

PISCICULTURE AND ITS IMPACTS ON THE LIVELIHOOD OF RURAL FARMERS OF ZIRO VALLEY OF THE EASTERN HIMALAYAN REGION IN ARUNACHAL PRADESH, INDIA**Mr. Dani Kacha**

Assistant Professor of Economics
Govt. College Yachuli
Dist. Lower Subansiri
Arunachal Pradesh

Abstract

The farmers buy the fish nurseries and start culturing in the paddy field either before or after the transplantation of paddy in their rice field. There are many farmers having fish ponds which managed by themselves in every village. They use to harvest full grown fish for their own consumption as well as for market. Moreover, the fingerling and advance fingerling fish nurseries are also harvested from the private and government fish ponds for culturing at their own paddy field and for selling to other farmers for culturing in their paddy field. Thus, fish culture in paddy field helps the farmers for year round employment opportunities which yield additional income to the farmers as some of them engaged by themselves throughout the year in the production of fish nurseries and its management in the Apatani valley. This paper is based on the researcher field survey of 250 sample households from seven traditional villages as well as few secondary datas from the government fishery department to analyse the pisciculture activities and its positive impacts on the livelihood of rural farmers of Ziro valley of the Eastern Himalayan region in Arunachal Pradesh.

Key Words: *Integrated, Pond, Nursery, Pisciculture, Trench, Ziro valley, Paddy-cum-Fish Culture, Ecosystem.*

Introduction

The headquarter of the Lower Subansiri district Ziro is situated at a height of approximately 1524 metres above mean sea level which lies at 26° 50' N- 98° 21' N Latitude and 92° 40' E and 94° 21' E longitude. The district has largest area under permanent agriculture cultivation among all the districts of the State. The Ziro valley is also known as Apatani valley under the Sub-Himalayas climatic zone and it covers an area of 10,135 km². Out of the total wet area of 715.7 hectares, rice-fish culture paddy field covers approximately 592.0 hectares which is surrounded by hills and mountains covered with vegetable gardens, pines, bamboos and other trees. The average rainfall in

Ziro valley is 108.1 cm and temperature ranges from maximum 31.6° C to minimum of 1.1° C. The relative humidity varies from 36.5 per cent to 82.8 per cent. The topography of the area is mountainous valley and the soil type is clayey loamy in nature. The permeability and water retention capacity of the soil is highly conducive for rice-fish culture (Saikia & Das; 2004).

The collection of fish from seas, rivers, streams and other water bodies is also an important traditional economic activity of most of the rural households in all countries. They primarily depend on production of agricultural crops and collection of fish from various water bodies as a single occupation for earning their livelihood. These households practice both the activities for increasing their household income and better living standard. Many cultivating families not only collect fish from their nearby water bodies but also from their paddy fields. Cultivators harvest the wild fish from their low lying crop fields particularly in rainy season. The farmers are having own private fish ponds for their family consumption as well as for producing nurseries to culture in own paddy fields and also to sale in the market for culturing by other farmers in Ziro valley.

In rainy season wild fish migrate to the crop fields from rivers/streams/water bodies through excess water flow and flood. These fish are trapped in the paddy fields and grow there for some months. After rainy season when water dries up in the paddy fields, farmers use to collect them from their crop fields. Thus, cultivators earn considerable revenue by collecting these fish from their crop fields and by selling them in market. In the process, farming families not only meet the domestic fish requirement but also earn sizeable income from their crop fields without investing single pie for fish rearing. With the passage of time farming communities in different areas all over the world try to harvest more fish from their crop fields particularly from their paddy fields which are more conducive/attractive for migration of fish in rainy season. Slowly and gradually, farmers started developing their paddy fields by making proper earthen bunds, drains and systems for draining out excess water from their fields before the crop season starts in order to trap more migrated fish in the crop fields during flood and water run-off.

Now a days, in many parts of India and also in other parts of the World, farmers try to trap wild fish and rear fish seedlings in their low lying crop fields like paddy, jute and other wet crops fields. Thus, cultivation/rearing of fish along with paddy in the same crop field has become a new and innovative practice followed by many farmers for earning more income from the same paddy fields. This unique farming practice is known as “paddy-cum-fish” cultivation. This concurrent growing of rice and fish is otherwise called as rizi-pisciculture or paddy-cum-fish culture. It is considered as the most efficient way of utilizing the limited wet paddy fields since the same land is being used for both paddy cultivation and fish rearing at a time. This system is known to be

originated from China 2000 years ago Li (1988) followed by India 1500 years ago Tamura (1961), Coche, A.G. (1967), Ali (1998). Presently some farmers in countries like China, Indonesia, Australia, Malaysia, Thailand, Japan, Philipines, Madagascar, Italy, Russia and some countries from Europe, North America and South America are practicing the fish culture in their paddy fields. However, in most of these countries farmers' rice-fish farming is not deliberate stocking of fish in their paddy fields. The fish stock density in the paddy fields depends on what come with the flood water. Thus, the species cultured usually reflect the stock of fish in the nearby rivers/streams/water bodies that use to irrigate into the rice fields. While the common carp is the most commonly cultured fish in the paddy fields in all over the world out of 51 different species as reported are being reared in different areas.

Development of Pisciculture

Initially S.K. Chakavarty, then Fishery officer approached Mr. Padi Lailang from Reru village and Mr. Dani Tassang from Hija village to culture fish ponds way back in 1960. The department supplied the fingerlings fish nursery as well as food to feed the fish at free of cost. As a result, in between 1962 and 1972 as many as 274 private fish ponds of various dimensions were constructed where fish cultured about 98,300 common carp fingerings fish nursery. Thus, efforts were made to develop the pisciculture and encourage the people's participation, so that it would yield subsidiary income to the farmers.

The yield of fish varies according to the conditions like nature, the quality of soil, frequency of water flowing, care in stocking and density of fish stocked in the paddy field, etc. The feeding to the fish in paddy fields is very rare in Ziro valley though it has beneficial effect to the growth of fish. Most of the farmers in the valley are still ignorant about such benefits of feeding. So, the fish is left for their natural feeding from paddy field whatever food available in the paddy fields. Thus, the growth of fish in paddy field is moderate. It is observed that the production of fish is high when the paddy fields remain free from flood and drought.

The fish culture in rice fields was almost as old as the practice of paddy cultivation itself in Apatani valley. The Apatanis are well known for their integrated system of rice and fish culture (*Ajii-Nguyi*) in the state. The practice of paddy-cum-fish culture was started in the valley with capturing of naturally available fish species like channa spp (*tali ngiyi*), puntius spp (*papi ngiyi*) in paddy fields. These fish normally migrate from river, nearby tanks and pools through irrigation water, rain water into the paddy fields and thereafter grow in the paddy fields. There are other species of fishes like schizothorax spp (*ngilyang ngiyi*), Eels (*tabu ngiyi*), nemaucheilus (*ribu ngiyi*), dorikona or weed fish (*ngiyi papi*) are found in the river (*kiley*). The natural occurrence of fishes in

the paddy fields such as Channa sp (*Tali-Nguyi*) and Puntius sp (*Papi-Nguyi*) led the Government of Arunachal Pradesh to start paddy-cum- fish culture in Apatani valley in 1960s. It is found that the paddy-cum-fish culture is considered as the economically viable and hence sustainable farming practice.

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

The common carp is the most frequently reared fish species since time immemorial in the valley. Species such as kuri mass, grass carp; silver carp etc are also sometime stocked along with common carp. But the success rate of these varieties are much less than the common carp. It is found that these fishes eat small insects like water beetle, larvae and other harmful insects of paddy plants. This variety of fish also contributes in increasing soil fertility by decomposing fish excreta, increasing available nitrogen accumulation at the soil surface on the other hand. So, the waste material of fish works as manure to paddy (Nimachow et al. 2010). 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.

Table-1
Fish and Fish Seed Production of Government Farms in Ziro Valley

Sl. No.	Year	Fish Seed Production (No)	Table Fish (kg)	Total Revenue (Rs.)
1	2011-2012	810857	200	273260
2	2012-2013	510000	300	180450
3	2013-2014	551300	218	200370
4	2014-2015	539333	607	262100

Source: DFDO, Ziro-2015

Table-1 illustrates that the government farm produced about 8.1 lakh units fish seed and table fish 200 kg which yielded the revenue of Rs.2.73 lakh during 2011-12. Whereas the fish seed

production declined to 5.1 lakh units but the table fish production increased to 300 kg yielding the revenue of Rs.1.8 lakh during 2012-13. The fish seed production has increased again to 5.5 lakh units whereas the table fish production declined to 218 kg and the revenue generation was Rs.2.0 lakh during 2013-14. Again the fish seed production increased to 5.4 lakh units and table fish has gone up to 607 kg giving revenue upto Rs.2.6 lakh during 2014-15.

It is observed that the naturally available fishes like channa sp (*tali nguui*) and puntius sp (*papi nguui*) are decreasing in the paddy fields, rivers and streams because the availability of water in the rivers and streams are decreasing continuously. In many places, the perennial river water which was earlier used for the paddy fields are also diverted and tapped at source for the drinking purpose with the increased population in the valley. Again, these wild fishes are dominated by the cultured common carp fish as the farmers put/rear fish fingerlings even before appearing wild fish in their paddy field. The Apatani tribe of Arunachal Pradesh has been practicing a traditional rice-fish culture system known as “*ajii nguui*” for many decades. The pisciculture is widely gaining acceptability among the farmers as a subsidiary occupation with the increasing demand for fish in the local market. Thus, area under paddy-cum-fish culture has marginally increased over the successive years. This attributes to an environment friendly rice-fish culture for increased productivity by recycling the waste matter of fish in sustainable manner in agriculture of Ziro valley.

The natural availability of fish in the rivers of Ziro valley is not sufficient to meet the domestic fish demand. Some people in the valley have started fish farming in their ponds commercially and farmers are rearing fish in their private water bodies and paddy fields where ever is possible. The valley is unable to meet its demand for fish with the rapidly increasing population because of the depletion of natural fish stock in the Ziro valley. It is found that nearly 51 species were reported to be reared varying from region to region in different types of climatic conditions of north east India. Out of which the naturally available fish species in Arunachal Pradesh are about 10 to 15. The most cultured fish species in Ziro valley are common carp and grass carp. The fisheries activities were introduced in Arunachal Pradesh in the year 1957-58. It was extended to Ziro valley in 1958-59 and mirror carp was supplied to culture in a pond by a farmer called Padi Lalyang of Reru village. Thus, in 1960 the farmers started rearing fish nursery to culture in their paddy fields. The successful harvesting of first batch of fish cultured in paddy fields by the farmers of Ziro valley induced the state government to take up the programme in 1964-65 on experimental basis initially with 23 plots of paddy fields covering an area of 10 acres which was a remarkable success.

Table-2
Area under Paddy-cum-Fish culture in Ziro valley
(In Hectare)

Sl. No.	Year	In Hectare
1	2007-08	570
2	2008-09	670
3	2009-10	764
4	2010-11	817
5	2011-12	1080
6	2012-13	1150
7	2013-14	1210

Source: DFDO, Ziro

The area under paddy-cum-fish culture during 2007-08 was 570 hectares in Ziro valley and it increased to 1210 hectares in 2013-14. The area under paddy-cum-fish culture in Ziro valley was 1210 hectare in 2013-14. As per the data in Table-2, the average growth rate of area under paddy-cum-fish cultivation in the Ziro valley during 2007-08 and 2013-14 is nearly 16 per cent per annum. It was observed from the study that there are many progressive fish farmers who are operating fish farms and producing fish nurseries of different sizes from their fish ponds. Currently, the number of farmers who are having fish farms in seven traditional villages is varying from 5 to 16 depending upon the location, size and availability of water supply.

These farms are culturing fishes such as common carp, silver carp, grass carp, rohu, catla, magur and Indian major carp. The growth of fish requires ideal location so that fresh air, sunlight and fresh water supply come to the ponds. Weeds are also piled up in the pond as source of food for cultured fish. The natural supply of food along with water supply and pilling of weeds are not sufficient for the fast growth of fish in the ponds. So time to time the farmers feed the cultured fish such as rice husk, oil cake, horyo, cow dung which is mixed with straws so that the foods are flow on the water with straw.

The progressive farmers usually have both big and small ponds for rearing as well as breeding of fish respectively. In February month, the matured male and female fish are separated. The farmer prepares pond for laying eggs and breeding of fishes. It is cleaned with lime mixed with water and then throws all around the fish pond in order to kill all the enemy insects of fish such as water beetle, frog, prawn, and tadpole. After one month water are completely drain out and allowed to enter fresh water for breeding of fish. The breeding period of fish starts from 25 March onwards till 3rd week of April, though the best breeding period of fish is from first week of April onwards due to the cold weather of the Ziro valley. In this new pond one female fish is kept with two male fish for good hassling. Within two days the egg are layed on the pond and then again parents' fishes are

taken out from the pond so that egg remains safe. It takes seven days to become a very small white fish from the eggs. Thereby 3 days later these fishes get bigger and change the colour of fish. Then 15 to 20 days are require for becoming the fry size fish nurseries and it needs full one month for the fish nurseries to become fingerling size in order to come to the market for culturing in the paddy field. The fry size fish nursery start coming to the market from 3rd week of April which continues till 2nd week of May every year for culturing fish along with paddy in agriculture of Apatani valley.

Again good days of fish farmers come in September and October months during which the fish once again breeds in the same manner. The farmer rear fish nurseries in the pond by segregating nurseries from the matured fish to another pond. Apart from their normal business of selling the nurseries to the farmers, they also harvest and sale different sizes of fish at different rate in the market for further culturing in fish pond and paddy nursery. Moreover, they also sale full grown fish to the customers from time to time which become the good source of permanent subsidiary family income for the farmers.

The Table-3 illustrates the production of fry and fingerling size in five progressive private fish farms during 2014. The rate of fry size is varying from Rs. 0.50 paisa to Rs. 1.00 in private nursery fish farms. Again the rate of fingerling size also varies from Rs. 2 to Rs. 5 per fish in private nursery fish farms. The Hage Dollo nursery fish farms produced the highest number of fry size of 50,0000 as well as fingerling size of 1,50,000 number in the tune of Rs. 2,50,000 and Rs. 30,0000 lakhs respectively during 2014. This is followed by Tilling Tadi nursery fish farms which produced 20,0000 fry size for Rs. 20,0000 at the rate of Rs. 1.00 per fish and 50,000 fingerling size for Rs. 2,50,000 at the rate of Rs. 5.00 per fish. Then, Hage Tado nursery fish farms produced 1,20,000 fry size for Rs. 60,000 at the rate of 0.50 paisa and 30,000 fingerling size for Rs. 1,20,000 at the rate of Rs. 3.00 per fish. The least fish nursery production took place at Tage Tatung farms where only 20,000 fry size and 4000 fingerling size at the revenue generation of Rs. 10,000 and Rs. 12,000 respectively during 2014.

It is followed by Talyang Santh nursery fish farms which generated total revenue of Rs. 1,50,000 from both the sizes during the same year. The total number of fry size produced by the private fish farms are 760000 with the revenue generation of Rs. 570,000 in Ziro valley primarily for culturing in paddy field during 2014 crops season. Again, the total of 734000 fingerling size are produced which generated the revenue of Rs. 782000. The fingerling size of fish is also produced to culture in the paddy field but it is limited in supply in the Apatani valley. Total revenue that the farmers earned from the production of both the fry and fingerling sizes of fish nurseries are Rs. 13,52,000 only during the year 2014.

Table-3
The Private Fish Farms and its Production in Ziro valley

Sl. No	Name of Farm Owner	Fry Size in Number & Rate per Fish	Total (Rs.)	Fingerling Size in Number & Rate per Fish	Total (Rs.)	Grand Total in (Rs.)
	(A)	(B)	(C)	(D)	(E)	(C) + (E)
1.	Talyang Santh	10,000 Rs. 0.50	50,000	50,000 (Rs. 2)	10,000	1,50,000
2.	Hage Tado	1,20,000 Rs. 0.50	60,000	30,000 (Rs. 3)	1,20,000	1,80,000
3.	Hage Dollo	50,000 Rs. 0.50	2,50,000	1,50,000 (Rs. 2)	30,000	5,50,000
4.	Tage Tatung	20,000 Rs. 0.50	10,000	4000 (Rs. 3)	12,000	22,000
5.	Tilling Tadi	20,000 Rs. 1.00	20,000	50,000 (Rs. 5)	2,50,000	4,50,000
	Grand total	760000	570,000	734000	782000	1,352,000

These five progressive fish farmers have permanent fish ponds at their own land. Of these some are managed the farms by themselves but Tilling Tadi keep the hired labours for its management along with their own family labour. It was found that Hage Tado is not having even a single permanent fish pond till date, so far he is managing the fish nursery in the paddy field itself as well as in rice nursery field itself where the water supply is regular throughout the year. The fish produced from these nurseries are supplied to all the villages and sales even at their home during the rearing season in April and May.



Private Fish Nursery Farms

Pisciculture in Paddy Fields along with Millet

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.

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.



[Fish collection from paddy fields]

The Apatanese culture some fish species in their ponds such as common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys rostratus*), rohu (*Labeo rohita*), catla (*Catla catla*), mirigal (*Cirrhinus mirigal*) and grass carp (*Ctenopharyngodon*). 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.

Analysis on the Surveyed Households

The study revealed that each household has various sources of annual income to meet their expenditure to full fill the needs of family members. The one household income source may not be similar to the sources of another household. The household income is taken into account the earning members of the family that living under the same roof. In order to analyse in detail, the sources of income are categorised in different headings as given in Table-5.

The well being of the people mainly depends on the annual household income of the people and household income comes from the household occupation or economic activities which they perform more or less regularly. It is observed from the survey in Ziro Valley that the households in all surveyed villages are routinely and/or more frequently carry out various economic activities for their livelihood. Further, it is noticed that most of the families have one primary occupation as well as one or more secondary activities for meeting their household expenses. The distribution of economic activities of the surveyed families is presented in Table-4. It is seen that all the families in the valley and/or traditional villages have agriculture either as primary or secondary source of income. Out of 250 surveyed households 89 families are practicing agriculture as their primary occupation while the rests are having agriculture as their secondary occupation. Again, only about 10 per cent farming families grow paddy alone and rest 90 per cent families practice paddy-cum-fish cultivation in their paddy fields.

It reveals the average annual income of the surveyed households of seven traditional villages in Ziro valley from their diverse economic activities. The average annual income of the households having permanent service is the highest Rs.3,26,563 and the second highest average annual income is Rs.46,554 from temporary service while the lowest average annual income is Rs.3,497 and second lowest average annual income is Rs. 9,044 from paddy alone cultivation and daily wage activities respectively in Ziro valley. The average annual income of the surveyed households from business activity, horticulture, paddy-cum-fish cultivation are Rs.31,911,

Rs21,392 and Rs.19,335 respectively.

Table-4
Activity-wise Average Annual Income of Surveyed Households

Sl. No	Economic Activities	Average Annual Income from Primary Occupation			Average Annual Income from Secondary Occupation			Average Annual Income of a Household			Activity wise % of HH Income
		No. of HH	Income per HH	Income per Hectare	No. of HH	Income per HH	Income per Hectare	No. of HH	Income per HH	Income per Hectare	
1	2	3	4	5	6	7	8	9	10	11	12
1	Agriculture	89	30,006	24800	161	10,790	26,972	250	17,673	25,613	0.20
2	Paddy alone	18	4,500	6,000	7	837	2,700	25	3,497	5,550	0.04
3	Paddy cum fish Cult.	71	36,575	27,500	154	11,400	27,800	225	19,335	27,620	0.22
4	Horticulture	3	1,02,519	1,49,300	42	16,342	1,72,450	45	21,392	1,64,554	0.25
5	Fishery	5	80,520	3,30,000	154	9,000	21,950	159	11,408	27,824	0.13
6	Animal Husbandry	2	25,950	-	76	12,140	-	78	12,494	-	0.14
7	Forestry	4	16,200	-	13	7,200	-	17	9,317	-	0.11
8	Permanent Service	24	3,26,563	-	-	-	-	24	3,26,563	-	
9	Temporary Service	37	46,554	-	-	-	-	37	46,554	-	0.54
10	Business	35	51,450	-	61	20,700		96	31,911	-	0.37
11	Daily Wage	51	10,141	-	20	6,250		71	9,044	-	0.10
12	Total	250	61,501	30,436	250	24,854	28,976	250	86,373	29,645	1.00

Farming System of Surveyed Households

The people of Ziro valley practice settled agriculture which is terrace type in nature. They never practice the shifting cultivation since time immemorial. Table-5 shows that out of 250 surveyed families, 25 families cultivate paddy alone whereas 225 households are practicing paddy-cum-fish culture in the valley.

Table-5
Farming System and Cultivation with or without Fish

Sl. No.	Farming System	In Number	Percentage
1	Only paddy cultivation	25	10
2	Paddy-cum-fish culture	225	90
3	Shifting cultivation	Nil	Nil
4	Total	250	100

Labour Engaged in Paddy alone and Paddy-cum-Fish Cultivation

The labour, the main factor of production use simple tools and indigenous techniques in agriculture in Ziro valley. The households in the valley usually manage the labours within the

village normally mutual help basis among the farmers. It is found that the participation of labour in paddy cultivation alone are less as compare to the paddy-cum-fish culture in the agriculture as per surveyed households. The wages of labour vary from Rs.150 to Rs. 200 depending on the timing of cultivation and session of agriculture among other factors. During the transplanted of nursery and harvesting of paddy the wage rate remains high whereas it remains low during the rearing of trench, bund and weeding of paddy fields.

Table-6
Labour Engaged in Paddy Alone and Paddy-cum-Fish Cultivation in a Year

Sl. No.	Activity	No.of HH	Total Land Area (Ha.)	Total no. of Labour Engaged	Land per HH (Ha.)	Labour Employment	
						Per Hectare	Per HH
1	Paddy alone	25	15.72	2262	0.63	144	90
2	Paddy-cum-fish	225	157.48	24378	0.70	155	108
3	Total	250	173.2	26640	0.69	154	107

The farming families which are practicing paddy alone are engaging on an average 57 man-days of labour per family in a cropping season while nearly 63 man-days of labour per household are engaged in a season by a farming family which are practicing paddy-cum-fish cultivation (Table-6). This indicates that the labour engaged in paddy-cum-fish cultivation is more than that of paddy cultivation alone in the valley. Similarly it is found that the labour force engaged in paddy alone is nearly 144 per hectare while the same is about 155 per hectare in case of paddy-cum-fish cultivation. It is, thus, evident that paddy-cum-fish cultivation system requires more physical labour which increases the scope of employment for landless cultivators/labourers.

Conclusion

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. The government fish farms are unable to supply sufficient fish nurseries at subsidies rate to the farmers as a result they are compelled to depend on the private farms for fish nurseries to culture in their paddy fields. Thus, there are many

progressive fish farmers who are operating fish farms and producing fish nurseries of different sizes from their permanent as well as temporary fish ponds. Currently, the number of farmers who are having fish farms in seven traditional villages is varying from 5 to 16 in numbers depending upon the location, size and availability of water supply throughout the year in Ziro valley.

References:

1. Ali, A.B., 1998: "Rice agro ecosystem and the maintenance of biodiversity" Agriculture Publishing House, Beijing. P.25.
2. C.V.F, Haimendorf, The Apatanis and their Neighbours, Free press of Geeycoc, New York, 1962.p.92.
3. Dollo, M., Samal, P.K., Sundriyal, R.C.,& Kumar, K. Environmentally Sustainable Traditional Natural Resources Management and Conservation of Ziro Valley, Arunachal Himalaya, India, Journal of American Science 2009; 5(5):pp.41-52.
4. Nimachow, G., Rawat, J.S., Dai, O & Loder, T. A Sustainable mountain paddy-fish farming of the Apatani tribes of Arunachal Pradesh, India. Research & Farming Techniques, vol. xv No. 12, April-June 2010.
5. Sakia, S.K. & Das, D.N., 2004, Aji gnui assonii- A Practice of Organic hill farming among the Apatani tribe of Eastern Himalaya. International Journal of sustainable development world ecology, 11, 211-217.
6. Coche, A.G., 1967: "Fish-Culture in Rice-Field". A world wide synthesis, Hydrobiol 30(1):pp.1-44.
7. Li, K., 1988: "Rice-fish culture in China: A Review". Aquaculture 712, pp.172-186.
8. Tamura, T., 1961: "Carp cultivation in Japan. In: Fish as a food". (ed. G. Borgstrom), Academic Press, New York, pp.103-120.