INDIGENOUS ORGANIC FARMING OF PADDY BY APATANIS IN ARUNACHAL PRADESH, NORTH EAST INDIA: A WAY OF LIFE

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Abatract

Primarily the Apatani economy is agrarian in nature. They practice the sedentary agriculture from time immemorial. Thereby, they have developed a systematic and eco-friendly system of integrated paddy-cum-fish culture and millet on the bund/dyke in their agriculture. The agriculture is the primary source of livelihood for the people of landlocked area. The whole economy, social, cultural and rituals are revolving round the rice cultivation of Apatanis for good harvest of crops. The agricultural operations in the valley are completely carried out through human labour. Loss of soil nutrients from the paddy field is being added by recycling crop residues and use of organic waste of the village. The farmers cultivate varieties of cultivars and its strains which have diverse characteristics of its own. The use of tractor, power tiller and animal energy in agriculture of Apatanis is far off distance. The continuous use of this technique in agriculture indicates its sustainability and efficiency. This paper has made a study on the indigenous way of organic farming of different paddy varieties with the help of fields' survey and primary source of data.

Key words: Sustainable, Sedentary, Cultivar, Strain, Paddy-cum-Fish Culture, Pisciculture, Organic, Multipurpose, Ecosystem, Indigenous, Integration, Tradition, Socio-economic, Implement, Recycle.

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Introduction

The Ziro valley is also known as Apatani valley under the Sub-Himalayas climatic zone. The valley is occupying a stretch of about 26 km^2 in the central part of the district. The Ziro valley 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^o C to minimum of 1.1^o 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). The major rivers of valley includes Khree, Panior, Kime, Ranga and Pange. The neighbours of Apatani valley are Nyishi and Hill Miri tribes.

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. The Apatanis occupy land at an altitudinal range of about 1000 to 1600 meters but terrace cultivation is most intense around 1300m to 1500m (Schaliha, S and Kant, P. 2011). The Ziro valley, of the Lower subansiri district of Arunachal Pradesh, having mountainous soil with high water holding capacity, is suitable for paddy cultivation. Despite the people of Ziro valley settling in different villages they strongly maintain their social relation, economically inter-dependence and similar culture. They are basically depending on agriculture and the human labour is the only factor used in the production process.

The north eastern part of India is perhaps the most rice biodiversity rich region in the world. The estimated diversity of rice found in the entire region is about 9650 (Mao et. al, 2009). The state of Arunachal Pradesh itself yielded around 616 germplasm collections of rice from 1987 to 2002 (Hore, 2005). The Apatanis tribe grows a wide variety of paddy in very small land holdings. 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). This tribe grows paddy varieties of unique grain characteristic, nutrition requirement, duration, productivity and resistance to disease and

insect pests in highly evolved wet paddy cultivation coupled with pisciculture. Wet land rice cultivation in Ziro valley is practiced in broad and well leveled terraces with strong bunds in which the hill streams are trapped, channelized and diverted into primary, secondary and tertiary networks to provide water in the terraces. Water from one terrace reaches another through bamboo or wooden pipes. Fish pits in the plots ensure water remains for pisciculture even when the field is drained off especially in the flowering and grain maturity stage.

A unique land and water resource utilization system 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. These fields are supported by strong bunds for preventing leakage of water and retaining it to the desired depth. 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.

This variety of fish culture in paddy fields such as common carp, kuri mass, grass carp; silver carp etc 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.

Soil Management

Soil the store house of the plant nutrients, has a substantial impact on plant growth and its sustainability for agricultural production in the long run. The efficient nutrient management is the key to increase the rice production in backward state of Arunachal Pradesh where cent percent of tribal population consume rice alone. Thus, the overall strategy for increasing rice production and sustaining them at a high level include an integrated approach towards management of soil fertility along with other complimentary measures like sufficient storage of water, proper provision for outlet and inlet of water from one paddy field to other paddy field and clearing of unwanted weeds during the growing stage of paddy.

The use of domestic waste products as manures in agriculture is predominant in the state. The application of modern techniques and farm machineries like tractor in their agriculture field is low as most of the cultivable land are in hilly terrains and the size of paddy fields are small. They are not using the chemical fertilizers, pesticides and weedicide 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.

Field Management

The Apatani tribe possesses unique terrace paddy fields in which they cultivate paddy along with

fish which is known as “Ajii-nguii-Assoni” or rice-fish culture. The recycling of the agricultural wastes is the age old process of nutrient management of their wet paddy fields. The left out straw and stump are allowed to decompose in the paddy field itself and later these are mixed completely into soil during the field preparation for sowing of the paddy sapling. This practically recycles the nutrients from the stubbles, straw and stocked weeds into soil in every crop cycle. Moreover, during the fallow period cattle are freely allowed to graze in the paddy fields that facilitate recycling of the other nutrients and cow dung in the paddy fields. The integrated nutrient management includes organic resources like crop residue, compost, animal wastes. This green manure is the key to higher crop production and achieving sustainability of agriculture in Ziro valley.

Straw are burned in the Paddy fields

The Apatanis categorize their agricultural fields as soft fields (zebi aji) and hard fields (aller aji). The area under hard fields is more than the soft fields. The soft field agriculture is negligible in Ziro valley. Generally, in soft fields the pyaping (oryza sativa) variety of paddy is grown. On the other hand, in hard fields different traditional species of oryza paddy such as empu emo, mipya, layi, missang emo etc and also pyaping are grown in the paddy-fish system. They mostly cultivate empu emo followed by mipya, pyaping and layi etc varieties of paddy are indigenous in nature. The Mipya, an early variety is harvested in the last part of July and early August whereas Emo, pyaping and others are the late varieties normally harvested in the last part of October and early November. Farmers mostly cultivate Emo, followed by Mipya and Pyaping, etc. varieties respectively. The low yielding varieties get less share of the tribal land (Pulamte, 2008). Thus, the area under Amo (Emo) covered 68 per cent of the fields with an average yield of 5.2 t/ha whereas the varieties like pyaping with an average yield of 4.0 t/ha and pyate with average yields

of 3.2 t/ha, covered 15 per cent and 10 per cent of paddy fields in the Apatani villages (Pulamte, 2008). The fish culture is usually done here synchronizing with late ripening rice variety and its production is substantial.

The residential areas of villages are located at a higher elevation and all the suitable surrounding areas are cultivated for their paddy fields. The plot which is not suitable for rice cultivation is being used for kitchen garden, horticultural activities and bamboo garden. The waste water that flow out from the village is also directed to the nearby paddy fields as a source of outlet and become the inlet for paddy fields. Such paddy field becomes fertile. Therefore, certain indigenous knowledge and practices for soil fertility management are still being in fashion among the farmers. The incorporation of those with modern agricultural practices holds a promise of sustaining the dualistic pattern of agricultural practices in the valley.

The common carp are usually grown without supplementary feeding in rice field by the Apatanis. The cultured fish is allowed to access the whole rice field as their grazing ground. It is, therefore, essential to raise the water level above the trenches of rice fields. The paddy fields which do not have trenches, water level is maintained at 4 to 5 inches above the ground or field level depending upon the growth of paddy and size of fish. Thus, during the entire cropping season the water level is maintained in such a way that neither the flooded water damaged the standing crop nor the available cultured fish are easily flown away by unwanted flooded water during torrential rainy season.

Thus, the participation of farmers in the cropping season increases substantially and hence the production of fish from paddy fields is higher in Ziro valley. The increased production of fish has resulted in increase in its share of contribution to the household income. Apart from the naturally available channa spp (tali ngiyi), Puntius spp (papi ngiyi) fish species in paddy fields, other varieties of fishes like schizothorax spp (ngilyang ngiyi), Eels (tabu ngiyi), nemaucheilus (ribu ngiyi), dorikona or weed fish (ngiyi papi) are also found in the river (kiley). However, the natural availability of these fishes are diminishing with the passage of time in the valley and the farmers are more dependent on cultured fish for their family consumption as well as family income.

There are various approaches of integrated farming system in state agriculture, of which the rice-fish integration is believed to be the most important and economically viable in Ziro valley. It helps not only for optimum utilization of available land and water resources but also for minimizing the risk element associated with single paddy crop in a year. Thus, integrated farming gives the provision for higher income to the farmers in terms of rice and fish production than the single crop farmers. This occurs primarily because of the natural compatibility between rice and fish in a managed ecosystem in their agriculture. Thus, the natural congregation of fish in rice fields often stimulates the farmers for rearing of fish in their rice field with the idea of having more economic resource utilization and productivity from limited land.

Irrigation

The good rainfall is boon to the farmers with the insufficient supply of river water to the paddy fields. The water from side mountain streams and springs are tapped and channeled into the paddy fields through a net work of primary, secondary and tertiary irrigations. This water flow start at the rim of the valley and canalized to paddy fields through cooperative efforts of the beneficiaries. The water is allowed to enter into the paddy fields through the bamboo, wood like pine (piisa) and castapnopsis sp (kiira) pipe. However, these pipes are slowly replaced by plastic and iron pipe by the farmers as it gives more longevity and durability which are readily available in the market.

In terrace type of agriculture, water is allowed from tertiary irrigation through the ditch into paddy fields by manually opening and blocking mechanism as per requirement. The water flows down from one paddy field to another paddy field through the series of network channels. Thus, the outlet of one paddy field functions as the inlet for the paddy fields of lower level. The available running water of the irrigation is equally distributed and benefitted to all the paddy fields in one after another. During the rainy season the amount of excess water is drained out into another plot based on the angle of placement of inlet or outlet system on the dyke of the plots. This also serves as a good source of nutrient to paddy field through irrigation water as outer part or layer of soil flow over from one field to another paddy field.

The long multipurpose trenches are also dug out in the paddy fields after the harvest of paddy in

Ziro valley agricultural system. This trench is prepared either vertically or horizontally and even in L-shape along the middle or near middle of the paddy field. This trench is repaired in every one or two years. Sometime the farmer dig new trench by abandoning the old one for facilitating its effectiveness of draining out of water from the paddy fields. It is used as the main source of water outlet from the paddy field at the time of weeding, flooding and also before the harvest of paddy. Moreover, this also provides a comfort zone for the cultured fish during weeding and also at the time of low water level in the paddy field.

However, the plain and terrace type of paddy fields in other districts have low level and small size of bund. They commonly use ditch for the transportation of water from one paddy field to other paddy fields. In these types of paddy field, the outlet and inlet of water from one field to another paddy field is not effective during heavy rain and flood. Thus, such types of paddy field are more prone to damage the standing crop and fish culture. Therefore, the agriculture is not suitable for fish culture along with paddy in other districts.

More or less the agriculture of Arunachal Pradesh is rain fed and rely on rain God. The nature of agriculture is terrace type and most of these paddy fields are cultivated either in corner or in between two corners of the valley. The source of irrigation water for paddy field is negligible in most of the districts.

Rice

Rice a staple food for the tribal people of Arunachal Pradesh in general and Apatani people in particular is consumed as their main food. The Ziro valley has own varieties of paddy that are cultivated with its variation in maturity duration and yield rates depending on the condition, type and fertility of soil. It is the dominant cereal crop cultivated in jhum as well as wet agricultural paddy fields in Arunachal Pradesh. Rice is grown by mankind as a source of livelihood from time immemorial. It is difficult to trace out the evidence regarding the history of beginning of the rice cultivation. The species of rice called oryza sativa is cultivated as an important food crop of the world, which is grown in wide ranges of conditions in different climatic zones (Yoshida, 1981). It is a staple food for more than 50 per cent of the world's population (Fageria & Baligar 2003). Out of the 25 rice species distributed throughout the world including tropical and sub-

tropical regions of Asia, Africa, America and Australia two species are cultivated widely viz., oryza sativa and oryza glaberrima (Veasey et al 2004). Oryza sativa is known worldwide but the cultivation of oryza glaberrima is only confined to West Africa within its area of origin (Linares 2002; Fageria & Baligar 2003). These two species are distinguished by the two major sub-species indica and japonica on the basis of geographical distribution and morpho-physiological variation (Kato et al 1928; Glaszmann 1987). The indica type account for 80 per cent of the cultivated rice areas in the world covering mostly the tropical and sub-tropical areas (Swaminathan 1982; Wu et al 1990). It is the dominant crop in Asia where in many countries, it covers half of the arable land used in agriculture (Centrell & Hettel 2004). Thus oryza sativa varieties are widely cultivated and considered as an important food crop of the tribal people of the Ziro valley.

Water Management

The land used for cultivation of rice is efficiently irrigated through well managed irrigation system since time immemorial. The Apatanis have developed a scientific method of irrigation through indigenous technique with available local materials in the valley. The every stream that flow from the surrounding hills is called borang is tapped soon after it emerges from the forest, canalized at the rim of the valley and diverted by a network of primary, secondary and tertiary channels. In absence of large river, the water from small river or streams is used in such a way that all the fields get equal benefits of irrigation water. In order to share the equal distribution of water, a volume of water is diverted in feeder canal (segang) and then to ducks (huburs) through which each paddy field gets water supply. The feeder canals have branches to feed as many terrace as possible by blocking and opening the connecting ducks. All the diversions leading to the paddy fields ducks are usually made up of wood and bamboo. The terraces are made along the gradient which is connected by using bamboo ducks of small circumference at the higher elevations where water intake is lower. In the lower valley where the volume of water is greater, pine ducks of larger circumference are used. These ducks are made from pine trunks split vertically, hollowed out and then the two parts are put back together. However, these days' big plastic and iron pipe are replacing them as it gives more durability and longevity to the farmers. The maintenance of irrigation is managed through cooperative efforts by all the beneficiaries under the supervision of selected person.

The flow of water from one field to another is maintained through a ditch (mugho) on bund and placed one or more outlet ducks. The ditch is especially for outflow of excess water as well as maintaining the desire depth. The desire level of water is maintained by putting straws or weeds accordingly from time to time. During winter season the irrigation system is thoroughly repaired so that it would last for 5-6 months even if there is a heavy flow of water in the stream due to heavy rains during summer season. Care is also taken so that no rice field gets flooded and damaged. Thus, the whole water management of the Apatanis revolves around three important factors namely mutual distribution of water, prevention of flood and soil erosion.

The trenches are usually dugout after the harvest of paddy from the December month onwards. Initially, these trenches were dugout in order to drain out the water from the paddy field before the time of harvesting as well as to make the paddy field hard where there are swampy areas. Further, it is dugout only in large paddy field with exceptional cases of the small swampy paddy field. The number of trenches that are dugout depend upon the size of rice field and it swampyness of that particular field. However, later these trenches became multi-purpose when the natural fish start appearing in paddy field and there after the farmers start culturing fish in their paddy field. The above Table-1 illustrates the tools and implements that are used in the agriculture of Ziro valley since time immemorial. The continuous use of this technique in agriculture indicates its sustainability and efficiency. The use of tractor, power tiller and animal energy in agriculture of Apatanis is far off distance. Moreover, the agriculture in Ziro valley is terrace type where the transportation of tractor, power tiller and other heavy farm machineries from one to other field is difficult. Thus Apatanis do not plough/till their paddy fields before the transplantation of nursery.

Table-1

Indigenous Farming Implements used by the Apatanis

Sl. No.	Name of Tools & Implements	Description and its Validity
1.	Deepe	Spade is used for ploughing the paddy field since time immemorial.
2.	Yatii	Traditional rain shield used before while working in agricultural

		field which is being replaced by plastic.
3.	Sampia	Wooden tray used for transporting soil from one corner to another corner during the field maintenance.
4.	Kele	Pointed splited bamboo stick or hoe used in weeding.
5.	Huta	A long wooden crowbar used for preparing trenches in field and leveling of nursery bed.
6.	Palii	It is made up of single piece of tin curved and sharpened on middle with a handle for weeding on bunds of agriculture.
7.	Tagi	Sickle for harvesting of paddy, millet, etc.
8.	Damu	Long wooden spike used to make holes for planting grain or nursery in dry field or on bund.
9.	Kedu	Short wooden spike used in making holes during transplantation of nursery in hard paddy field.

The whole agricultural operation is performed with the help of manual labour and few agricultural implements. The principal traditional implement of the Apatani is long handle spade (diipe). Before the arrival of iron spade long handled wooden crowbar (hiita) implement was used to dig the soil. Spade is used for digging as well as for other earth works like leveling, preparing and repairing of bunds, irrigation channels etc. The second important tool is a flat wooden oval shaped tray known as sampia. This is used for carrying the mud from one end of the rice field to another end to level the field. During the time of weeding of bund and horticultural garden a hook like implement made of bamboo shaves known as Pale are used. Kele a small bamboo shaved stick is used to weed the grass and under-growth from the paddy field as well as bund. Sickle (Tagi) is used to harvest the crops. Baskets (yagi) made of cane or bamboo is used for carrying purposes. As no animal energy is used in the agricultural operations, so these implements are very useful to the Apatani farmers for the cultivation of agricultural as well as horticultural garden. Thus, they take a lot of care to maintain them.

Farmers Group for Sustainable Farm Management

The traditional farmer groups of the Apatani have been successfully managing the natural resources in the Ziro valley. They maintain the sustainable production out of the limited

resources available. The Apatanis have different types of traditional farmer groups which evolved over the decades. There are no written records to trace the history of formation and development of these groups. The traditional agro-ecosystems are intricately linked with nature and are well fitted to local environmental conditions for socio-economic and cultural needs of the people of the valley.

These agro-ecosystems are sustainable, self-sufficient and efficient due to the strong organizations and sharing of ecological knowledge such as crop-soil interaction, nutrition management, soil and water conservations among the farmers in the agriculture of Ziro valley. Table-2 illustrates the 8 different types of informal farmer organizations. Each group has their own task and workload as described below. These traditional farmer groups are important for maintaining sustainable production from all the sectors such as agriculture, horticulture and forest activities in the economy of landlocked Apatani valley. All the patang groups are temporary in nature which ceased to exist soon after the completion of task for which it was formed. The groups like bogo, aji lenda and sulu-sikii need financial support particularly for soil erosion control, fencing and drainage maintenance from the government departments. So far these groups are managed by themselves in self help basis through contribution in cash and kind among the members in group as there is no financial assistance from the government for its maintenance. However, some of the bogo/siling of paddy fields received negligible financial assistance from the government for its maintenance of soil erosion area of that particular agriculture.

Table-2

Traditional Farmer Groups and their Nature of Works in the Ziro Valley

Sl. No.	Local Name	Description of the Group	Nature of Works
1.	Bogo/Siling	A farmer group sharing common water sources. The group leader leads all the activities.	Construction and maintenance of irrigation and regulation of water sharing among the group members.

2.	Aji lenda/ Aji doingnii	A group which have fields in the same area. The group leader leads all the activities.	Protect the paddy fields of members from stray animals during paddy growing season.
3.	Sulu-Sikii	A group which have fields in the same region. The any member of the group leads all the activities from time to time.	Construction and maintenance of fencing to protect the paddy fields from animals
4.	Tanser patang	Group organized during paddy field preparation and weeding. It consist of 3 to 8 members.	Paddy field and nursery bed preparation, seed sowing and weeding.
5.	Konchi patang	This group works early in the morning between 5 am to 7.30 am. It consists of 3 to 8 members.	Field preparation, transplantation and weeding.
6.	Halying patang	This group shares labour during nursery transplantation which consist of 3 to 10 members.	Transplantation of nurseries particularly paddy and millet.
7.	Enthee patang	This group forms to share labour during harvesting of paddy which consist of both male and female in equal numbers from 6 to 12 members.	Paddy harvesting and carrying of paddy.
8.	Bijee lenda	A group having bamboo garden at the same location.	Construction and maintenance of foot path for carrying bamboo, timber and fuel wood.

Types of Paddy Fields

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.

Preparation of Nursery Beds (Midding)

After the preparation of nursery bed, the paddy seeds are spread over the nursery bed called midding 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 preparations 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. Then, the farmers take a break for around two weeks in the month of March for the celebration of Myoko festival from the third week of March month till the last week of March.
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.

Cultivation of 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. Rice crop in terraces are infected by folder, rice hispa, gundhi bugs (leptocorisa oratius) and grasshopper. Commonly growing weeds in paddy fields of uplands of North east India are Eichino chloa glabrescens and cyperrus iria (Chanu et al, 2010). Though Apatanis have over centuries innovated different traditional methods to repel pests and weeds from their rice fields, they might find it difficult to control pests only with these methods in the future when climate change induced pest attacks are likely to increase (Rosenzweig et al, 2001).

[Traditional Local Varieties of Paddy cultivation]

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.

The paddy varieties of Apatanis have been reported by different researchers and their account vary greatly (Dabral, 2002; Pulamte, 2008; Dollo et al, 2009; Nimachow et al, 2010) on account both of limited tools at their disposal as also the geographical areas actually explored. The extensive survey of rice growing area of Apatani valley revealed the presence of 15 local cultivars. However, (Dollo et al, 2009) reported 16 landraces grown amongst the Apatani tribe. These are: Ampu Ahare, Ampu Hatte, Radhe Eamo, Eylang Eamo, Ampu Puloo Hatte, Kagii Pyate, Zeehe Pyate, Pyate Pyapu, Tepe Pyaping, Pyapu Pyaping, Kogii Pyaping, Zeehe Pyaping, Pyare Mipya, Mishang Mipya, Mithu Mipya and Eylang Mipya (Dollo et al, 2009). Four varieties have been reported by (Nimachow et al, 2010) locally known as Ampo, Mipya, Layi and Misang Amo. Misang Amo variety originally belongs to the neighbouring Nyishi tribe and not cultivated widely by the Apatanis. Mipya, an early variety is harvested in the early part of July whereas Ampo being a late maturing variety is harvested in the month of October Nimachow, 2010). 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.

Table-3 illustrates the different categories of indigenous rice and its characteristics. These are the varieties of landraces of rice which are cultivated in Ziro valley. 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.

Table-3

Classification of Indigenous Rice (oryzae sativa) Varieties of Ziro Valley

Sl. No.		Land races & Strains	Duration (Days)	Cultivation	Characteristics
1.	**Emo**				
	a.	Empu Ahre	Early variety (240-250)	moderately cultivated	Breakable, dropping, short high, thin bunch.
	b.	Empu emo/ Ahre-haso ponko	Medium variety (240-260)	Commonly cultivated	Long tail/bunch, easily breakable.
	c.	Empu hath	Late variety (250-270)	moderately cultivated	Not breakable, short high, thick bunch and most productive rice.
	d.	Radhe Emo	Late variety (250-270)	Rarely cultivated	Red thorn, short high, thick bunch and soft rice.
	e.	Eylang Emo	Late variety (250-270)	Rarely cultivated	Red rice, taste, not breakable, short high and thick bunch.
	f.	Halyang Emo	Late variety (255-275)	Rarely cultivated	Short high, white rice, no thorn, breakable bunch.

2.	**Mipya**				
	a.	Kogea mipya	Early variety (180-210)	Rarely cultivated	Long bunch, black thorn, big rice
	b.	Zeehe mipya	Early variety (180-210)	Rarely cultivated	Black colour, no thorn
	c.	Pyate mipya	Early variety (180-210)	Rarely cultivated	Black colour, no thorn
	d.	Pyare mipya	Fastest ripening variety (180-200)	Rarely cultivated	White rice with thorn
3.	**Pyaping**				
	a.	Tepe pyaping	Medium variety (225-240)	moderately cultivated	Long tail, mixture of black & white colour, no thorn
	b.	Pyapu pyaping	Medium variety but faster than tepe pyaping (225-240)	Commonly cultivated	Long tail, no thorn, white colour, medium bunch, breakable.
	c.	Zeehe pyaping	Medium variety & similar to pyapu pyaping (225-240)	Rarely cultivated	Black in colour, no thorn, medium bunch
	d.	Mishang pyaping	Medium variety (225-240)	Moderately cultivated	No thorn, medium bunch
	E.	Itu paying	Medium variety (225-240)	Rarely cultivated	No thorn, short tail, heavy bunch

Mipya rice is the fastest ripening variety of strain which is usually cultivated in the periphery of village but the area under mipya cultivation is decreasing with the increased cultivation of Emo

and pyaping rice cultivars. Mipya cultivar is again sub-divided into kogea mipya, zeehe mipya, pyate mipya and pyare mipya. Each of these has its own characteristics such as early variety, thorn type, colour, bunch and its size. Pyare mipya strain is the fastest ripening variety of rice among the mipya strains. Pyaping cultivar is the medium variety of rice. It ripes between Emo and Mipya rice cultivars. The most common characteristics of pyaping rice are absence of thorn.

It is evident from the survey that the Apatani is having high rice diversity with 15 indigenous land races which differ in high, grain characteristic, nutrition requirement, duration, productivity and resistance to diseases from insects and pests. Out of these local cultivars Empu Emo/Empu Ahre-Haso ponko, Empu Ahre, Tepe paying and Pyapu paying are most dominant crops as per farmers choice. Again, strain like Halyang emo and all types of Mipya strains are rarely cultivated which cultivation is almost vanished in the Ziro valley. Ampu Pullo Hatte a late variety is not grown any more (Dollo et al, 2009). It is also found that Mipya is a low yielding variety and not preferred much by the farmers who give more emphasis on other varieties for higher productivity and quality (Nimachow & Coworkers, 2010).

Further, the duration of rice crops for all types vary from 180 days to 275 days with an average of 225 days. Pyapu paying strain is preferred mostly by the farmers because of its high yielding and capacity to sustain in the marshy and low fertile paddy field. Normally, the Emo land races are cultivated in medium fertile soil while Mipya varieties are preferred in high fertile paddy field. The yield of Emo, Mipya and Pyaping is however dependent on the management of nutrient flow from the villages and recycling of crop residues according to their growth requirement. The farmers understanding regarding soil fertility and its suitability for cultivation of a particular crop is equally important to maintain the productivity of crop

The above 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 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. 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

These paddy varieties are maintained and preserved by the tribal cultivators who grow their own special varieties that they have inherited from their forefathers and the rich genetic diversity of rice is thus passed on from one generation to the next. There are various approaches of integrated farming system in state agriculture, of which the rice-fish integration is believed to be the most important and economically viable in Ziro valley. It helps not only for optimum utilization of available land and water resources but also for minimizing the risk element associated with single paddy crop in a year. The Ziro valley has own varieties of paddy that are cultivated with its variation in maturity duration and yield rates depending on the condition, type and fertility of soil. These agro-ecosystems are sustainable, self-sufficient and efficient due to the strong organizations and sharing of ecological knowledge such as crop-soil interaction, nutrition management, soil and water conservations among the farmers in the agriculture of Ziro valley.

It is found that the high rice diversity with 15 indigenous land races which differ in high, grain characteristic, nutrition requirement, duration, productivity and resistance to diseases from insects and pests. Out of these local cultivars Empu Emo/Empu Ahre-Haso ponko, Empu Ahre,

Tepe paying and Pyapu paying are most dominant crops as per farmers choice. Again, strain like Halyang emo and all types of Mipya strains are rarely cultivated which cultivation is almost vanished in the Ziro valley. Further, the farmers of Ziro valley simultaneously cultivate rice in the paddy field and millet on the bunds. Thus, the farmers harvest two crops in a season and net return of profit is higher in case of Ziro valley farmers.

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