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Integrated Paddy, Fish and Finger Millets Cultivation by Apatani Tribes in the Eastern Himalayan Region- Arunachal Pradesh

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ABSTRACT

A system of integrated Paddy fish and finger millets (IPFFM) farming along with practices of agriculture ritual by worshiping the Mother Earth, Rain and Sky to shower blessing upon standing crops and vegetable in Agriculture field, with colorful celebration wearing tradition attire and sacrificing livestock to please the God of agriculture for bumper harvest is a unique feature practiced by Apatani agrarian. The farmers enjoy fish production, two harvests a year without providing any supplementary feed to fish stocked in the paddy-fields along with harvest of finger millets and paddy as a primary agriculture produce. Thus protein from fish and carbohydrate from rice and millets, thereby, providing nutritionally balanced agriculture produce from same plot, generation after generation, maintaining the production and productivity of three components at constant level, with biofertilizer from livestock-poultry dropping and waste byproducts recycle of agriculture and horticulture produce, without use of chemical fertilizer. The present integrated Paddy fish finger millets (IPFFM) farming practices followed by Apatani farmers are ecofriendly, without much manipulations of natural environment which may led to climate change.. So IPFFM farming can be consider as remunerative and sustainable integrated farming model for replication in similar climatic and topographical geographical location of other parts of India and the world.

1. Introduction

Agriculture is considered as next to panacea for farming community of rural area, especially for indigenous tribes of North-East India. Apatani is one of the most primitive tribes of Arunachal Pradesh, concentrated in a hilly plateau of Lower Subansiri district called 'Apatani Plateau' located at 27º30´-27º40´N latitude and 93º57´ and 94º12´E longitude and mean sea level of 5000 ft . Rice being the staple food of Apatanis, paddy cultivation of settled type agriculture is practiced, in which fish and finger millets are integrated for higher economic return and judicious utilization of land pattern system. Apatanis are very laborious and hardworking in nature, men, women and even children take part in agricultural activities; men are engaged in making bund, maintenance of common irrigation canal and fencing to protect the paddy field from crop raid by Mithun (*Bos frontalis*) and cattle, while women and children mostly engaged in transplantation of paddy saplings and weeding. In the recent era of indiscriminate fertilizer use for higher production, it is astonishing to know that without much technical intervention and any chemical application, the Apatanis are practicing integrated farming system of Paddy-Fish-Finger Millets (PFFM) from ages, sustainably maintaining the production and productivity of three components at constant level since from forefather. The system of rice fish is being practiced in Bangladesh, Cambodia, China (1.2 million ha), Egypt (173000 ha), Indonesia (138,000 ha), Republic of Korea, Madagascar (13,000 ha), Thailand (3 million ha) and Vietnam (40,000 ha) (Halwart 1998).

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Similarly (Schuster 1955) reported that fish culture in rice fields offer one of the best means of "contemporaneous production of grain and animal protein on the same piece of land" and is one of the most ideal methods of land use. However, information is scanty in India on the unique integrate Paddy-Fish-Finger Millets (IPFFM) farming system. Keeping this in view, the present study was undertaken to explore and document this unique IFS model of integrated paddy-fish-finger millets (IPFFM) practiced by Apatani tribes of eastern Himalaya (Arunachal Pradesh of North-East India).

2. Materials and Methods

The present study was carried out at Hong and Siro village of Apatani Plateau during 2013 to 2014, evaluating one complete cycle of (IPFFM) farming system. Fifty (50) farmers were randomly selected representing heterogeneous group of farmer *viz.* Gaon Bura, priests, men, women and youth, considering twenty five farmers as a sample representative of each villages, right from starting of land preparation to harvest of paddy, fish and finger millets. The management system were keenly explored and documented by visit to farmers field once a month with personal interview method by using a uniformly standardize questionnaires and through focused group discussion on different management aspect of paddy, fish and finger millets productions. Agriculture related rituals practices and their objective of performing such practices, information were gathered from the respective village priest.

3. Results and Discussion

A unique integrated paddy fish finger millets (IPFFM) agriculture practices by Apatani tribes are unequivocally appreciated not only from the corners of Arunachal Pradesh but also from outside state and foreign country. It is one of the factors that makes Apatani plateau a potent world heritage site. There are three major local varieties of paddy (Table 1.), *viz.* Mipya, Amho and Papying. Few sub-varieties within the major varieties are cultivated of which, some sub-varieties are not cultivated these at present, due to early harvest season, such varieties are very prone to vertebrates pest (birds & rats) attack and unlike olden days care taker of paddy field are not available in present days as a result, early harvest paddy varieties are not prepared by farmers considering extra labour involved in guarding vertebrate pests. The practices of IPFFM start with the canal preparation in the month of November to December as depicted in activities calendar (Table 2), in order to drain out water and make the plot dry till it cracks. This is done to check the pest attack on paddy sapling. It is noted that if the paddy field is kept wet after harvesting till the next transplanting season, maggot develops on the roots of newly transplanted paddy sapling and starts dying, the maggot attract crow, as a result the paddy sapling are plucked out by crows to eat the maggot and this phenomenon is locally called as Poha Lindu (crow comes) in Apatani. Presence of canal in paddy field keep the plot dry preventing such incidence beside facilitating fish rearing and effective water management system. The continuous supply of water in paddy field is managed by diverting streams originating in the forest into a single canal to which each field is connected with bamboo or pinewood pipe (Dollo et al. 2009). The canal are dug measuring 1.5 to 2 feet depth, across the paddy fields dividing the plot either perpendicularly or horizontally along the bund (Agar), the number of canal, depth and length depend upon size of plot. Ultimately different canal merges into the main canal from where main outlet points (pipe) made of bamboo is fixed on the lowest point of canal across the bund to drain out the water completely (Figure 1). The canals provide the rearing space for fishes and shelter during the harsh condition or whenever water level of paddy field falls beyond the movement of fish in general area. It is noted that for effective water management system paddy fields has two outlets and one inlet (Figure 2). One outlet is used to divert overflow of water, barricaded with split bamboo net to prevent the escape of fish from paddy field, while the other remains at the bottom in main canal is meant for complete drainage of water during harvesting of fish and before harvesting of paddy to make the field dry for convenient movement of worker during harvesting time. In the month of November to January manuring of paddy plot is carried out (Figure 3) using organic fertilizer from animal waste product such as poultry droppings (Paro Pai), pig excreta (Alyi Ekha) and cow dung (Shee Ekha). Other sources of organic fertilizer are such as rice husks (Pinang), waste product of local beer (Ooh Poi), ashes from household fire wood burned remains (Mubu), burnt straws ashes (Muyu) after the harvest is over (Figure 4) and compost fertilizer such as decomposed straws (Lissi) and weeds (Tamii). Naturally Azolla and lemna grows because of their favorable condition for growth which aid in fixing nitrogen to paddy field. Thus manuring help in enhancing soil fertility thereby maintaining crop productivity at constant levels, as well as raw material for fish feeds. Similar finding was observed that, the plot utilize for rice cum fish culture is mainly based on organic fertilizations with a variety of animal excreta such as poultry dropping, wastes of plant husks, ashes from household burnt and remain of burnt straws after the harvest is over (Reena and Nani 2014).

Table 1. Local paddy varieties of Apatani

Sl. No	Rice variety	Characteristic	Harvesting time
01	Papying		
	a. DulleyPapying	Yellow rice husk	September
	b. Papying Phakhe	Black rice husk	September
02	Mipya		
	I. Pyate Mipya		
	a. Pyate Paphyu	Yellow rice husk	August (Lost)
	b. Pyate Phake	Yellow rice husk	August (Lost)
	II. Phulu Mipya	White rice	July
	III. Phare Mipya	Yellow rice husk	July (Lost)
03	Amho		
	I. Radhe Amho	Yellow rice husk	October
	II. Tanii Amho		
	a. Ampu Amho	Off white rice husk	October
	b. Alang Amho	Red rice, very hard	August (Lost)
	III. Arehe Amho	Yellow rice husk	July (Lost)
	IV. Ankhee Amho	Black rice husk, rice white	August (Lost)

Source: survey data 2013-14

During January to February bunds (Agar) were repaired where ever crake were noticed or weak point is observed which may not be able to withstand the pressure of water during the peak period of rainy season. Unlike other wet rice cultivation (WRC) practices, Apatanis makes a very strong bund (Figure 5) with the intention to rear fish along with paddy cultivation and along the bunds finger millets were cultivated, which aid in soil conservation of bund and help to prevent the erosion of bund during torrential rain and to withstand pressure from water logging in paddy field. At the same time ploughing of paddy field is done and land were made even by distributing the soil in different direction of paddy field of same plot, using equipment locally called Sampya (a flatten wood were soil are loaded and at one end tied with rope to pull). Unlike other farmers Apatanis never use cattle or other livestock for ploughing purpose they plough the field manually with the help of spade and break the soil with legs by marching till it become fine enough to make a liquid past and distribute the soil evenly with the help of legs by splashing the soil thereby moving the legs in semi-circle manner clock wise and anti-clock wise direction till the surface of land is made even. It has been observed that farmer ear mark a particular field for nursery which is maintains throughout the entire year for that purpose only, the plot is filled with water throughout the year and weeding is done on monthly basis. After preparation of land, the nursery bed were slightly elevated with the help of wood or bamboo which is further divided into two-three different compartment so that excess water is drain out through the depression present between each compartment.

Two indigenous paddy varieties locally called Mipya and Amho are sown (Andhi Lilo) in month of mid-February to March first week after preparation of nursery bed (Figure 6). It is assured that nursery bed should not be too dry or wet during the sowing till germination of seed to ensure greater percentage of germinations. Transplantations of paddy sapling start from April to May first week (Figure 7), when saplings attend a height of 12 cm. The sapling were plucked from the nursery bed and made into bunch by tying with weeds locally called (Mima) till they are ready for transplant in prepared paddy plots. Transplantation is done manually by hand, one sapling at a time maintaining a distance of 5-7 cm in length and breadth wise thereby, progressing forwards till the plot is completed. First weeding (Tamii Hodu) is done in the month of May (Figure 8), and re-transplantation (Andhi Lithidu) of paddy saplings is carried out selectively, for died or vacant spot. There after weeding is done once in every two month from June to August till paddy attends milking stage. By the end of September the paddy becomes mature for harvest and harvesting continued till 3rd week of October (Figure 9). Harvesting of paddy by Apatanis is one of the most interesting part of entire paddy cultivation activities, women cut the paddy with sickle in the middle of stalk after grasping on paddy stalk by left hand and continue till she grips a handful of cut paddy, then she hand over to man standing behind her, carrying a basket made up of bamboo and wood plate hanged inside the basket. The man thrash the paddy in the basket there itself by hitting on wood plate and grain are collected in basket. When grains fill half of the basket, it is emptied to a common collection centre in large mat locally called Pere.

Figure 1. Canal Preparations

Figure 2. Out let pipe made of wooden material

Figure 3. Manuring

Figure 4. Burning Straw

Figure 5. Bund Making

Figure 6. Paddy Nursery

Figure 7. Paddy transplantation

Figure 8. Weeding

Figure 9. Bumper harvest

Figure 10. Transferring the harvest to granary

Figure 11. Harvesting of first batch fish

Figure 12. Farmer selling fish in road side Market.

Figure 13. Millets transplantation

Figure 14. Finger millets at milking stage

Figure 15. Dree celebration for bumper harvest

Figure 16. Priest chanting at Dree celebration

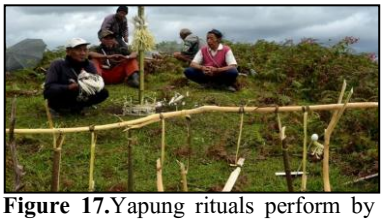

Figure 17. Yapung rituals perform by priest

Figure 18. Tamu padu

In evening the collected grains are transferred from pere to granary (Figure 10) locally called Nesu. It is interesting to note that, the granary (Nesu) are constructed 50-100 meter away from human dwelling, to avoid fire incidence, when fire out breaks in the village, as villagers house are generally made of bamboo and wood, which is very prone to fire mishap. Apatani grow all the strains of Common carp (*Cyprinus carpio*) *viz.* Mirror carp (*Cyprinus carpiospecularis),* Scale carp (*C. carpiocommunis),* leather carp (*C. carpionudus)*. It is noted that some progressive farmer rear fingerling in two batches *viz.* in the month of January/February and April/May as shown in (Table 3.). First batch that were released in paddy field on January/February were harvest in the month of April/May before transplantation of paddy sapling and second batch of fingerlings are released in the month of April/May after one week of transplantation of paddy saplings, in this way two batches of fish can be reared and harvest in a year from same plot of paddy field. Fingerlings those released in the month of January/February just after completion of making bund and levelling of paddy fields are harvest on May/June by then they attain avg. 195 gram/fish (Figure 11), and if harvested late in the month of August or September they attend Avg. 635 gram/fish. Second batch of fingerling released in the month of April/May were harvested in the month of July/August by then fish attend a weight of avg. 250 to 280 gram/fish. It has been observed that fish grow faster when released in the month of April/May than fish released in the month of January/ February. It is also assumed that availability of feed source from paddy pest which fall on the water and the conducive environment for growth of phytoplankton and zooplankton aid in gaining weight, as a result the body weight gain of later batch is better compared to former batch. Similarly, it was found that rice-field water in Arunachal Pradesh showed conducive environment for planktonic organisms that practically escalate the production potential of fish species stocked in the field (Das et al. 2007). Further they have reported that the Common carp (*Cyprinus carpio* L.) stocked in the rice-fields of Apatani Plateau feeds mainly on periphyton colonized on underwater part of the rice-stem. The fish displays opportunistic behaviour rendering its planktivorous nature to periphytophagus nature in these rice-fields and self-subtrating periphyton based aquaculture(SSPBA) system for the role played by rice plant as a surface for periphyton growth (Saikia and Das 2008). The available amount of fish after keeping for home consumption are sold in market (Figure 12) Apatani cultivate two varieties of finger millets locally called Mipu Sarsee and Rube Sarsee. The finger millets nursery preparation starts early in the month of May and consequently seeds are sown seen in Table 4. Transplantation of millets sapling are carried out in the month of April/May manually by dibbling method with the help of dibbler, made up of locally available wood and one sapling in each hole is planted (Figure 13).

Table 2. Activities calendar of Paddy field management

Sl.No	Month	Activities	Local name
01	November-December	Chanel's	Hattar
02	December –January	Manuring of paddy field with,	Abu akhebadu
		a) Poultry droppings b) Pig excreta c) Cow dung d) Rice husk e) Local beer waste product f) Ashes from household fire wood burn product g) Ashes from burn straw h) Decompose straw and weeds	a) Paropaii b) Alyiekha c) Sheeekha d) Pinang e) Ooh poi f) Mubu g) Muyu h) Lissi&tamiiyanii
03	January- February	Bund	Agar
04	February mid to March first week	Sowing	AndhiLilo
05	April to May first week	Transplanting	Andhi Ali
06	May	Weeding & re-transplant	Tami Hodu&AndhiLithidu
07	June to August	Weeding once a month	Tami Hodu
08	September last week to October 3rd week	Harvesting	AnteeDandu

Source: survey data 2013-14

Weeding is done in the month of June/July before millets attend milking stage (Figure 14), and harvest on the month of August/September by cutting at the neck of finger millets with the help of sickle. It is known that finger millets play a very important role in soil conservation of bund in addition to its food value. It is observed that bunds are more prone to crake due to excessive heating of sun, if finger millets are not grown on the bunds, as result bunds are not able to withstand the stored water for rearing fish and slogs off. Apatani tribes use millets for two purpose i.e. Preparation of wine and as a food after grinding the millets, it is used as millets flour ready to eat after mixing in hot water. Four major Agriculture rituals associated with Apatani agrarian for bumper harvest of Agri and allied field crops are shown in Table 5. Kide Midu: It is pray to mother earth by offering chicks and eggs for protection against pest and other soil born diseases, so that plant and vegetables grow healthy for better harvest. It is done with accordance to the date of samapidu (inauguration of Myko celebration) on the month of march every year. After performing rituals, for subsequent three days entry on paddy fields and vegetable gardens are strictly prohibited and violator were penalized and it is assume that the agriculture produce of the culprit will be affected by bad omen. Dree Sodu: It is commonly celebrated by Apatani community on 5th July of every year wearing colour full traditional attire (Figure 15), but Hong village (Asia second largest village) celebrate the event separately from rest of Apatani community on same date. It is celebrated to please the God by sacrificing Mithun, cow, goat, chicken and eggs for bumper harvest of paddy and other agriculture produce. Priest chant to almighty God of agriculture to kill all pests, subside other diseases and also to shower rain and wash away the pest and other disease along with rain which destroy the agriculture produce (Figure 16).

Entry in paddy field is prohibited for 7 days and vegetable garden and forest for 3 days. Priest advice the people of Apatani community not to enter in Agri and allied plot for the specified period of days, so that the God of agriculture will be pleased by the act of Apatani agrarian and thereby, He will prevent and control the agriculture pests and other diseases effectively. Yapung Mudu: It is a worship to mother sky not to bring torrential rain, hail stone and to mitigate thundering during the peak period of agriculture fruit bearing stage, before the harvest of paddy because often torrential rain along with hail stone destroys the standing crop and vegetable adding misery to the farmer hard earn labour round the year (Figure 17). Yapung is performed by every village of Apatani community on different date as per their practices but in Hong Village, Yapung is fixed on 10th September every year and Hong Village Yapung prayer is consider to be the most effective amongst all the yapung performed by Apatani community. So every village of Apatani community respect Hong yapung and customarily, imposed restriction to work on agriculture field, vegetable garden and forest for 3 to 7 days, respectively. It was experienced that whenever someone violates the prohibition entry order in Agri and allied field by priest, thundering starts indicating someone has violated the prohibition order and Mother God of sky is unhappy for the violation. So groups of priest enquire the involvement of violator and impose fine to please the God. Tamu Padu: It is done occasionally, whenever there is any sudden change of climatic factor that leads to adverse effect on agriculture or pest attack to Agri crops. Priest chant to God to stop the adverse condition by offering chicken and egg (Figure 18). After performing rites for subsequent three days, entry on paddy field and vegetable garden is prohibited.

Table 3. Release of fingerling and harvest of fish

Sl.No	Release of fingerling	Fish species	Harvest of fish
01	January – February	1. Mirror carp (*Cyprinus carpiospecularis)* 2. Scale carp (*C. carpiocommunis)* 3. Leather carp (*C. carpionudus)*	May – June
02	April – May	1. Mirror carp (*Cyprinus carpiospecularis)* 2. Scale carp (*. carpiocommunis)* 3. Leather carp (*C. carpionudus)*	July – August

Source: survey data 2013-14

Table 4. Calendar for Millets

Sl. No	Plantation	Weeding	Harvest
01	April	June	August
02	May	July	September

Source: survey data 2013-14

Conclusion

Paddy fish finger millets (PFFM) farming system followed by Apatani tribe in Lower Subansiri district of Arunachal Pradesh is unique by its own, in the way of practicing three components in systematic way, through judicious use of land by taping the potential of every inches of cultivable land by conservation of water along with fish rearing and soil conservation through plantation of finger millets along the bund thereby improving the land use pattern.

Apatani usually practice monocropping pattern in paddy field, however two cropping can be achieved by using early maturing varieties of paddy, then followed by rape seed cultivation by adopting zero tillage package of practices on the same plot, without much use of manpower, would definitely provide extra economic return per unit area of cultivable land and improve the present integrated farming land escape scenario of Apatani valley, in general to promote ecotourism sector of beautiful valley, Ziro. Same model can be promoted in other areas as a possible prototype for integrated farming system.

Table 5. Agriculture ritual perform for bumper harvest

Sl. No	Name of Rituals	Date	Reason	God	Prohibition period
01	Kide Midu	19th March	To prevent the soil born pest attack and other disease of Agri and Allied products.	Pray to Mother earth	3 day
02	Tamu Padu	Any time	Whenever there is unexpected pest attack, disease outbreak that leads to heavy morbidity and mortality of paddy, finger millets and vegetables.	Pray to God of pest and other disease of Agri and Allied field.	5 day
03	Dree Sodu	5th July	Normally celebrated to please the God of Agriculture for bumper harvest of Agriculture and Allied products.	Pray to God of Agriculture in general	7 days wet, 3 days dry
04	Yapug Mudung	10th September	To prohibit torrential rain and hall stone and to mitigate thundering before the harvest of paddy	Pray to God of Sky	3 days

Source: survey data 2013-14

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