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Fish culture in mountainous paddy fields with varieties of indigenous paddies in Ziro valley north eastern part of India

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Abstract
Apatanis practice the sedentary agriculture and developed a systematic and eco-friendly system of integrated rice with fish culture and millet on the bund. The agricultural operations are carried out through human labour. Broadly, there are three indigenous caltivars of rice namely Emo, Mipya and Pyaping. Each caltivar of rice has own different strains. Common carp is the most cultured fish species with medium and late varieties of cultivars in the paddy field of Ziro valley whereas the grass carp is usually grown in fish ponds only. Fish nurseries are being supplied from both the private and government fish nursery ponds to the local farmers in order to culture in their paddy fields. Some farmers culture two batches of fish in a crop season where there is regular water supply and free from soil erosion and flood zone. However, most of the farmers prefer single batch of fish during entire crop season in Ziro valley. This paper attempt to analysed the fish culture with different varieties of paddy which are most suited to the fish growth in line with the maturity of crops. The researcher has cultured fish in own paddy fields and also visited all the seven villages to collected the primary data to draw conclusion on the set objectives.

Keywords: Bunds, Nursery, Cultivar, Strain, Integrated, Culture, Ponds, Common Carp, Harvesting, Transplantation.

Introduction

Ziro valley is situated at a height of approximately 1524 metres above mean sea level which lies at 26º 50 N- 98º 21 N Latitude and 92º 40 E and 94º 21 E longitude. It has the largest area under permanent agriculture cultivation among all the districts of the State. The valley is also known as Apatani valley under the Sub-Himalayas climatic zone which covers an area of 10,135 km^2. 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 ºC to minimum of 1.1 ºC. 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) [5]. The major rivers of valley includes Khree, Panior, Kime, Ranga and Pange. The neighbours of Apatani valley are Nyishi and Hill Miri tribes. The population is spread over thirty five villages of which seven villages are traditional viz. Hija, Dutta, Mudung-Tage, Bamin-Michi, Hong, Hari, and Bulla; while the rests are modern villages. Despite settling in different villages they strongly maintain their social relations, economically dependent with similar culture. They are basically depending on agriculture and the human labour is the only factor used in the production process.

The land and water resource utilization system known as 'paddy-cum-fish culture'or rizi-pisciculture 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 physical, socio-cultural and economic factors of the area have played vital role to make the valley distinct from the rest of the districts.

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) [2].

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 rates 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) [4]. Similarly, the integrated nutrient management is one of the key factors 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.

Paddy Fields and Nursery Beds (Miding)

The paddy fields are categorized into three types based on nature of practice viz. *Jaibee-aji, pitang-aji* and *miding. Jaibee-aji* is the marshy agricultural field which normally kept without watering during the fallow period while *pitang-aji* is the dry agricultural field that requires water supply during fallow period at least for one to two months stagnant water otherwise the productivity of land will be low with high weed infestation. The *miding* is a small agricultural land maintained for rising rice nursery. The size of the *miding* depends on the availability of agricultural field and its area of cultivation. In such a plot water is maintained round the year, though it needs to drain out just before the preparation of bed and sowing of seed but always kept with light water around the bed.

After the preparation of nursery bed, the paddy seeds are spread over the nursery bed called *miding* which is separately cultivated and well protected from the entrance of stray animals. Size of nursery bed is determined by the area of paddy field owned by the farmer. It is usually vary from $15m^2$ to $60m^2$ which is further sub-divided into small nursery beds, size of about 3x1 meter (length and breadth) in each. The nursery beds are prepared after the completion of *murung* festival in February month (*parge pillo*) with the help of traditional implement made of wood called wooden crowbar (hiitaa). Seeds are spread over the nursery bed which was collected from the last season of harvesting with high care. These seeds were stored in the 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 mixing of seedlings. These paddy nurseries (*iindee*) are maintained for 70-80 days until they attain the height of about 14-20 cm for the transplantation to the paddy field.

The field for nursery is normally prepared either in narrow valley or near to the settlement area by taking into consideration 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 bed (*miding*).

Preparation of Paddy Fields

The preparation of paddy field starts in the month of December (*nenke pillo*) after the gap of almost a month from the last agricultural season. The grown up weeds are cleared so that it would not get matured and spread seeds over the paddy field during the post harvesting period of 3 to 4 months and before transplantation of nursery to new paddy field. Dried straws are burned around the field during this month. The farmers transport materials of household such as poultry droping (*paro pai*), pig excreta (*alyi ekha*), rice husk (*piina*), ashes from household stove (*mubu*), waste product of local beer (*poi*), etc to their paddy field whenever the farmer felt that the fertility of soil has diminishes over time in the process of cultivation. In the months of January and February (*murung* and *parge pillo*), the festival of *murung* performs throughout the January month in the entire villages of Ziro valley. The maintenance of dams, irrigations, water conduits, etc are done in January to April months for smooth flow of water supply to paddy field during the cultivation season and also to prevent flood during rainy summer to avoid the damage of standing crops.

Further, the maintenance as well as new construction of dyke and trenches is usually performed in the months of December to February months. 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.

Table 1: Name of Roman calendar Months vis-à-vis Indigenous

Sl. No.	Name of Roman Calendar Month	Indigenous Name of Month
1.	January	Murung pillo
2.	February	Parge pillo
3	March	Myoko pillo
4.	April	Halying pillo
5.	May	Enda pillo
6.	June	Ampu pillo
7.	July	Mihlo/Diime/Dree pillo
8.	August	Hahlo pillo
9.	September	Bunchi pillo
10.	October	Bunchi/Antii pillo
11.	November	Emo pillo
12.	December	Nenke pillo

The taboos are observed more for the persons who perform ritual in this festival by not performing paddy field related activities for about a month. By the end of March month and beginning of April month, the preparations of paddy fields like weeding, leveling are over and fields are ready to receive the transplantation of new paddy nursery with the fall of spring season.

Traditional Varieties of Paddy

The transplantation of nurseries begins in the middle of April month (*Halying pillo*) and it continues in the May called *Enda pillo*. The women and young girls are the main labourer who performs entire transplantation operation though men folk are involved in sowing the nurseries in paddy fields but the involvement of men are negligible. They pick the rice nurseries from the nursery bed and tied them into bundles for easy transportation and carry them in basket to the paddy fields for sowing. The transplantation of nurseries is done two times in a season. The first round starting from the edge of the field and moved forward as work progress. They plant single seedling at intervals of about 7 to 8 inches. In the second round, the farmers verify and plant wherever the nurseries are not survived and have big gap in between. This continues even in the month of early June (*Ampu pillo*). During the early stage of nursery growth the water level is strictly maintained.

Of all the paddy nurseries, the transplantation *of mipya* variety takes place first in April month and it continues till May month. Initially, the cultivation of this variety helps 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 are usually cultivated in the periphery of villages along with late ripening variety in separate paddy fields. The paddy fields are usually flooded with the required water level before and after the transplantation of nursery.

The July month is known in various names such as *Mihlo/Dime/Dree pillo*. In other words, it is known for acute scarcity of rice in storage. This is followed by the harvesting of early ripening variety of paddy called *mipya* in the month of August. So the festival of agriculture begins on 4th July and continues till 6th of July every year. Community rituals perform during this festival and taboo are observed for two weeks by not performing agriculture, horticulture and forest related activities. This festival is performed especially to freed from all kind of insects that are harm full to the paddy, millet, maize, cucumber, chili, etc in the agriculture and horticulture of Ziro valley.

The weeds (*ahru-tami*) are the major problems of farmers and it is cleared 3-4 times in a year. First weeding is done before soil preparation for transplantation of paddy nursery in the month of February (*Parge-pillo*) followed by second weeding in the month of April (*Halying pillo*). In late July and August months, the farmers again cleared weeds when the paddy start growing besides harvesting of cultured matured fish and put back half grown fish to the paddy field for next harvesting during this time. The last round of weeding takes place in September (*Bunchi pillo*) and early October months when the varieties of paddies are fully grown up and start ripening early variety of paddy.

The cultured fish are also harvested simultaneously while draining out the water from the paddy field, so that it gets dried in course of time before the harvesting of paddy. The October (*Bunti/Anti pillo*) and November (*Emo pillo*) are known as the harvesting months. The harvesting begins with the early varieties of paddy in the second week of October and ended with late variety of paddy in the second week of November. Thus, the Apatani community remains engaged in agriculture pursuits throughout the year.

[Weeding of paddy-cum-fish cultivating fields by woman worker]

The extensive survey of rice growing area of Apatani valley revealed the presence of 15 local cultivars. Broadly, they are divided into three categories of rice namely *Emo, Mipya* and *Pyaping*. *Emo* rice variety- basically a late variety, is cultivated by all the farmers. The cultivars are characteristically diverse and they are differing in height of the plant, leaf colour, grain colour and size, drooping of bunch and thorn. All these varieties have long been utilized by the farmers as a tool to identify the suitable cultivar for a specific land form and agro-ecology. Thus, the Apatanis maintain age old varieties of rice in their system of paddy cultivation since time immemorial. Out of these cultivars they have imported only *mishang paying* from the neighbour Nishi tribe and *halyang emo* from outside the Assam.

Analysis on Fish Culture with Varieties of Cultivars

The terrace type of agriculture helps the inlet and outlet of water from one paddy field to another paddy field easily which is considered as the best suited to the system. All the paddy field has proper inlet facility for fresh water supply from the upper side of the immediate neighbour paddy field or else directly supplied from the irrigation source if the field is adjacent to it. It is equally significant to the fish culture in paddy field that the proper leveling of field helps the retaining of water in equal level over the ground for healthy growth of paddy and grazing of fish especially of big size agriculture which is commonly prevail in Ziro valley. In such a paddy field there is a faster growth of fish with the more natural availability of food supply. These paddy fields are surrounded by strong and thick dyke with good height depending upon the gradient of the area and flood prone zone. With these characteristics and its nature of paddy fields, the rearing of fish in rice field becomes a culture of farmers in Apatani valley.

The fish cultures in paddy fields are commonly practiced by the farmers in Ziro valley. It is highly depends on water source and its regular supply. The agriculture with good source of water supply and its connectivity led to the culture of fish in paddy field round the year by many of the farmers except during the harvesting period. They usually rear fish two times in a crop season. The common practice of fish culture in paddy field begin in the months of April and May (*Halying* and *Enda pillo).* Protection wall are also erected with splited bamboo all around the duck (*Hubur*) and ditch (*Mugho*) of fish rearing agriculture. Then, the field water are monitored frequently as during April and May months the rainfalls are scanty which ranges from 60 to 61.2 unit in milli meters only in Ziro valley.


[Researcher Harvesting Fish from Paddy fields]

Simultaneously, the paddy nurseries are transplanted from nursery bed to field and this continues till second week of June with the second round of transplantation where ever the newly transplanted paddy are not survived. Further, with this the millet are also transplanted from nursery bed (*Yorlu papii*) to paddy field bund only once during the same month. So the collection of fish nurseries from the private and government farms for culturing in newly prepared rice fields starts from April month. However, the nurseries supplied from the government farms are limited, so most of the farmers rely on private farms for their requirements. The private farms supplied the fish nursery especially of fry size to the farmers at their door step during the season to all the seven traditional as well as some of the modern villages of Apatani valley.

Apart from supplying of fry size fish nurseries by the government fishery department at subsidised rate to the fish cultured farmers, there are innumerable number of small farmers who grows the fish nurseries either at their own fish farm or rice nursery bed (*midding*) in order to culture in their own paddy field. The fingerling and advance fingerling size fish nurseries are rarely available and supplied by both the private and government nursery fish farms. So, most of the farmers depends only on fry size fish nurseries which are supplied from the government as well as private nursery fish farms in Ziro valley. The supply of fry size fish nursery also come from the neighbour state Assam to sale to the farmers for culturing in the paddy field. It is found that the common carp breeds freely in pond natural environment two times in a year viz. one in later March till April end and second in September to October. There is no need of hypophysation for its breeding in Ziro valley. The eggs adhere to sub-merged vegetation such as floating plants, stalk and straws which the farmers usually prepared for breeding purpose. The egg lying capacity of per fish depends on the size of fish with an average of 80,000 to 100000 in the valley.

The business oriented farmer culture two batches of fish in a crop season. First batch of fish is usually stocked during late February and early March before the transplantation of paddy saplings to the rice field. This period was found suitable to culture fry size fish nursery because the farmers found that the stocking of fish fingerling and advance fingerling sizes damages the newly transplanted paddy nurseries in root while searching for food in the paddy field. So, the first batch of fish is harvested in mid June and July. The farmers usually stocked fish nursery ranging from 100 to 1500 fingerling size depending upon the size of agricultural paddy field, its location, water supply and free from soil erosion and flood zone.

The Apatanese culture some fish species in their ponds such as common carp (cyprinus carpio), silver carp (hypopthalmiclthys rodepix), rohu (labeo rohita), catla (catla-catla), mirigal (cinihnus mrigal) and grass carp (ctenopharyn godon). The common carp is most frequently and successfully cultured fish species in the paddy field of Ziro valley. The grass carp is not favoured by the farmers as it damages the standing crops when they are grown up in the rice field. Thus, the farmers culture all other fish species in their fish ponds only which are economically beneficial to them. It is found that almost 90% of fish productions are common carp followed by grass carp in Ziro valley. The second batch of fish was put in the month of June end and July. In this batch the farmers stocked fingerling and advance fingerling sizes of fish nurseries and also returns all those half grown fish of the first batch in their paddy field. They allow these fishes to grow for three to four months and harvest in the months of September and early October before the harvesting of medium and late ripening varieties of paddy. However, most of the farmers rear single batch of fish especially the common carp during entire crop season as it is known to the farmers that the peak season for growing of fish in paddy fields are from April to August.

Table-2 illustrates the village wise cultivation of various paddies in their agriculture and the source from which they culture fish nursery. The commonly cultured fish is common carp along with paddy in the agriculture. However, almost every farmer uses traditional manures to enhance the fertility of soil after the harvesting of crops in all the seven villages. Commonly cultivated crops are *Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, Pyaping pyapu, Tepe pyaping, Mishang pyaping, Itu pyaping, Zeehe pyaping* in all the seven traditional villages. The crops like *Eylang emo, Pyate mipya, Kogea mipya, Zeehe mipya* are rarely cultivated in the valley. Out of all the crops, the *Ahre-haso ponko, Radhe emo, Pyaping pyapu, Tepe pyaping, Mishang pyaping* crops are intensively cultivated by the farmers in Ziro valley. Though some of the farmers are self sufficient of fish nurseries for culturing in their paddy fields but most of the farmers of these seven traditional villages are depending upon the government and private fish farms for their requirements of fish nursery to culture in their paddy field. It is shown in Table-2 that the fish nursery supplied to the Hija, Dutta, Mudang-Tage, Hari and Bulla villages are very low.

Table 2: Village Wise Cultivation of Strains of Paddy of Fish Nursery and Use of Chemical/Manures in the Agriculture of Ziro Valley

Sl. No	Name of Village	Strain of Paddy/Sub-Paddy in Local Name	Source of Fish Nursery	Name of Fish	Fertilizer use
1.	Hija	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, Halyang emo, pyaping pyapu, Tepe pyaping, Zeehe pyaping, Mishang pyaping, Itu pyaping, Kogea mipya and Zeehe mipya.*	Govt.+ Pvt. ++++	Common carp	Ch.- Tr. +++
2.	Dutta	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, pyaping pyapu, Tepe pyaping, Zeehe pyaping, Mishang pyaping, Itu pyaping and Kogea mipya.*	Govt.+ Pvt. ++++	Common carp	Ch.- Tr. ++
3.	Mudang-Tage	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, pyaping pyapu, Tepe pyaping, Zeehe pyaping, Mishang pyaping, Itu pyaping and pyate mipya mipya,*	Govt.+ Pvt. ++++	Common carp	Ch.- Tr. ++
4.	Bamin-Michi	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, Eylang emo, pyaping pyapu, Tepe pyaping, Mishang pyaping, Itu pyaping and pyate mipya*	Govt.++ Pvt. +++	Common carp	Ch.- Tr. ++
5.	Hong	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, pyaping pyapu, Tepe pyaping, Mishang pyaping, Itu pyaping, Zeehe pyaping and pyate mipya, kogea mipya,*	Govt.++ Pvt. ++++	Common carp	Ch.- Tr. ++
6.	Hari	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, Eylang emo, pyaping pyapu, Tepe pyaping, Mishang pyaping, Itu pyaping, Zeehe pyaping and pyate mipya, kogea mipya, zeehe mipya.*	Govt.+ Pvt. ++++	Common carp	Ch.- Tr. +++
7.	Bulla	*Ahre-haso ponko, Empu ahre, Hath emo, Radhe emo, Eylang emo, pyaping pyapu, Tepe pyaping, Mishang pyaping, Itu pyaping, Zeehe pyaping and pyate mipya, kogea mipya, zeehe mipya.*	Govt.+ Pvt. ++++	Common carp	Ch.- Tr. +++

Note: Govt. ++ = moderately used in Govt. farms. Govt. + = lowly used in Govt. farms.
Pvt. ++++ = highly used in private farms Pvt. +++ = moderately used in private farms
Ch. - = Chemical fertilizers not used. Tr. +++ = highly used traditional manures.
Tr. ++ = moderately used traditional manures.

Moreover, the numbers of households and fish nurseries given to these villages by the fishery department are very less as compared to the total households of each village, so farmers from most of these villages' depends on the private farms for fish nursery requirements to culture in their paddy fields. However, The Bamin-Michi and Hong villages received fish nurseries comparatively better off than rest of the villages from the Government fish farms at subsidised rate. So their dependence on the private fish farms is less during the year 2014.

It is also found that the fish growing farmers are not using chemical fertilizers in their agriculture instead they use the domestic organic manures with a variety of animals excreta such as poultry dropping (*paro pai*), pig excreta (*Alyi ekha*), cow dung (*Sii ekha*) and plants waste like husk (*piina*), local beer (*poi*), ashes (*Muyu*) from household stove. 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. Thus, the use of these waste products enhances the soil fertility which also becomes the food for the cultured fish 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 weeds are cleared 3 to 4 times during the entire season of agriculture and even weeds are allowed to decomposed by pilling small sizes in between the paddy plants during the crop growing season. Thus, the entire system of practicing of paddy fields by the Apatanis is organic in nature which is solely based on available natural resources in the system.

The Table-3 illustrates the type of cultivar and its strains cultivated in the agriculture of Ziro valley. There are three cultivars and each cultivar has own strains. The production of these cultivars are varying according to its duration and under type of land that are cultivated. Among the strains of long duration, *Emo* cultivars like *Empu hath, Ahre-haso-ponko* and *Radhe emo* are the most productive paddy that are cultivated between February to November. This is followed by *Empu ahre* and *Eylang emo*. *Empu ahre* paddy takes shortest duration for its production between February to October. The *Halyang emo* yield the least production among the *Emo* strains and rarely used fish culture. The medium strains like *Tepe pyaping*, *Zeehe pyaping*, *Pyapu pyaping*, *Itu pyaping* and *Mishang pyaping* are medium cultivars which is cultivated between February to October. All these varieties of *pyaping* strains are considered as more or less equally productive excepting the *Pyapu pyaping* and *Itu pyaping* which is said to be little more productive than rest of the *pyaping* strains. The farmers moderately culture fish nursery of fry size along with *Pyapu pyaping* and *Itu pyaping* in the paddy field but lowly with *Tepe Pyaping, Zeehe Pyaping* and *Mishang pyaping* in the agriculture of Apatani valley.

Table 3: Local Cultivars and Strains-cum-Fish Culture in Apatani Valley

Sl. No.	Cultivar	Strains in Local Name	Cultivation Months	Used in Fish Culture	Duration in Group
1.	*Emo*	*Empu ahre*	Feb; to Oct	++++	Long duration cultivar
		Ahre-haso-ponko	Feb; to Nov	++++++	
		Empu hath	Feb; to Nov	++++	
		Radhe emo	Feb; to Nov	+++	
		Eylang emo	Feb; to Nov	+++	
		Halyang emo	Feb; to Nov	+	
2.	*Pyaping*	*Tepe pyaping*	Feb; to Oct	+++	Medium duration cultivar
		Pyapu pyaping	Feb; to Oct	++++	

		Zeehe pyaping	Feb; to Oct	+++	
		Mishang pyaping	Feb; to Oct	+++	
		Itu pyaping	Feb; to Oct	++++	
3.	*Mipya*	*Kogea mipya*	Feb;to Sept	-	Short duration cultivar
		Zeehe mipya	Feb;to Sept	-	
		Pyate mipya	Feb;to Sept	-	
		Pyare mipya	Feb;to Sept	-	

Cultivar = Cultivar is a cultivated variety.
Strain = Strain is sub-group of cultivar with distinguishable quantitative & qualitative feature.
Note: ++++++ = Dominantly used. ++++ = Moderately used. +++ = Lowly used.
+ = Rarely used. - = Not used.

The cultivation of *Mipya* cultivar becomes negligible among the farmers in the agriculture of all the seven villages due to the damaged caused by the birds in the agriculture before it get matured. Moreover, *Mipya* cultivar is cultivated between February to September months and usually cultivated in small paddy fields. Under the *Mipya* cultivar, the farmers are not culturing fish excepting naturally available small fishes. Thus fish culture activities here synchronizes well with *Emo* cultivar along with Eleusine Coracana which is cultivated on elevated portion of bunds between the rice plots. The early varieties of paddy had higher density but reduced basal area compared to the late varieties but the economic yield per plant and per unit area of the early varieties are significantly lower than the late varieties.

Conclusion

Primarily the Apatanis practice the sedentary agriculture. Thereby, they have developed a systematic and eco-friendly system of integrated rice with fish culture in a traditional way and millet on the bund. The agriculture of Ziro valley is the primary source of livelihood for the people of landlocked area. The agricultural operations in the valley are completely carried out through human labour. The role of women is predominant in agricultural operation though men folk are involved in activities like construction and repairing of dams, channels and bunds. The Apatani valley revealed the presence of 15 local cultivars. Broadly, they are divided into three caltivars of rice namely *Emo, Mipya* and *Pyaping.* Each caltivar of rice has own different strains. The cultivars are characteristically diverse and they are differing in height of the plant, leaf colour, grain colour and size, drooping of bunch and thorn. The farmers utilized this as a tool to identify the suitable cultivar for a specific land form and agro-ecology. Thus, the Apatanis maintain age old varieties of rice in their system of paddy cultivation since time immemorial.

The common carp is most frequently and successfully cultured fish species mostly with medium and late varieties of cultivars in the paddy field of Ziro valley. The grass carp is not favoured by the farmers as it damages the standing crops when they are grown up in the rice field. Fish nurseries are made available from both the private and government fish nursery ponds to the local farmers in order to culture in paddy fields. Thus, the farmers culture all other fish species in their fish ponds only which are economically beneficial to them. Of these, some farmers culture two batches of fish in a crop season where there is regular water supply and free from soil erosion and flood zone. However, most of the farmers rear single batch of fish especially the common carp from April to August during entire crop season in Ziro valley of Arunachal Pradesh.

References

1. Ali AB. Rice agro ecosystem and the maintenance of biodiversity Agriculture Publishing House, Beijing, 1998, 25.
2. Haimendorf CVF. The Apatanis and their Neighbours, Free press of Geeycoc, New York, 1962, 92.
3. Dollo M, Samal PK, Sundriyal RC, Kumar K. Environmentally Sustainable Traditional Natural Resources Management and Conservation of Ziro Valley, Arunachal Himalaya, India, Journal of American Science. 2009; 5(5):41-52.
4. Nimachow G, Rawat JS, Dai O, Loder T. A Sustainable mountain paddy-fish farming of the Apatani tribes of Arunachal Pradesh, India. Research & Farming Techniques, 2010, xv(12).
5. Sakia SK, Das DN. Aji gnui assonii- A Practice of Organic hill farming among the Apatani tribe of Eastern Himalaya. International Journal of sustainable development world ecology, 2004; 11:211-217.
6. Coche AG. Fish-Culture in Rice-Field. A world wide synthesis, Hydrobiol 1967; 30(1):1-44.
7. Li K. Rice-fish culture in China: A Review. Aqusculture 1988; 712:172-186.
8. Sakia SK. Diversity of Periphyton with Emphasis on feeding Ecology of fish in rice-fish culture syatem of Apatani Plateau, Arunachal Pradesh; unpublished Ph.D thesis R.G.U; Itanagar, 2005.
9. Ramakrishnan PS. Apatani wet rice cultivation: an example of a highly evolved traditional agro ecosystem. J.N.U., New Delhi, 2003.
10. Xu Y, Guo Y. Rice-Fish Farming System Research in China. In: Rice-Fish research & development in Asia (Eds. C.R. De, La Cruz., Lightfoot, B.A. Costa Pierce, V.R. Caranga & M.P. Bimbao) ICLARM conference proceedings 1992; 24:315-324.