. In contrast, the rest of the district and state have more than 50% medium-sized farmers. On the other hand medium size landholdings in Ziro valley are only 17% of farms and the large size landholdings are a low 0.8% of holdings compared to the district and state figure of 5.1%. The paucity of the arable land has compelled the Apatanis to evolve and indigenous technique of intensive farming and efficient method of land and water management. The Indian Council for Agricultural Research for North East Himalayan region has demonstrated sustainable agriculture through paddy-cum-fish culture in Manipur. The Apatanis of Ziro valley have also developed their own techniques of rearing fish along with paddy to meet both the requirements of rice as well as fish as an important part of their diet.

Land, water and nutrient management

The Apatanis have developed a multipurpose water management system, which integrates land, water and farming systems by protecting against soil erosion, conserving water for irrigation and paddy-cum-fish culture⁶. It is managed by diverting streams originating in the forest into a single canal to which each field is connected with bamboo or pinewood pipe⁷. The streams are trapped into a major

Table 1. Population & density (people/km²) of Ziro Valley vis-a-vis Arunachal Pradesh & India

Year	Apatani		Arunachal Pradesh		% to state	India density
	Population	Density	Population	Density		
1961	10,793	415	336,588	4	3.21	142
1971	12,888	496	468,511	6	2.75	177
1981	16,580	638	631,839	8	2.62	216
1991	22,526	866	864,558	10	2.61	267
2001	24,650	948	1,091,117	13	2.26	324

Source: Census of India (1961, 1971, 1981, 1991 & 2001), Government of India.

Table 2. Landholding wise number and proportion of farmers

Holdings	Apatani Valley		Lower Subansiri		State's Total (%)
	Number	%	Number	%	
Marginal	1,360	47.5	2,323	20.01	19.24
Small	990	34.6	2,678	23.07	19.33
Medium	489	17.1	6,017	51.82	55.65
Large	23	0.8	592	5.10	5.75

Sources: 1. District Ag. Officer, Lower Subansiri & Agricultural Census 1995-96.



Wooden pipe to convey water in another terrace.

channel and again redistributed to numerous secondary channels to convey water in each and every field plots. The water is conveyed from one terrace to another through the bamboo or wooden pipes put above 15 – 25 cm above the bed to ensure the proper water level. In order to contain soil erosion, bio-fencing is installed alongside of the main canals. The irrigation systems are managed by a group of farmers led by *Bogo Ahtoh* to ensure proper supply and sharing of water².

Paddy fields terrace are developed with size ranges from 235 to 2740 m² which are levelled uniformly to ensure the uniform water height. In order to hold the water level dykes or bund, supported by bamboos and wooden clips, are constructed in the fields. The width of the dykes ranges from 0.6 m to 1.4 m and height varies between 0.2 m to 0.6 m. No ploughing is done in the field to retain the soil fertility and land is prepared with the help of spades. The household's waste water drained to the irrigation canals provides good source of manure in the field. Soil nutrients are also maintained through recycling of agricultural wastes, paddy straw, rice husk, ash, weeds, etc. After the harvest free cattle grazing is allowed to add green manure. In addition, the decomposed leaf litter leaching from the forest floor is collected in separate pipes connected to the main canal so that it goes on to the plots.

Paddy-fish culture

People believe that tali nguyi (*Channa* sp.) and papi nguyi (*Puntius* sp.) fishes were naturally available in the paddy fields. Usually, these fishes are caught by opening the outlet of bunds so that the volume of water becomes lesser in the field. Indigenous trap prepared from bamboo is placed in the outlets to catch the fishes. The remaining fish in the field are caught by indigenous baskets, nets, etc. Such natural occurrence of fish in paddy fields led the Government of Arunachal Pradesh to start paddy cum fish culture in Apatani valley during 1964-65 on experimental basis. The experiment started with 23 plots of paddy fields covering an area of 10 acres and was found remarkably successful⁸. The Paddy fields are



Paddy harvesting and digging trenches side by side.

suitable for fish culture because these fields have strong dykes or bunds locally known as agher for preventing leakage of water and retaining it to the desired depth and also to prevent the escaping of cultivated fishes during floods. On the bunds, sarse (millet) is cultivated which is a common practice among the Apatani people. Therefore, no portion of paddy plots remains unutilised.

Apart from the naturally available tali ngiyi (*Channa* spp.) and papi ngiyi (*Puntius* spp.) fish species, there are other varieties of fishes like ngilyang ngiyi (*Schizothorax* spp.), tabu ngiyi (eels), ribu (*Nemaucheilus*), ngiyi papi (dorikona or weed fish) found in Kiley River draining the valley. The Government of Arunachal Pradesh had introduced aji ngiyi (common carp or *Cyprinus carpio*) in the paddy fields of the people. Presently, this is the most frequently reared fish species in the region. Currently, species such as kuri mass (*Labeo gonius*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), *Barbonymus gonionotus*, etc. are also stocked along with common carp. But the success rates of these varieties are much less than the common carp. The reason may be unfavourable climatic conditions of the Ziro valley for these varieties of fish. Fish rearing in field is reported by the farmers to be beneficial in multiple ways. These fishes feed on small insects like water beetle, larvae, and others harmful to the paddy. In turn the waste material of fish works as manure to paddy plant. Fish such as the grass

carp feeds on paddy leaves and hence it damages the crops. So this variety of fish is being stocked when the paddy is grown well above water level.

The people categorise their fields as *zebi aji* (soft field) and *aller aji* (hard field). Generally in soft fields the pyapin (*Oryza sativa*) variety of paddy is grown and lesser numbers of common carp are reared for once in a year. Due to the softness of the field, there is a risk of roots being damaged by fish. Hence, only one batch of paddy and fish are reared. On the other hand, in hard fields, two batches of fish are reared in a crop season. The first batch of fish is stocked during late March to early April before the transplantation of paddy saplings. These fishes are harvested in mid June and the second batch is put in the month of July which is harvested in the month of September. A long multi-purpose trench is prepared along the middle of the paddy field. When weeding the paddy field fish are kept in the trench. When there is no rain, hot weather, etc the stagnant water of the field become warm. However, the water in deep trench provides cool hideouts for the fishes. While harvesting the fishes, water is completely drained out from the paddy field. Fishes are bound to concentrate in the trenches from where they are caught easily using the traditional traps. Such trenches dug out just after the harvest of paddy or even during the harvest. Different traditional species of *Oryza* are grown in the paddy-fish system locally known as *ampo*, *mipyra*, *layi* and *misang amo*. They mostly cultivate *amo*, *mipyra* and *layi* varieties

of paddy which are indigenous in nature. *Missang amo* is a variety of paddy that have been taken from the neighboring Nyishi tribe. *Mipyra* is early variety and harvested in the early part of July whereas *Empo* is a late maturing variety ripe at different periods and harvested in the month of October. *Mipyra* is at the verge of extinction due to more emphasis on other varieties for higher productivity and quality.

The average weight attained by the fingerlings at the time of harvest ranges from 130 to 400 g. Based on the conservative estimates of village elders a hectare of land on an average yields about 200 kg of fish. The excellent efficiency of the fish production is despite high mortality of fingerlings⁹. The fishes form an important part of diet of the Apatanis and fetches them subsidiary income with low inputs. Paddy-fish systems help poor and small farmers having too small holding for crop production and a few heads of livestock to diversify their farm production, increase cash income, improve quality and quantity of food produced and exploitation of unutilised resources¹. It has been observed that until now paddy-fish culture is not been carried out on a larger scale or on full time commercial purpose thus leaving a good scope for improvement. This practice has potentials of becoming commercially vibrant only if the people and the government works towards its development. Such an important culture can also be disseminated among other surrounding tribes. The success of paddy-fish culture in the area can be used in the form of illustration to the farmers belonging to other different ethnic groups for sustainable mountain agriculture. This would enhance the economic prosperity of the rural people. By now almost every tribe in the state has started wet rice cultivation in the available cultivable lands. Thus, paddy-rice practice can be encouraged initiated in those fields. It is a relatively easy, low-cost and low-risk entry point for rural farming communities to improve their livelihood and household income without jeopardising the sustainability of rice production¹⁰.

It was realised from the present study that increased population leads disintegrating/fragmenting of cultivable land. Therefore, the available land can be managed in such a manner that it will yield both paddy and fish together at a time to meet the need of food and capital simultaneously.

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From "Tragedy of Commons" to "Wisdom of Conservation"

*"That which belongs to everyone
Is not taken care of by anyone"
was Aristotle's serious apprehension
About common property resource exploitation*

*Came in 1968, Economist Garret Haddin's assertion
Through his "Tragedy of Commons" proposition
That unless we care for and take immediate action
To prevent resources' over exploitation
There won't be any resource left for consumption*

*A team of Canadian scientists have already forecast a
grim situation
For world's marine fish stock position
That if not reversed the current pace of destruction
By 2048 all world fish stocks would face extermination*

*With growing concern for dwindling fish stock condition
Came in 1982 a collective global opinion
Through FAO's World Conference deliberation
To steer the world towards aquatic resource
conservation*

*Snowballing subsequently,
The idea got a definite shape and improvisation
And culminated in
Rio de Janeiro's 1992 Earth Summit's discussion*

*With emphatic world opinion
Generated through UNCLOS resolution
Finally came into force in 1995
FAO's Code of Conduct for Responsible Fisheries and
its draft circulation*

*Let every nation arise and realise
And take concrete preventive action
To channelize the wisdom of fish conservation
To ensure the availability of fish for future generation!!*

S.M.Shivaprakash.