

PADDY-CUM-FISH CULTURE: EMPLOYMENT OPPORTUNITIES IN ARUNACHAL PRADESH (INDIA)

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ABSTRACT

Out of many farming activities in the state rice-fish integration is believed to be the most economically viable. In a managed ecosystem the integrated farming gives the provision for higher income to the farmers in terms of rice and fish production than the single crop farmers. The Ziro valley in Arunachal Pradesh is considered as one of the most suitable area for fish culture in paddy fields with their choice strains of paddy. However, there is no price regulating mechanism for both the government as well as private farm owners. The price of the fish seed especially fingerling size vary from farm to farm depending upon the size and its availability. The paper attempted to analysis the practice of paddy-cum-fish culture and employment opportunities available in the state with the help of the primary and secondary source of data.

KEYWORDS: Paddy-Cum-Fish Culture, Wet Rice Cultivation, Terrace Rice Cultivation, Strains, Sustainability, Multipurpose, Ziro Valley, Pisciculture, Synchronize

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INTRODUCTION

Arunachal Pradesh “The land of dawn-lit mountains” is situated in the extreme North-East part of India. Geographically the state lies between 26° 28’N to 29° 38’ N latitudes and 91° 30’E to 97° 30’ E longitudes with total area of 83,743 km². The soil in the major part of Arunachal Pradesh is rocky. The soils of the state have a high degree of acidity containing humus with a high degree of nitrogen and a rich organic layer. Moreover, due to the land erosion and deposition by the rivers, the soils are sandy loam and clay mixed with nitrogenous matrix. Different types of soils i.e. red soil, soil mixed with sand, alluvial soil comprising black and radish elements and pure alluvial soil are found in different parts of the state. The climate of Arunachal Pradesh is tropical, sub-tropical, alpine, sub-alpine, temperate and humid depending on the topography and altitude. The rainiest part of Arunachal Pradesh is the land below the elevation of 1000 metres surrounding the Bramaputra valley. The annual average rainfall in the state is nearly 250cms.

The intensive and efficient use of resources like land, water and forests has become the prime concern of not only the rural people but also the government of the state or country concern. From time immemorial people in rural area have been practicing their indigenous knowledge for producing and earning more for their economic prosperity. The rural households normally farmers, agricultural workers and other landless households adopt varieties of rural occupations related to land, water and forests. The people of Arunachal Pradesh in general and of Ziro valley in particular are the best example of rural people who have been using their indigenous technique for better earning from their available land, water and forest resources.

The geo-topography of Arunachal Pradesh is bit different from that of other states of the country. The people of the state in general and the sample area i.e. Ziro valley (also called as Apatani valley) in particular have been practicing a unique farming system called “paddy-cum-fish” cultivation in their limited cultivable land. Initially this practice was not so much systematic and planned manner. But especially after 1960 they cultivate paddy and fish simultaneously in the same paddy field. For the said purpose they are preparing the paddy field which would be suitable for rearing fish in the paddy field. 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). Now this has become a normal practice of the farmers not only in Ziro valley but also at some other places in Arunachal Pradesh

The integration of fish with paddy cultivation started in a natural process. During rainy season while water flow from upper level paddy fields to down level fields the wild fish are trapped in the corn fields and later on cultivators use to catch/harvest these fish from their corn fields. Through this process farmers used to earn some income by selling these fish without spending single pie for rearing fish in their paddy fields. They also did not lose any amount of paddy production. So in order to attract and trap more wild fish thus started preparing their paddy fields accordingly. With the passage of time in many parts of the world, in India, in Arunachal Pradesh and also in Apatani valley, cultivators started rearing fish along with the migrated fish in their paddy fields to earn more income (In terms of paddy and fish combinely) from their paddy fields. This form of farming system is characterized as “Paddy-cum-Fish” cultivation

It is found that the yield of fish varies with input, care in stocking and density of fish stocked. The fish is usually cultured with varieties of paddy. The common carp is the most cultured fish with late ripening variety of paddy called *emo* in Ziro valley. The fish cultured in their fields becomes the main source of protein to the farmers and also gives them subsidiary source of income. The Ziro valley in Arunachal Pradesh is considered as one of the most suitable area for fish culture in paddy fields. The local Apatani farmers also adopted this farming system as their indigenous culture.

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. Moreover, the culture of fish along with paddy helps to 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 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. The use of chemical fertilizers, pesticides and weedicide in their agriculture is negligible. It is found that most of the farmers prefer to use traditional method of cultivation in which they are more comfortable. It was also found that the soil and water condition are highly favourable for fish culture in the rice field of Ziro valley (Kanwar, 2010).

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 concurrent growing of rice and fish is known as rizi-pisciculture or paddy-cum-fish culture in the traditional sense. Singh et al. (1980) define rice-fish-culture as the stocking of fish fingerlings of a given size and species or species combination in a rice field to obtain a crop of fish in addition to the main crop of rice. They consider it as an ideal method of land use since the same land is being utilized for both rice and fish concurrently.

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.

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*, *mipyra*, *layi*, *missang emo* etc and also *pyaping* are grown in the paddy-fish system. They mostly cultivate *empu emo* followed by *mipyra*, *pyaping* and *layi etc* varieties of paddy are indigenous in nature. The *Mipyra*, 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 *Mipyra* and *Pyaping*, etc. varieties respectively. 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 tribals of the state. The incorporation of those with modern agricultural practices holds a promise of sustaining the dualistic pattern of agricultural practices in Arunachal Pradesh.

The most of the Arunachal farmers practice the traditional system of mono rice cropping in their fields. They do not cultivate any crop on the bund as it is in small size and also low in height. However, 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. The fish culture in paddy fields and growth of millet on bunds are highly sustainable for the economic growth of farmers with a high degree of ecological efficiency in Ziro valley (Rai, 2005). Moreover, the irrigation system of Apatanis enables them to adopt concurrent culture of fish in their wet rice field and harvest additional protein for the farmer which is also considered as their supplementary source of family income.

The two batches of fish are reared in a crop season. The first batch of fish is stocked during the late March to early April before the transplantation of paddy sapling. These fishes are harvested in June and July depending on the size and growth of fish while keeping the half grown fish in the paddy field for next phase harvest. The second batch of fish is put in the month of June-July and harvested in the month of September and October. However, generally the farmers' rear single batch of fish during entire crop season stocked in the month of April and harvested in the months of July, August and September. The time of harvesting varies from farmer to farmer depending on the growth and size of the cultured fish and also demand for local fish in the market. The last batch of the cultured fish is harvested in the month of October at the time of drying the paddy fields before harvesting of crop.

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 castanopsis 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.

Nature of Agriculture

In Arunachal Pradesh around 90 per cent rural tribal households are pursuing either shifting cultivation or settled cultivation. The wet rice cultivation (WRC) and terrace rice cultivation (TRC) are normally considered as permanent cultivation. The entire cultivable land in the state is under the private ownership. The private households operate as a unit while carrying out the cultivation of crops, comprising field crops as well as horticulture crops. The individual household therefore, takes all the technical decisions for agricultural cultivation, manage and control resources and ultimately bears the entire responsibility.

The size of land under the technical command of a family forms 'operational holdings' for all purposes according to the established norms followed under agricultural census in India as well as in Arunachal Pradesh and termed as 'individual holdings. When the land resources of two or more persons to households are pulled together for carrying out agricultural operations are called as 'joint holdings'. When the land is controlled, managed and technical decisions are taken either by an institution or the government organization or any private organization such units form operation holdings as 'institutional holding'. Thus, there are three types of operational holdings in Arunachal Pradesh.

As per the practice followed under agricultural census in Arunachal Pradesh, all the holdings enumerated are classified according to the categories in terms of hectares. Keeping in view agro-climatic condition and other related aspects of the land resources, the land holdings in the state are classified into four categories such as (1) Marginal (2) Small (3) Medium (4) Large holding. The households having land holding less than one hectare are termed as marginal

household. Similarly, those who are possessing landholdings more than 1 hectare but less than 2.5 hectare are regarded as small landholding households. The households possessing the land holdings within 2.5 to 5 hectares of land are known as medium and the families occupying more than 5 hectares of land are classified as large households or large farmers.

All the tribes of Arunachal Pradesh practices settled agriculture besides practicing shifting cultivation. They have different and distinctive ways of soil and nutrient management of paddy fields. The method of cultivation is also varying depending on the nature of topography and their age old farm practice. Apatanis, one of the major tribes among 26 tribes of the Arunachal Pradesh are having settled agricultural practices without having jhum cultivation in the Ziro valley. The small terraces are built by tribal communities around the flat valley land extending into the foot hill slopes. The soil in valley land is fertile due to nutrient wash-out from the hill slopes.

The cultivable land-population ratio in Ziro valley is low. Thus, they produce rice and fish in the same crop fields. Hence, it is essential to increase in order to meet the ever growing demand for rice and fish. Since they rear fish in paddy fields, they do not use chemical fertilizers and pesticides in their paddy fields. So in order to improve the land productivity they normally grow indigenous improved variety of rice. Again the use of chemical fertilizer is negligible in the wet paddy cultivation as well as in shifting cultivation. Thus, the farmers are in trade-off between traditional soil management and modern technique of production process in the state's agriculture.

Rice

Rice a staple food for the tribal people of Arunachal Pradesh is consumed as their main food all over the state. The state 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 most commonly cultivated crop in Arunachal Pradesh. It is considered as an important food crop of the tribal state of Arunachal Pradesh. It is grown in different climatic zones of the state.

Development of Fish Culture in Paddy Fields

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. At the beginning, in order to encourage the farmers, the government provided 50 per cent subsidy for excavation of ponds while the other half was borne by the pond owners. The department also 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 fingerlings fish nursery. However, it was declined to 122 private fish ponds, 21 people fish farms and one government fish farm during 1998-99. Again, the government provided 40 per cent subsidy for the cost of excavation, sluice gates, feeder and drainage channel, etc. to those beneficiaries who were capable to construct the commercial viable fish pond and 50% subsidy were given towards the cost of input such as fish seeds, fish food, fertilizers, manure, lime and cow dung. 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 wet paddy cultivation and its area available for fish production are limited in the state. The small size of the paddy field, low level of bunds, frequent flood and untrained farmers are not familiar to the unique technique of paddy-

cum-fish culture in other districts of Arunachal Pradesh. 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 Arunachal Pradesh though it has beneficial effect to the growth of fish. Most of the farmers in the state 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.

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.



Figure 1: Fish Harvesting from Paddy Field Trench by Farmers]

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 culture of fish and paddy together could potentially increase and stabilize income from rice farms and increases the total annual income Purusshan (1986).

The natural availability of fish in the rivers of Arunachal Pradesh is not sufficient to meet the domestic fish demand of the state. Some people in the state 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 state is unable to meet its demand for fish with the rapidly increasing population because of the depletion of natural fish stock in the state. 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 1: 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 1, 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.

Table 2: Allotment of Fund for Fish Culture in Paddy Fields of Ziro Valley (In Hectare)

Sl. No.	Year	In Hectare
1.	2007-2008	221
2.	2008-2009	140
3.	2009-2010	205
4.	2010-1011	170
5.	2012-2013	301
6.	2013-2014	120

Source: DFDO, Ziro, 2014

The fund allocation for the fish rearing in paddy fields in Ziro valley by the state government is shown in Table 2. The data as presented in Table transpire that the funding of the Arunachal government is widely fluctuating. The government allotted fund for 221 hectares of paddy fields for fish culture in Ziro valley during 2007-2008. The allotment of fund decreased to 140 hectares of paddy fields for fish culture in 2008-2009. It is found that the fund allocation was the highest for 301 hectares in 2012-2013 for fish culture in paddy fields in Ziro valley. It is further decreased to mere 120 hectares in 2013-14. The graph of fund allocation in terms of fields is almost horizontal with huge ups downs (Figure 2).



Figure 2: Allotment of Fund for Fish Culture in Paddy Fields of Ziro Valley(In Hecture)

Fishery Activities in Lower Subansiri District

The govt. of Arunachal Pradesh has taken steps for expanding the fishery activities in the state. Accordingly various fish ponds have been created both by Fishery Department and private individuals too. The progress of fishery units

in the said district is shown through table and graphs. As per data transpired in Table 3, the number of fish farms/ponds are remaining same i.e two govt fish farms, 54 private people's fish ponds and one other fish ponds during 2008-09 and 2013-14. On the other hand the village fish ponds has increased from 874 in 2008-09 to 895 in 2013-14 showing an increase of 21 units. It is also observed that the area under fish culture in Lower Subansiri district has slightly increased from 246 hectare in 2008-09 to 260 hectares in 2013-14.

Table 3: Fish Farms/ponds in Lower Subansiri District

Sl. No.	Type	Year					
		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
1	Govt. fish farms (In no.)	2	2	2	2	2	2
2	People fish ponds (In no.)	54	54	54	54	54	54
3	Village fish ponds (In no.)	874	895	873	889	892	895
5	Area under fish culture (In hectare)	246	248	254	255	257	260

Source: DFDO, Ziro

The inland fish production in the district was 170.5 tones during 2007-08 and it increased to 299 tones during 2013-14 as shown in Table 4. Again, the fish fry seed production was 20.3 million units in 2007-08 and it increased to 20.8 million units during 2009-10 which declined to 20 million units during 2013-14. However, the production of fish fingerlings size are comparatively low against the fish fry size in the district. The production of fish fingerlings size are more or less same during entire period from 2007 to 2014.

Table 4: Fish and Fish seed production in Lower Subansiri District

Sl. No.	Items	Year						
		2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
1	Fish production (M.T)							
1.a	Marine	-	-	-	-	-	-	-
1.b	Inland	171	173	174	293	297	297	299
2	Fish Seed Production (Number in Million)							
2.a	Fry	20.3	20.6	20.8	20.0	20.0	20.0	20.0
2.b	Fingerlings	0.5	0.6	0.5	0.5	0.6	0.6	0.6

Source: DFDO, Ziro

Table 5 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.h during 2014-15.

Table 5: 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

Fishery Activities in Arunachal Pradesh

The integrated paddy-cum-fish farming was also introduced for the first time in Lohit district in 2012. This system was introduced in two villages namely Khaoji and Juna-IV covering three hectares area on trial basis by Lohit KVK under the sponsorship of NABARD. The rice (bahadur variety) and fish was cultured in the month of May and harvested in the month of September. Average weight of fish was 250 gm (100gm-450gm in 130 days). It was known to be a little different type of technique than the indigenous type of paddy-cum-fish culture. However, they never practice fish culture in their paddy fields before the introduction of fish nursery by the government department. But the farmers discontinue the practice of paddy-cum-fish culture in their agriculture from next year onwards.

Again the practice of fish culture in paddy fields are found at Balijan circle where only one farmer is practicing the fish culture successfully in his paddy fields near his private fish pond since last five years but the data of area under fish culture and production is not available. The fish culture in paddy fields were also tried at Doimukh circle in 2012 and 2013 under Papum-Pare district by the fishery department but it was unsuccessful due to non-availability of perennial source of river water in the area. So the farmer discontinued fish culture in paddy fields in next year. Further, the fishery department is all set to experiment another fish culture in the paddy field of East Kameng district during 2015 agricultural season.

As shown in Table 6 the total area developed for pisciculture in the state has increased from 2388 hectares during 2006-2007 to 3500 hectares in 2013-2014 registering an annual growth rate of around 6.6 per cent.

However, the area under paddy-cum-fish culture in the state has been increasing every year. It was 1171 hectares in 2006-07 and it has increased to 1825 hectares in 2013-14 (Table 6). The Area under paddy-cum-fish culture in Arunachal Pradesh is also illustrated graphically in Figure 3. The average annual growth rate of area under paddy-cum-fish cultivation in Arunachal Pradesh is nearly 8.0 per cent.

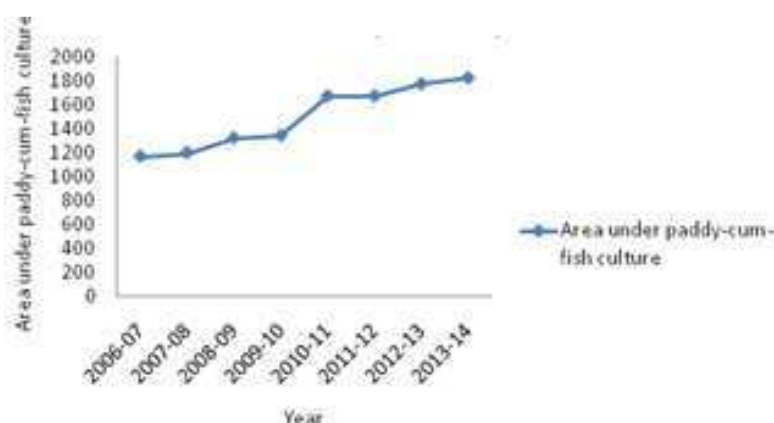


Figure 3: Area Under Paddy-Cum-Fish Culture in Arunachal Pradesh (In Hectare)

Table 6: Area under Pisciculture in Arunachal Pradesh (Area in Hectare)

Year	Govt. Fish Farms	People Fish Pond/Farms	Hatcheries in Numbers	Area under Paddy-Cum-Fish Culture	Total area Developed for pisciculture (Hech.)	Fingerlings (Lakh) Distribution
2006-07	31	1011	11	1171	2388	90
2007-08	35	1100	11	1200	2465	100
2008-09	35	6070	6	1325	2700	100
2009-10	30	6377	6	1345	2700	120

Year	No. of Ponds	Area (ha)	No. of Fish	Production (kg)	Production (tonnes)	Production (kg/ha)
2010-11	36	9200	6	1675	3200	150
2011-12	36	9500	6	1675	3200	150
2012-13	36	10,500	10	1775	3425	165
2013-14	33	10650	10	1825	3500	169

Source: Director of Pisciculture, Government of Arunachal Pradesh.

The growth of fish ponds/farms in the state has been shown in Table 6. The table reveals that the number of fish ponds has increased from 1011 during 2006-07 to 10,650 farms in 2013-14 recording a growth rate of 136.2 per cent. However, government fish farms were more or less same ranging from 30 to 36 numbers during the same periods i.e. from 2006-07 to 2013-14. The fish is left for its natural feeding in the paddy fields. The rice fields of Ziro valley where fish seeds are cultured are free from the use of agro-chemical and additional input of supplementary feeding to fish. The fish culture in paddy fields is primarily meant for their self consumption. But it has become the subsidiary source of family income in the valley. The production of local fish are good substitute to the imported fish in the market.

Employment in Fishery Activities

The activities related to fishery like fish farming and fish hatchery have been gaining popularity in the state though it is spreading steadily. These activities are carried by both private people and government department. The data in Table 7 depicts that during 2006-07 and 2013-14 people engaged in government fish farms were 372 in 2006-07 while it was 432 in 2013-14 and people working in govt. hatcheries were around 50-55. Thus, the labourer or workers in government run fish farms and hatcheries were 427 and 482 in 2006-07 and 2013-14 respectively.

While the people engaged in private fish farms and hatcheries during 2006-07 were only 5,905 while this number increased to 56,200 in 2013-14. It is observed that more private people in the state are participating in fishery activities in the state. Taking both private and government into consideration, it is seen that number of people engaged in these activities has increased considerably from 6,332 in 2006-07 to 56,682 in 2013-14 registering nearly 114 percentage annual growth rate.

Table 7: Labour Engaged in Government, Private and Hatcheries in Arunachal Pradesh

Year	Labour						Total
	Government			Private			
	Fish farms	Hatcheries	Total	Fish Farms	Hatcheries	Total	
2006-07	372	55	427	5055	850	5905	6332
2007-08	420	55	475	5500	850	6350	6825
2008-09	420	30	450	30350	1260	31610	32060
2009-10	420	30	450	31885	1260	33145	33595
2010-11	432	30	462	46000	2450	48450	48912
2011-12	432	30	462	47500	2450	49950	50412
2012-13	432	50	482	52500	2950	55450	55932
2013-14	432	50	482	53250	2950	56200	56682
Total	3360	330	3690	272,040	15,020	287,060	290750

The growth of fish seed production in the state is also studied. The Table 8 shows that the fish seed production of fingerling size was around 8.5 million during 2006-07 and it has increased to about 20 million in 2013-14. The production of fry size fish fluctuates from 25 million in 2006-07 to 27.00 million during 2010-11 and the production of fish fry size were nil from 2011-12 to 2013-14.

Table 8: Fish and Fish Seed Production in Arunachal Pradesh

Year	Items		
	Fish Production Inland (In Tons)	Fish Seed	
		Fish Fry size (Million)	Fish Fingerling Size (Million)
2006-07	26.00	25.00	8.5
2007-08	27.30	30.00	9.50
2008-09	27.70	26.50	11.00
2009-10	27.50	27.00	12.00
2010-11	29.00	27.00	11.00
2011-12	30.10	28.00	15.00
2012.13	30.80	28.00	18.00
2013-14	30.85	30.00	20.00

Source: Director of Fisheries, Govt. of Arunachal Pradesh., Itanagar.

It is observed from above table that the distribution of fingerling size fish seeds has been increasing continuously in each financial year. Initially the production of fry size by the farms was more than the fingerling size. However, it was short lived and production decreased to 27.00 during 2010-1. Again fry size fish increased to 30 during 2013-14. The demand for fingerling size by the farmers has been continuously increasing since 2006-07. The reason may be the growth of fingerling size fish takes short time to get matured which is being harvested early by the farmers.

The most of the government fish farms are lacking required maintenance. It may be due to the shortage of departmental labours. Thus, these farms are not maintained properly for sufficient production of fish nursery. The short fall of these requirements are met by the production of private nursery farms as well as fish nursery brought from the neighbour state Assam. Moreover, it is also noticed that there is no price regulating mechanism for both the government as well as private farm owners. The price of the fish seed especially fingerling size vary from farm to farm depending upon the size and its availability. The price of fingerling size fish seed vary from Rs. 2 to Rs. 5 in the private fish farm.

CONCLUSIONS

The demand for local fish in the market has been increasing. The ever increasing purchasing power of people encourages the unemployed youths and farmers to take up fish pond or farms activities as their semi-permanent occupation which gives good source of livelihood. The development of fish farms in private sector fulfilled the gap between government fish seed supply and farmers demand to culture in their paddy fields as well as ponds. Thus, it is found that the private fish ponds or farms have outnumbered the government fish firms. The development of pisciculture in the state helps to generate more employment opportunities in both the government as well as private level. However, the paddy-cum-fish culture activities are limited to the Ziro valley only and rest of the districts has pisciculture alone to support the rural households in their area.

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