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The Traditional Way of Paddy-Cum-Fish Culture in Ziro Valley, Arunachal Pradesh (India)

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Abstract:

Indigenous land use of Ziro valley has multi-dimensional aspects. Traditional ways of agricultural cultivations are not affected by the ever growing science and technology. People are more believed in their way of cultivation with simple techniques of production rather than going for modern technology, high yielding varieties and chemical fertilizers in the arena of commercialization of crops in the growing market. The farmers prefer medium variety of paddy over early and late varieties. Moreover, farmer realizes the benefits of fish culture in paddy field while growing millet on dyke simultaneously. The paper evaluates the traditional way of paddy-cum-fish culture in the midst of modernity of Ziro valley.

Keywords: Wet rice cultivation, Strains, Sustainability, Multipurpose, Pisciculture, Synchronize, rizipisciculture, hypophysation, agro-chemicals, Indigenous, landraces, Mythology.

1. Introduction

Ziro, the headquarter of the Lower Subansiri district is situated at a height of approximately 1524 metres above mean sea level which lies at 26° 50' N- 98° 21' N Latitude and 92° 40' E and 94° 21' E longitude. The Lower Subansiri district has largest area under permanent agriculture cultivation among all the districts of the State. The Ziro valley is also known as Apatani valley under the Sub-Himalayas climatic zone. The Ziro valley covers an area of 10,135 km². Out of the total wet area of 715.7 hectares, rice-fish culture paddy field covers approximately 592.0 hectares which is surrounded by hills and mountains covered with vegetable gardens, pines, bamboos and other trees. The average rainfall in Ziro valley is 108.1 cm and temperature ranges from maximum 31.6° C to minimum of 1.1° C. The relative humidity varies from 36.5 per cent to 82.8 per cent. The topography of the area is mountainous valley and the soil type is clayey loamy in nature. The permeability and water retention capacity of the soil is highly conducive for rice-fish culture (Saikia & Das; 2004). More than 76% (2011) of population of the valley are residing in seven villages namely Hija, Dutta, Mudang-Tage, Bamin-Michi, Hong, Hari and Bulla. This tribe settled in Ziro valley under Lower Subansiri district in Arunachal Pradesh. They are basically depending on agriculture and the human labour is the only factor used in the production process.

Cultivation of paddy is the primary economic activity in almost all the societies. It provides the basic livelihood for the sustenance of the human civilization. Similarly, collection of fish from seas, rivers, streams and other water bodies is also an important traditional economic activity of most of the rural households in all countries. Though these two are separate occupations for large number of households mostly in rural and coastal areas. They primarily depend on production of agricultural crops and collection of fish from various water bodies as a single occupation for earning their livelihood. These households practice both the activities for increasing their household income and better living standard.

In rainy season wild fish migrate to the crop fields from rivers/streams/water bodies through excess water flow and flood. These fish are trapped in the paddy fields and grow there for some months. After rainy season when water dries up in the paddy fields, farmers use to collect them from their crop fields. Thus, cultivators earn considerable revenue by collecting these fish from their crop fields and by selling them in market. In the process, farming families not only meet the domestic fish requirement but also earn sizeable income from their crop fields without investing single pie for fish rearing.

With the passage of time farming communities in different areas all over the world try to harvest more fish from their crop fields particularly from their paddy fields which are more conducive/attractive for migration of fish in rainy season. Slowly and gradually, farmers started developing their paddy fields by making proper earthen bunds, drains and systems for draining out excess water from their fields before the crop season starts in order to trap more migrated fish in the crop fields during flood and water run-off.

Nowadays, in many parts of India and also in other parts of the World, farmers try to trap wild fish and rear fish seedlings in their low lying crop fields like paddy, jute and other wet crops fields. Thus, cultivation/rearing of fish along with paddy in the same crop field has become a new and innovative practice followed by many farmers for earning more income from the same paddy fields. This

unique farming practice is known as “paddy-cum-fish” cultivation. This concurrent growing of rice and fish is otherwise called as rizipisciculture or paddy-cum-fish culture. It is considered as the most efficient way of utilizing the limited wet paddy fields since the same land is being used for both paddy cultivation and fish rearing at a time. This system is known to be originated from China 2000 years ago followed by India 1500 years ago. Presently some farmers in countries like China, Indonesia, Australia, Malaysia, Thailand, Japan, Philippines, Madagascar, Italy, Russia and some countries from Europe, North America and South America are practicing the fish culture in their paddy fields. However, in most of these countries farmers’ rice-fish farming is not deliberate stocking of fish in their paddy fields. The fish stock density in the paddy fields depends on what come with the flood water. Thus, the species cultured usually reflect the stock of fish in the nearby rivers/streams/water bodies that use to irrigate into the rice fields. While the common carp is the most commonly cultured fish in the paddy fields in all over the world out of 51 different species as reported are being reared in different areas.

A unique land and water resource utilization system known as ‘paddy-cum-fish culture’ was developed by the energetic early settlers in the valley. They used to build up dams and dug channels in the valley bottom to an unbroken series of rice fields. Ever since the Apatanis established themselves in their present habitat, rice cultivation on irrigated terrace fields has been the main base of their economy. It has been necessitated due to the limited land resource of the Apatani settlers in the valley.

The fish culture in rice fields was almost as old as the practice of paddy cultivation itself in Apatani valley. The Apatanis are well known for their integrated system of rice and fish culture (Ajii-Nguyi) in the state. The practice of paddy-cum-fish culture was started in the valley with capturing of naturally available fish species like channa spp (tali ngiyi), puntius spp (papi ngiyi) in paddy fields. These fish normally migrate from river, nearby tanks and pools through irrigation water, rain water into the paddy fields and thereafter grow in the paddy fields. There are other species of fishes like schizothorax spp (ngilyang ngiyi), Eels (tabu ngiyi), nemaucheilus (ribu ngiyi), dorikona or weed fish (ngiyi papi) are found in the river (kiley). The natural occurrence of fishes in the paddy fields such as Channa sp (Tali-Nguyi) and Puntius sp (Papi-Nguyi) led the Government of Arunachal Pradesh to start paddy-cum- fish culture in Apatani valley in 1960s. It is found that the paddy-cum-fish culture is considered as the economically viable and hence sustainable farming practice.

These fields are supported by strong bunds for preventing leakage of water and retaining it to the desired depth and also to prevent the escaping of cultivated fishes during floods water run-off. Moreover, the cultivation of millet (Sarse) on the bunds of paddy fields is commonly practiced by the farmers in the valley. It also adds the economic self sufficiency of farmers in the village. Therefore, no portion of paddy plots remains uncultivated. The Apatanis with a highly developed valley cultivation of rice with fish over several decades are considered to be the one of the relatively advanced tribal societies in the North Eastern Region of India (Haimendorf, 1962).

The common carp is the most frequently reared fish species since time immemorial in the valley. Species such as kuri mass, grass carp; silver carp etc are also sometime stocked along with common carp. But the success rate of these varieties are much less than the common carp. It is found that these fishes eat small insects like water beetle, larvae and other harmful insects of paddy plants. This variety of fish also contributes in increasing soil fertility by decomposing fish excreta, increasing available nitrogen accumulation at the soil surface on the other hand. So, the waste material of fish works as manure to paddy (Nimachow et al. 2010). Similarly, the integrated nutrient management is one of the key factor of higher crop production for achieving sustainability. Thus, there is a need to recycle all available organic resources like crop residue, compost, animal wastes, green manure, etc.

Despite being inter-dependent of paddy and fish in paddy-cum-fish cultivation system, the loss of soil nutrients from the paddy field is being added by recycling crop residues and use of organic waste of the village. The field preparation, bund making and repairing, trench digging, etc. along with water delivery system in the valley require substantial community work and all these works are done collectively by human labour only. In the absence of disciplined schedule and scale of water distribution among the beneficiaries, very often economic returns from paddy and fish production declines.

2. Nature of Operation

Indigenous land use was evolved out of well experimented on resources management and their effective utilizations. The categorization of land by Apatani was largely based on their perception of most appropriate and sustainable use of their limited land resources. The agriculture of Ziro valley is the primary source of livelihood for the farmers of landlocked area. With the limited geographical area, the people of Ziro valley was never practiced shifting cultivation as every part of land were utilized for one purpose or another. Thus, Apatanis with a highly developed valley cultivation of rice perfected over centuries has often been suggested to be one of the relatively advanced tribal societies in the North Eastern Region of India (Furer-Haimendorf; 1962). The wet paddy fields of Apatanis like those of other tribes, depend upon nutrients. With crop harvest, it is believed that considerable quantities of nutrients of soil are lost through economic yield. This lost are replaced by recycling crop residues and organic wastes of the village for maintaining the crop productivity level while sustaining the soil fertility of agricultural field. The regular supply of water through irrigation is equally important to wet paddy field. It requires communal work to maintain it and also to improve the water delivery system, very often in the absence of rain and irregular water distribution among the beneficiaries lead to the decline of production from paddy field. Therefore, the cooperative efforts of farmers under the overall supervision of village active member have optimized the water use along with nutrient use in their rice field.

The long multi-purpose trenches are usually dug out after the harvest of paddy in December month. Initially, these trenches were dug out in order to drain out the water from the normal as well as swampy paddy field. Further, it is used only in large and medium size

paddy fields with exceptional cases of the small swampy paddy field. However, later these trenches became multi-purpose when the natural fish start appearing in the paddy field.

Thus, the Apatanis are well known for their wet paddy field cultivation in the valley since time immemorial. In the beginning, the farmers cultivate rice alone in the paddy field as per the mythology of its origin of cultivation. They tilled small size of the paddy field for the cultivation of early ripening variety of paddy called *mipya*. The transplantation of *mipya* takes place first in the last week of April till the first week of May. The cultivation of this variety help the farmers to feed their family members at the time when old stock of grain in the granary were finished off while late ripening variety of paddy *Emo* is still in early stage. Such type of paddy fields is usually cultivating in the periphery of villages along with late ripening variety of paddy fields. The paddy fields are usually flooded with the required water level before and after the transplantation of paddy nursery.

The weeding of paddy field start from the month of February, so the first round of weeding takes place in this month itself. The maintenance as well as new construction of dyke and trenches was usually performed in the months of November and February. This was followed by leveling of paddy field right after the *murung* festival in February month. Simultaneously, the clearing of millet stump from the bund are also done in order to receive the new transplantation of millet nursery on the bund. By the end of April month, preparations of paddy fields are over and fields are ready to receive the transplantation of new nursery with falls of spring season.

The paddy seed was spread over the nursery bed called *miding* which was separately cultivated and well protected from the entrance of stray animals. Size of nursery bed was determined by the area of paddy field owned by the farmer. It is usually varying from 15 m² to 60 m², which is further divided into small nursery beds, size of about 4x1 meter (length x breath) in each. The nursery beds are prepared after the completion of *murung* festival in February with the help of traditional implement made of wood called *hiita* wooden crowbar. Seeds are spread over the nursery bed which was collected from last season of harvesting with high care. These seeds are stored in basket (*yagii*) separately and keep it on top of the grain which stored in the granary.

Each rice variety is maintained separately in nursery bed in order to avoid the possible mixed up of seedlings. These *indee* seedlings are maintained for 70-80 days until they attain the height of about 14-20 cm for the transplantation to the paddy field. The new agricultural season start with the transplantation of early ripening variety of *mipya* rice in the paddy field for early harvesting followed by late ripening variety which covers large areas. The field for nursery is normally prepared either in narrow valley or near to the settlement area by taking into consideration of its nutrient contents and availability of water supply for the convenient of its leveling as well as healthy germination of seeds. If the settlement is nearby then nurseries are fed with small canals by carrying human wastes and animal excreta. This led to the healthy growth of nursery in *miding* bed.

The finger millet nursery for sowing on paddy field bund was raised in the horticultural garden. The size, time and preparation technique of nursery bed *papii* are almost as same as that of rice but only the difference is that it is rain feed horticultural garden and may dry at the time of its preparation. It takes time at the average of 70-80 days for attaining of 10-15 cm for transplantation from nursery bed to paddy-field bund. The millet nursery was sown with the help of traditional *dam* wooden spike to make holes on the bund. In this way, the farmers of Ziro valley cultivate paddy and millet simultaneously in a crop season while leaving no area of agricultural land remains uncultivated.

3. Sustainable Cultivation of Paddy

The paddy fields of Ziro valley are categorized into three types based on practices such as *jaibee-aji*, *pitang-aji* and *miding*. *Jaibee-aji* is the marshy agricultural field which is normally kept without watering during the fallow period, so that the field would get dried up but keeps the field as soft like normal paddy field. *Pitang-aji* is an agricultural land that requires water supply during fallow period so that the paddy field gets soft at the time of transplantation of paddy nursery. *Miding* is small size of agricultural land maintained for rising of rice nursery. In such plots water is maintained round the year though it need to drain out just before the preparation for sowing of seeds but always kept in wet even after the sowing of seeds.

The Apatanis in Ziro valley maintained age old varieties of rice in their system of paddy cultivation. These farmers are cultivating the indigenous varieties of rice since time immemorial. They have not imported new variety of paddy from out of the district to cultivate in their paddy field except the *mishang* pyaping which is imported from the neighbour Nishing tribe.

These are the varieties of landraces of rice which are cultivated in Ziro valley. Broadly, they are divided into three categories namely *Emo*, *Mipya* and *Pyaping*. *Emo* rice variety is basically a late variety which is cultivated commonly by all the farmers. *Emo* is again sub-divided into five varieties of rice such as *Empu Ahre*, *Empu Emo/ Ahre-haso ponko*, *Empu hath*, *Radhe Emo* and *Eylang Emo*. Each one of them has its own characteristics and can be easily identified by the farmer. Among these *Empu Ahre-haso ponko* is the most commonly cultivated rice followed by *Empu Ahre* and *Empu hath* are early and late varieties respectively are moderately cultivated rice. *Empu hath* is the most productive rice among the *Emos* paddy.

Mipya rice is the fastest ripening variety of rice which was usually cultivated in the periphery of village but the area under *mipya* cultivation is decreasing with the increased cultivation of *Emo* and pyaping rice varieties. *Mipya* is again sub-divided into *kogea mipya*, *zeehe mipya*, *pyate mipya* and *pyare mipya* which are characterized by early variety, late variety, thorn type and absence of thorn on it. *Pyare mipya* is the fastest variety of rice among the *mipya* sub-types of rice.

Pyaping rice is the medium variety of rice. It ripens in between *Emo* and *Mipya* rice varieties. The most common characteristics of *pyaping* rice are absence of thorn. The sub-varieties of *pyaping* rice are *tepe-pyaping*, *pyapu-pyaping*, *zeehe pyaping*, *mishang pyaping* and *Itu-pyaping*. The area under *pyaping* cultivation is less than *Emo* rice variety but more than *mipya* variety of rice. *Pyapu pyaping* is the fastest variety of pyaping rice among the sub-types of *pyaping* and commonly cultivated in Ziro which ripens in between

kogea mipya and *empu hath* but faster than *tepe pyaping*. *Tepe pyaping* and *mishang pyaping* are moderately cultivated rice varieties among the *pyaping* sub-types.

4. Fish Culture in Paddy Field

The Apatani tribe of Arunachal Pradesh practiced permanent agricultural cultivation with a traditional rice-fish culture system known as "*ajii-nguii*" or rizipisciculture for many decades. This was started with the practice of collecting wild and naturally available fish in the river and reproduces the same in the paddy field was probably as old as rice cultivation itself. Fish culture in rice-fields was introduced into South East Asia from India about 1500 years ago, where presently it is the best developed (Tamura, 1961; Coche, 1967; Huet, 1967; Vincke, 1979). Thus, integrated paddy-fish farming system can also be found in parts of China (Taiwan), Japan, Indonesia, Philippines, Vietnam, Malaysia, Thailand, Myanmar. Among these countries, rice-cum-fish culture is well established in other paddy growing countries especially in China (Taiwan) and Japan.

In India rice-fish culture is practiced in Arunachal Pradesh, Tripura, Assam, West Bengal, South Bihar, Andhra Pradesh, Tamil Nadu, and Kerala (Tripathi 1984). The production of fish from many of these states are low and considered that their system is inefficient as they trap the fish rather than culture which naturally occur in the irrigation water, nearby tanks, pools and enter into paddy fields and grow there until they are harvest along with the paddy. However, in Arunachal Pradesh, the Apatani tribe practices fish culture in their paddy field simultaneously. The main determinants in feasibility of raising fish in any given rice-field is the availability of water and its holding capacity by forming strong dyke with good height all around the paddy field. It also needs proper inlet for fresh water supply either from the neighbour paddy field or from the irrigation channels to the fish rearing paddy field and outlet with the help of ducks as well as ditch on the bund so that the stored water is not over flown the bund. On the other hand, the rice field where the water supply is highly seasonal and lack of irrigation water have limited option for rice-fish culture; where as a perennial water supply provides greater potential for rice-fish culture even for rearing of fish two times in a crop season. In such feasible rice field, the farmer of Ziro valley rear fish two times in a crop season.

The fish culture in paddy field is widely gaining acceptability among the farmers as a subsidiary occupation as a result of the increasing demand for fish in the local market. Thus, the area under paddy-cum-fish culture is known to increase over successive years. This attributes to an environment friendly rice-fish culture with increased productivity by recycling the waste matter of fish as manure in paddy field. The gaining popularity of rice fish culture in South-East Asia (Halwart, 1998) explains its potentiality of both from ecological and economical point of view. Thus, the fish integration with rice farming can result in nutrient enhancement, pest control, feed supplementation and biological control in Philippines (Cagauan et al-2000). Therefore, it is considered as an ideal method of land use since the same land is being utilized for both rice and fish concurrently. Moreover, it provides a cheap source of protein additionally for the people living in rural areas. The fish culture in paddy field have been traditionally practiced with a stocking of fish ranging from 50-1000 fingerlings depending upon the size of agriculture paddy field, its location, water supply and free from flood prone zone. These rice fields are stocked with common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*). Of these, the common carp is the most frequently reared fish species in the valley. But the success rates of other varieties of fish are much less than the common carp. The reason may be unfavourable climatic condition of Ziro valley as well as farmer's preferences. The grass carp is not favourable by the farmer because it damages the crop when they are grown up in the paddy field.

There are many breeding centers established in Ziro valley by private individuals as well as by government. It is found that the common carp breeds freely in pond natural environment and there is no need of hypophysation (artificial breeding). The eggs adhere to sub-merged vegetation and the egg lying capacity being 1.10 to 1.20 lakh of fish, a high fecundity (fertility) is maintained (Pussang, 1999). Moreover, the fish nurseries are also brought from the Assam to sale to the farmers at the time of rearing of fish in the paddy field.



Figure 1: Farmers are harvesting fish from paddy fields

The pro-business farmer reared two batches of fish in a crop season. The first batch of fish is usually stocked during late February and early March before the transplantation of paddy saplings. These fishes are harvested in mid June and July months. The second batch of fish is put in the month of June and July. In this batch the farmers put fry size of fish nurseries and also return half grown fish of the first batch in their paddy field. They keep these fish for three to four months and harvested in the month of September and early October before the harvesting of paddy crop. However, most of the farmers' rear single batch of fish especially the common carp during entire crop season as the peak time of growing of fish is known to be from April to August months.

The size of fish usually ranges from 80gm to 200gm and 150 to 250 gm after three and five months of rearing respectively. However, the growth and size of fish depend upon the size of fish nurseries at the beginning of culturing along with the density of fish culture in paddy field. Moreover, paddy field near the human settlement area have more potential growth rate of fish as waste water from the village drain to the nearby paddy field which worked as food for the cultured fish as well as manure for the paddy in agricultural field. The integration of fish along with rice cultivation helps each other growth on the one hand and assures higher economic return from the paddy field on the other. Thus, the excreta of fish, manures used and any remnants of supplemental food also increased the fertility of soil. It is also found that these fishes eat small insects like water beetle, larvae and other harmful to the paddy (Nimachow, G., Rawat, J.S; Dai, O and Loder, 2010). In China, the stem borer is said to have been controlled by the introduction of fish (China Fresh Water Fish Committee; op.cit). Further, rearing of fish in rice fields facilitates better aeration of the water and greater tilling (Hora & Pillang; 1962). Thus, fish culture in paddy field help the farmers for year round employment opportunities as some of them are engaged in the production of fish nurseries during the lean period of agricultural season in Ziro valley. The production of fish from paddy field more or less depend upon the good rainfall and number of fish remain in the owner's paddy field without fleeing to neighbour agriculture due to over flowing of water over bund, opening up of duck and ditch. So the number of fish remains in paddy field at the time of harvesting vary from time to time either it is more than or less than the number stocked.

The paddy fields of Ziro valley are mainly feed with variety of organic manures such as animals excreta like *paro pai* (poultry dropping), *Alyi ekha* (pig excreta), *sii ekha* (cow dung) and plants waste like *piina* (rice husk), *poi* (local beer), *muyyu* (ashes from household burnt). Moreover, after harvesting of paddy, the crop residue is also recycled by burning of the stump, straws and natural decomposition of weeds as well as remaining stump and straws. Therefore, the rice field under study of Apatani valley is free from the use of agro-chemical and additional input of supplementary feed for fish (Saikia & Das, 2004). Thus, the Apatanis utilized varieties of domestic waste products to their rice field to enhance the soil fertility which also become the food for fish as well and in turn increases the overall production of agriculture in terms of rice as well as fish during a crop season. Otherwise, the farmer would harvest single crop in a year. The 3 to 4 times of weeds are cleared during the entire season of paddy-fish culture and even weeds are allowed to decomposed by pilling small sizes in between the paddy plants during the crop season. The entire system of practicing of paddy field is an organic, which is based solely on available natural resources in the ecosystem.

The paddy-cum-fish culture of Apatanis is traditional in nature as fish is integrated with paddy without any modification of indigenous agronomic practice of the tribe. It is the only kind of rizipisciculture based on without supplementary feeding at Ziro valley in entire north east States and India as a whole. This system utilizes the available limited agricultural paddy field judiciously to produce rice-fish-millet simultaneously and consider as one of the best utilization of land in the world of agricultural practices. The paddy fields are also free from the use of agro-chemicals such as weedicide, pesticide, and insecticide excepting the traditional manures. The techniques of production are traditional with little modification under the influence of improved modern technology. The Apatanis farmers through the indigenous practices of rice-fish culture not only conserve biological diversity but also manage sustainable utilization of the available resources in the agriculture for their triple benefits in Ziro valley. Thus, the Apatani rice-fish-millet culture

can be a role model for rest of the country as well as not only for South-East Asian Countries but also for rest of the world towards sustainable organic farming of two or more crops at a time in given land.

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