FISH FARMING IN RICE ENVIRONMENTS OF NORTH EASTERN INDIA

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Fish have been harvested from rice fields as an additional crop since ancient times. Biologically, rice fields can be considered as agriculturally managed marshes, which remain dry for varying periods of time during the year. Physically, the aquatic phase has varying water depth according to the land topography and local rainfall patterns and water tables. In its flooded state, the rice field is a rich and productive biological system which can produce a crop of aquatic organisms, both plant and animal, for human consumption in addition to the rice.

The farmers of the Northeastern part of India (Fig-1) in all the seven states viz. Assam, Arunachal Pradesh, Nagaland, Meghalaya, Mizoram, Manipur and Tripura cultivate rice as their staple food. The ecology of their rice fields in the region is quite diverse, but can be divided primarily into upland, lowland and deepwater rice ecosystems. On the basis of water sources there are two types of fields viz., irrigated and rain fed rice fields. In this region of the country, a fish crop is traditionally raised only from the paddies of rain fed lowlands (both shallow and deepwater). In many areas, irrigation-fed rice fields have also been adapted locally by the farmers to include fish farming. Traditional rice-fish production systems have an important socio-economic part in the life of the farmers and fishers in the region.

Rice-fish farming

Unlike most agriculture and animal husbandry, which evolved millennia ago, many aquatic farming systems have relatively recent origins. Traditional rice fish farming may be considered to derive solely from the farmer-based technology, where modern rice fish farming involves a shift from completely farmer-based technology relying mainly on use of on-farm and agricultural by products to science-based technology such as use of improved breeds, inorganic fertilizers and formulated feeds.

Figure 1: Northeastern states of India

The system of raising fish from the rice fields probably started in the northeast with the beginning of rice cultivation itself. Since the water logged rice field forms natural habitat for wild fish so it is believed that it appeared first only as the simple capture. The fish communities of rice fields were exploited as common property resources for rice growers as a whole in the earlier days. The concept of intentional rearing or culture farming evolved later, particularly when the farming communities faced a demand for increased and organized fish production. Even then the impact of modern research and developmental endeavors hardly touched the rice farmers of these remote region of India.

Existing farming practices: Methods and Status

The indigenous rice-fish farming practices prevailing among the farmers in the northeastern India can be categorized as (a) rice field capture fishery systems (b) wild aquatic cropping systems (c) mountain valley rice fish farming system and (d) running water terrace rice-fish farming systems.

Rice field capture fishery system

In the unmanageable vast waterlogged rice environments, perennial waterlogged wet rice lands, oxbow type rice fields or flooded river basin rice fields, naturally occurring fishes and prawns enter the field during the monsoon and grow together with the rice crop. The gravid females and young fingerlings enter the field during the wet season when field water overflows and connects neighboring watercourses to form a vast sheet of water under the rice canopy. The floodwater carries huge and diversified community of fish, prawn, crabs and other aquatic organisms into the rice paddies. This situation is very common in the flood plain rice fields of whole of the Brahmaputra and Barak Valleys of Assam. The fishing activities there start just after arrival of the floods from late June and continue until the water recedes in November-December. In a true sense, these areas become temporary fishing grounds. The farmers and fishers use those fields as common property resources for about 5-6 months of the year using gill nets, cast nets, and various indigenous traps, either operating them in the rice-free spots or fixing the traps at appropriate water entry and exit points in the fields. In such fisheries, the average capture rate is typically around 3kg/ha/yr[1,2]. Such practices are highly prevalent in the districts of North Lakhimpur, Dhemaji, Barpeta, Nalbari, Bongaigaon, Dhubri and Kachher district of Assam and certain districts of Manipur and other Northeastern states. The deepwater rice environment where such practice is most common covers more than 460,000 hectares in Assam State alone.

All of the states of Northeastern India lie in a heavy rainfall zone and therefore a longer aquatic phase is possible in these areas than in rain-fed low lying rice fields. Harvesting of the rice starts in November-December after the recession of floodwater at the end of wet season. All the low-lying ditches, marginal swamp and natural depressions inside the field area are also harvested at the same time. This is done either by pumping out the water or by using traditional nets or traps. The fish fauna from such flooded fields are very diverse (figure 4).

In Barpeta district, Assam, this is a very common system among the local tribal and fishers for collecting fish and other aquatic resources from the paddies. The yield of fish from such indigenous practice ranges from 45-280 kg/ha/season[3] (table 1). The tribal folks of lower Assam traditionally practice community fishing during the night. They use indigenous night lamps made from bamboo or burning bicycle or rickshaw tires for light fishing. By walking in and around the flooded field at night with the light they can attract and capture stunted fish, frogs, crabs and other animals with a sharp weapon. In rice-less patches of open deepwater rice fields or oxbow lakes the farmers also practice cast netting using bait during the evening hours.

The tribal women of the lower Assam traditionally collect wild resources through group fishing of the flooded rice areas using local devices. In general, small fishes, snails and crabs are the common harvests from most of the rice environments. Group fishing is performed throughout either the either the whole of the wet season or at the end of the season. Aside from animals, various aquatic vegetables like Ipomea, Alternathera, Nymphaeia are also harvested for family consumption.

Figure 2. Open deepwater rice fields during October- November i.e. water recession period

Wild aqua cropping system

The practice of wild aquatic cropping is a common practice in the rice fields of Assam, Manipur and foothills of other hilly states of Northeastern India. In this system the farmers or fishers trap and rear the fish, which enter the fields from the wild and thus intentionally utilize the rice environment. This practice is mostly carried out in impounded rain fed lowland and the closed deepwater rice fields, which are embanked all around and linked with canal systems of varying sizes and designs. On average, canals occupy 8% of the area of such fields and average 0.6-1.5m in depth[4]. The rice cultivars traditionally grown in these fields are a tall type commonly known as Sali rice in lower Assam and Aman rice in Cachhar district. In some closed deepwater rice field, tall traditional Bao cultivars are grown. These plots are seasonal wetlands where water depth may reach 2.5 meters or more during the monsoon, but partially or completely dry up during December-January. The rice is planted during April-May by direct seeding and after getting first shower of rain the seeds are germinated. In many areas, tall seedlings are also transplanted after accumulation of rainwater during June-July. The fields connect with neighboring watercourses during the monsoon when they overflow, allowing seeds of various wild fish and prawns into the field. Sometimes farmers dig trap ponds inside the field intentionally to give the animals refuge and facilitate their entry in the field. In addition to direct capture during the wet season, the farmers also rear wild seed until the water level drops down below the level of the fields. During this phase wandering fish accumulate in the trap ponds or natural ditches in and around field contour. These fishes are harvested after dewatering the ditches and canals. The rate of production is ranges around 200-300kg/ha/season.

Figure 3. Use of trap in the field at the entry &exit points in post flood low land rice fields

Figure 4. Wild fish and prawns commonly available in rice fields in northeastern India

In Assam, many of the old fortresses constructed by tribal chief of the state are being used under this type of farming practices. One such fortress Jangal Balahu garh (37ha) in Nagaon district has a high perimeter dyke surrounding the entire area, horizontal deep trenches and wooden sluice structures present in one corner of the plot offering a readymade site for rice-fish farming[5]. In districts of Barpeta, Bongaigaon and Kokrajhar rice fields are often connected by canal systems locally called as 'Dong'. To facilitate aquaculture the Dong are enclosed by bamboo pens to prevent escape of the fish from the rice field, which are harvested after recession of the water. The tribal communities of Boro and Rajbangshis are very well trained in this type of aquaculture and local fishers supply huge fish to local markets from such harvests. In the lowland areas of Barpeta and Nagaon district 'wild' aquatic farming is so popular among the farmers that they often use their jute retting tanks as trap ponds in the field. In many areas farmers deliberately stock their closed rice fields with fish seed during the wet season but they normally they do not normally follow and any scientific system of culture.

Mountain valley rice-fish system

In the hilly states of Northeast India many rice fields are located in mountain valleys where water accumulates from adjoining slopes and flows down the valley. Dwarf varieties of rice are generally cultivated in such plots mainly integrated with culture of common carp *Cyprinus carpio*. Naturally various weed fishes from colonize in those fields during the period of inundation.

The states of Arunachal Pradesh, Mizoram, Meghalaya, Nagaland and Tripura have a type of huge rice field where farmers intentionally allow various fish species to grow along with their rice crop. These are harvested at the end of rice season either from the irrigation channel or from the specially dug fish refuges in the plots. The production rate from such plots could be raised up to 200kg/ha/season.

The best example of mountain valley rice fish culture in the region is in the Apatani plateau of Arunachal Pradesh. These plots have more or less uniform elevation. Mountain valley plots are gently sloping and are characterized by two- and three-sided dykes. These types of plots are common in the valley areas of the northeast but are not generally utilized for culture fisheries.

Running water terrace rice-fish system

In the hilly terrain of Meghalaya, Sikkim and in certain parts of Arunachal Pradesh, the rice fields are in the form of terraces spaced over mountain slopes. This provides opportunities, as in Japan, to develop running water fish culture systems in the rice fields. The water from the stream irrigated and rain-fed plots trickles down from plots at higher altitude to lower ones creating a flow through system within the plots. The terrace type of plots are stocked with common carp at a density of 6,000/ha and fed either with 1:1 mustard oil cakes and rice bran at 1kg/ha or simply provided with domestic kitchen waste, giving an average production of 186kg/ha in two months.

Farmers practice terracing in certain areas of Arunachal Pradesh, particularly in most of the hilly areas adjoining the Apatani plateau contour. To reduce soil erosion, water is funneled into trench constructed at the edge of each terrace. This seems to have good potential for replication in hilly areas where soils have good water retention. A dyke on one side is usually sufficient to retain water in an

Figure 5. Community harvesting of a marginal swamp of the rice fields

Figure 6: Dewatering of perimeter canal for harvesting of fish

800-1000 m^2 trench. An earthen spillway in the dyke is needed to drain off excess water. A one-way bamboo gate across the spillway serves to prevent stocked fish from escaping but also allows wild fish to enter the field. Traditionally a simple bamboo gate is used to prevent stocked fish from escaping.

Fish farming in rice fields has become an additional source of income and important economic avenue among the Apatani farm families of the state. Local farmers have modified the system in such way that it has become an excellent example of rice fish-farming system in hill tracks and it has also become intimately related with the agrarian life of Apatani people in Northeastern states of India.

Indigenous versus modern culture systems

All the rice fish systems prevailing in Northeastern states of India (except mountain valley and terrace culture systems) are chiefly dependent on wild fish seed resources. The wild fish and fry enter the rice fields during initial flooding and additional water exchange from the permanent lakes and rivers. Therefore, the success of fish output from such fields depends on adequate natural spawning

Figure 7: Wild stream fishes from waterlogged mountain valley rice fields

Figure 8: Use of bamboo pens in wild aqua-cropping system

and survival of fingerlings, much of which occurs in seasonally flooded rice fields during the monsoon. This natural stocking system is hampered if (a) indiscriminate fishing at first flooding is allowed due to depletion of gravid females leading to poor spawning in the field or (b) if rice cultivation is intensified adopting modern management practices, which will also inhibit spawning and fry production.

"Fish farming in rice fields has become an additional source of income and important economic avenue..."

Irrespective of the rice ecosystems the indigenous farming of rice and fish are mostly concurrent in nature. So, the capture fishery and wild aquatic cropping systems are commonly found in areas that are water logged during the water season and where inundated fields become connected with perennial water bodies. The capture system is a customary and seasonal habit of rice farmers and fishers living around waterlogged rice agricultural systems. These areas face a lot of constraints in adopting modern rice production systems. The indigenous practices that prevail there were developed locally by farmers. The supplementary harvest of fish from rice fields is an innovation to increase returns.

In upland or shallow water rice fields where dwarf high yielding rice varieties are cultivated, modern tools and practices are required. The seepage of agricultural chemicals through runoff water into flooded fields can cause the destruction of aquatic fauna. As a result, the capture yields of fishes from rice fields are gradually declining in many states of India. A survey report from the district of Barpeta, Assam revealed that many species of wild fishes and prawns are

Table 1: Wild fish production from deep-water rice field environment of Barpeta district, Assam

Development bocks	No. pockets surveyed **	Fish production (kg/ha/season)	Average yield (kg/ha/season)
1. Barpeta	10	45.0-136.0	98.4
2. Chenga	5	80.0-118.0	97.8
3. Mandia	5	105.0-215.0	135.5
4. Bhabanipur	12	82.5-280.0	138.0
5. Gobardhana	5	63.5-115.0	75.0
6. Rupahi	4	49.0-120.0	71.0
7. Bajali	5	82.0-160.0	89.8
8. Jalah	4	58.0-116.2	78.0
Total	**45**	**45.0-280.0**	**97.9**

** Individual farmers were interviewed during the period of fish capture*
*** Based on farmers interview during the Season (June-December) 1992*

Table 2: District-wise rice area, developed rice fish culture area and total fisheries area in Arunachal Pradesh

District	*Rice area (ha)		Culture fisheries area (ha)**	
	Irrigated	Un-irrigated	Rice-fish culture	Total
Tawang	216	533	50.0	66.23
West Kameng	133	1433	75.0	114.70
East Kameng	954	3475	15.0	39.18
Lower Subansiri	4443	8867	547.0	626.76
Papum Pare	-	-	10.0	136.19
Upper Subansiri	913	7461	69.0	123.19
West Siang	4335	9853	40.0	87.14
East Siang	6011	3717	22.0	72.22
Upper Siang	-	-	17.0	42.25
Dibang Valley	684	6249	-	38.98
Lohit	1428	8466	7.0	148.97
Tirap	11	4120	10.0	45.22
Changlang	2677	6583	-	70.70
Total	21805	60757	862.0	1611.73

** Approximated land census data*
*** Approximated data from fisheries report, Govt. of Arunachal Pradesh*

Table 3: Potential rice-fish culture areas of the Northeast India

State	Scope for Cultivation (ha)	Area under cultivation (ha)	Total production (ha)	Average (Kg/ha/year)
Arunachal Pradesh	2,650	150	2800	125
Assam	15,000	N/A	15,000	N/A
Manipur	1,600	400	2,000	200
Meghalaya	2,200	50	2,250	380+
Mizoram	400	N/A	400	N/A
Nagaland	400	120	520	250
Tripura	5,000	N/A	5,000	300++
Total	27,250	720	27,970	251

NA Not Available
** Adopted after Lipton, 1983*
+ Experimental observations (Ghosh, 1981)
++ Experimental observations (Lipton, 1982)

declining sharply in their availability throughout the season. In that context, the traditional wild capture and aqua cropping systems should either be improved or replaced by adopting suitable culture techniques. Almost in all the states of Northeastern India have plenty of areas under flooded paddy fields (Table 2,3). This would definitely increase yields, enhancing socio-economic development in rural areas.

Figure 9. A terrace plot under rice-fish farming in Apatani plateau, Arunachal Pradesh, India.

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