Oryza Vol. 49 No. 1, 2012 (53-56)

# Rice-fish farming – a potential venture for livelihood security for the tribal community of East Siang district of Arunachal Pradesh

**Debashish Sen, Shah M. Hussain[1] and M. Pathak[1]**
*College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh*
*[1]KVK, East Siang Dist.,CHF, CAU, Pasighat, Arunachal Pradesh*

## ABSTRACT

*A multi-locational trial on rizi-pisciculture was conducted to evaluate the feasibility and economic viability of rice fish culture (RFC) in the East Siang District of Arunachal Pradesh. The experiment was conducted in the wet season of 2010 and 2011 in 4 villages of the district viz. Ngorlung, Niglok, Balek and Mirem. One experimental unit at each location was prepared for RFC, while at Ngorlung, another adjacent plot of rice sole cropping (control) was studied separately. In all the location under study, survival rate of advanced fry was recorded between 41.7 % and 45.4 % with an average size of 80g to 90 g at harvest. Average grain yield recorded in RFC field (4.86 t ha$^{-1}$) was 12% higher than the control (4.33 t ha$^{-1}$) with additional mean fish productivity of 3.56 q ha$^{-1}$. Total cost of cultivation of RFC and sole cropping of rice was recorded to be ₹ 40,800 and ₹. 24,450 respectively. Average gross income and net income increased by ₹. 44,528 and ₹. 28,178 respectively by practicing RFC over the sole cropping of rice and it also raised the benefit-cost ratio of the system (2.19)*

***Key words:*** *rice fish culture (RFC), yield, production economics, livelihood, Arunachal Pradesh*

Integrated rice-fish farming system is an age old practice followed in countries like China, Japan, Indonesia, Philippines, Vietnam, Malaysia, Thailand, Myanmar and India. Rice and fish are fundamental components of farming systems and diets in many nations (Ofori et al., 2005). Rice-fish duo culture is a type of farming system in which rice is the main enterprise and fish are taken as additional means to secure extra income. This system may open a new horizon to improve farmer's socio-economic conditions enhancing land use efficiency at low inputs and by waste recycling. Rice-fish culture (RFC) under either capture systems or culture systems is a low-cost sustainable practice to obtain high value protein food and minerals (Frei and Becker, 2005a).The rice-fish ecosystem in an agro ecosystem, which is made up of two components, where rice and fish component each other utilize different ecological niches and function together. This system can increase overall farm output by increasing rice production, offering better weed and pest control at certain times and enhancing soil fertility (Fernando, 1993). Irrigated rice areas with appropriate infrastructure can potentially be used for concurrent fish production (Frei and Becker, 2005b).

Tribal community of north eastern states including Arunachal Pradesh is predominantly non-vegetarian and demand fish in their daily diet. Per capita consumption of fish in NE region is around 11 kg, against the desired level 21 kg. The region is shortfall by 50-55 per cent of fish requirements, and this amount is met by procurement from outside the region. Hill topography of north eastern states constraints development of ponds and tanks for aquaculture. While, there is a high pressure on foothills for agriculture mostly riziculture and other activities. Under these circumstances, there is a need to switch over from traditional method of agriculture to technically sound integrated farming approaches. Potential rice-fish area of Arunachal Pradesh is 2650 ha, out of which only 150 ha is under this system with an average productivity of 125 kg$^{-1}$ ha$^{-1}$ year$^{-1}$ (Das, 2002). Rice-fish system is practiced traditionally by the farmers of Apatani Plateau in Arunachal Pradesh since time immortal with

production of fish ranging between 150–250 Kg ha$^{-1}$ within 3 months in addition to rice production.

East Siang District receives ample rain water during the monsoon period, during which rice culture is the major activity of the tribal community. As the region receives high rainfall, there is a tremendous potential of producing fish from existing rice field. The ecology of rice fields of the district can be divided into upland terrace cultivation, lowland/foothill rice ecosystems. Catching fish from rice fields is a common traditional practice between the villagers of the district. Keeping these in view, a multi-locational trial on rizi-pisciculture was conducted to evaluate the feasibility and economic viability in the prevailing agro-ecological condition of the district.

## MATERIALS AND METHODS

The experiment was conducted in the wet season of 2010 and 2011 in 4 villages of East Siang District *viz.* Ngorlung, Niglok, Balek and Mirem, all surrounding the district headquarters Pasighat at 219 m altitude. One experimental unit at each location was prepared for rice-fish culture (RFC), while at Ngorlung, another adjacent plot of rice sole cropping (control) was studied separately. Area under study at each location ranged between 1000 and 1500 m$^2$ (Table 1). Around 8% of the total area was utilized for making the trenches and ditches for providing shelter to the fish during the dry spell and for easy harvesting of fish while rest of the area was under rice cultivation. Land preparation for rice cultivation was done according to the common practice of the farmers. Agricultural lime @ 50 kg ha$^{-1}$ was applied in the experimental sites during the land preparation of the rice field. One month old seedlings of local rice variety Deku were transplanted in the 2$^{nd}$ week of July, 2010 and 2011at the spacing of 20 X 10 cm. After 15 days of transplanting, advance fry of common carp (*Cyprinus carpio*), rohu (*Labeo rohita*) and mrigala (*Cirrhinus mrigala*) were released in the rice field at the rate of 10000 ha$^{-1}$ (Table 1) with a ratio of 3:1:1. In the inlet and outlet of water channel, bamboo made net was fixed to check escape of the fishes. Supplementary feeding with mustard oil cake and rice bran in 1:1 ratio were provided to the fishes. No fertilizer and other agricultural chemicals was used in the experimental units. Rice-fish integration reduces use of fertilizers (Yong *et al*., 2006), pesticides and herbicides (Kathiresan, 2007) in the field. To prevent entry of snakes, locally available Patchouli (*Pogostemon cablin*) and Tulsi (*Ocimum sanctum*) plants were planted in the periphery of rice- fish plots. Harvesting of rice and fish was done in the first fortnight of November in both the years under study. Pooled data of 2010 and 2011 were utilized for comparative study of the experimental findings.

## RESULTS AND DISCUSSION

It was observed that there was not any distinct differences in the water quality parameter *viz.* pH and temperature between the RFC and rice sole cropping (Table 1). In both cases, water in the rice field observed during maximum tillering stage was moderately acidic and water temperature was found to be optimum for growth and development of both rice and fish. In all the location under study, survival rate of advanced fry was recorded between 41.7 % and 45.4 % with an average size of 80 g to 90 g at harvest (Table 2). Very good harvest of rice ranging from 490 kg to 675 kg from the small holding of 0.10 ha – 0.15 ha was recorded in all RFC and rice sole cropping plot. Fish harvest to

**Table 1. Total area (fish area), rice area, number of fish stocked and water quality parameters observed in various experimental units (pooled data of 2010 and 2011)**

| Village | Total Area/ Area under Fish (m$^2$) | Area under rice (m$^2$) | Number of advance fry stock | Water quality parameter | |
|---|---|---|---|---|---|
| | | | | pH | Temperature (ºC) |
| Ngorlung (RFC) | 1500 | 1380 | 1500 | 5.5 | 29.8 |
| Niglok (RFC) | 1200 | 1100 | 1200 | 5.1 | 27.9 |
| Balek (RFC) | 1000 | 930 | 1000 | 4.8 | 29.3 |
| Mirem (RFC) | 1500 | 1360 | 1500 | 5.6 | 30.6 |
| Ngorlung (control) | 1500 | 1500 | —- | 4.6 | 30.1 |

**Table 2. Survival rate, average recovery size of fish, gross harvest of rice and fish in various experimental units (pooled data of 2010 and 2011)**

| Village | Number of fish recovery (Survival %) | Average size of fish at harvest (g) | Rice harvest per plot (kg) | Fish harvest per plot (kg) |
|---|---|---|---|---|
| Ngorlung (RFC) | 650 (43.3) | 85 | 675 | 55.80 |
| Niglok (RFC) | 523 (43.6) | 82 | 490 | 41.04 |
| Balek (RFC) | 454 (45.4) | 80 | 491 | 33.50 |
| Mirem (RFC) | 625 (41.7) | 90 | 654 | 56.25 |
| Ngorlung (control) | — | — | 650 | — |

the tune of 33.5 kg to 56.3 kg was recorded as an additional source of both income generation as well as rich nutrition of the farmers' own family member (Table 2).

Total cost of cultivation of RFC and sole cropping of rice was recorded to be ₹. 40,800 and ₹. 24,450 respectively (Table 3). An additional amount of ₹. 1,000 was required in tillage and earth work operation for preparation of trenches and ditches for the fish in RFC. On the contrary, rice seed cost was comparatively low in RFC than the pure rice culture since in the former case, around 92% of the total area was under rice. It was noted that, the rice yield was more in all RFC than sole cropping of rice irrespective of the location (Table 4). Average grain yield recorded in RFC field (4.86 t $ha^{-1}$) was 12% higher than the control (4.33 t $ha^{-1}$). This might be attributed to increased oxyzen level by movement of fishes, supplementary soil nutrition by addition of their feacal material and control of insect pest of rice. Similar observations were also made by

**Table 3. Cost of cultivation of Rice-Fish Culture and sole cropping of rice**

| Head of Expenditure | Qty./No. ($ha^{-1}$) | Rate (₹) | Cost (Rs $ha^{-1}$) | |
|---|---|---|---|---|
| | | | RFC | Sole cropping of rice |
| Tillage and Earth work | — | | 8,000 | 7000 |
| Rice seed | 50 kg $ha^{-1}$ | 10 | 450 | 500 |
| Manure | 6 t $ha^{-1}$ | 700 $t^{-1}$ | 4200 | 4200 |
| Agril. lime (for soil reclamation) | 50 kg | 15 $kg^{-1}$ | 750 | 750 |
| Fish seed (advance fry) | 10000 Nos | 1 $piece^{-1}$ | 10,000 | — |
| Mustard oil cake (fish feed) | 300 kg | 12 $kg^{-1}$ | 3600 | — |
| Rice bran (fish feed) | 300 kg | 6 $kg^{-1}$ | 1800 | — |
| Agricultural labour | 120 person days | 100 $day^{-1}$ | 12,000 | 12,000 |
| Total | — | — | 40,800 | 24,450 |

**Table 4. Production and sale revenue of two components in the rice-fish farming system**

| Component | Unit | Rice-fish culture | | | | | Sole cropping of rice at Ngorlung |
|---|---|---|---|---|---|---|---|
| | | Ngorlung | Niglok | Balek | Mirem | Average | |
| Rice yield | t $ha^{-1}$ | 4.89 | 4.45 | 5.28 | 4.81 | 4.86 | 4.33 |
| Straw yield | t $ha^{-1}$ | 7.22 | 6.71 | 7.84 | 7.07 | 7.21 | 6.77 |
| Fish yield | q $ha^{-1}$ | 3.72 | 3.42 | 3.35 | 3.75 | 3.56 | —- |
| Income from rice grain | ₹ $ha^{-1}$ | 48,900 | 44,500 | 52,800 | 48,100 | 48,600 | 43,300 |
| Income from rice straw | ₹ $ha^{-1}$ | 1,444 | 1,342 | 1,568 | 1,414 | 1,422 | 1,354 |
| Income from fish | ₹ $ha^{-1}$ | 40,920 | 37,620 | 36,850 | 41,250 | 39,160 | —- |
| Gross income | ₹ $ha^{-1}$ | 91,264 | 83,462 | 91,218 | 90,764 | 89,182 | 44,654 |

**Table 5. Cost return analysis of RFC (Average of multi-locational trial) and sole cropping of rice**

| Parameter | Average of RFC (₹ ha$^{-1}$) | Sole cropping of rice (₹ ha$^{-1}$) |
|---|---|---|
| Income from Paddy | 48,600 | 43,300 |
| Income from Paddy straw | 1,422 | 1,354 |
| Income from fish | 39,160 | —- |
| Gross Income | 89,182 | 44,654 |
| Cost of Production | 40,800 | 24,450 |
| Net Income | 48,382 | 20,204 |
| Benefit-Cost Ratio | 2.19 | 1.83 |

Mohanty, 2002 and Gupta *et.al.*, 1998. Fish productivity from the RFC recorded from 3.35 q ha$^{-1}$ to 3.75 q ha$^{-1}$ in different locations under study with an average value of 3.56 q ha$^{-1}$. Average gross income and net income in RFC was ₹. 89182 and ₹. 48382 respectively, while in sole cropping of rice it was ₹. 44654 and ₹. 20204 respectively (Table 5). Integration of fish in rice culture increased the net profit of the system. This corroborate the findings of Saikia and Das, 2008. Benefit-cost ratio was also reported to be higher in RFC (2.19) than that of the sole culture of rice (1.83).

Main advantage of RFC is proper utilization of land resources and irrigation water as well as securing extra income from fish without additional labour. This system could be beneficial venture for optimum utilization of land and water resources especially for hilly terrain of East Siang district of Arunachal Pradesh. Moreover, it has the benefit of supplying rice as a source of carbohydrates and fish as a source of high quality protein. This aspect may be particularly relevant for the nutrition of tribal community of region. Adoption of this technique will open avenues for self-employment, supplement the income of the farmers and enhance fish production.

## REFERENCE

Das DN 2002. Fish farming in rice environments of North eastern India. Aquaculture Asia VII (2): 43-47.

Fernando CH 1993. Rice field ecology and fish culture-an overview. Hydrobiologia 259: 91-113.

Frei M and Becker K 2005a. Integrated rice-fish culture: Coupled production saves resources. Nat. Resour. Res., 29: 135-143.

Frei M and Becker K 2005b. Integrated rice–fish production and methane emission under greenhouse conditions. Agric. Ecosyst. Environ., 107: 51-56.

Gupta MV, Sollows JD, Majid MA, Rahman A, Hossain MG and Dey MM 1998. Integrating aquaculture with rice farming in Bangladesh: Feasibility and Economic viability, its adoption and impact. ICLARM, Tech. Rep.55, 90p.

Kathiresan RM 2007. Integration of elements of a farming system for sustainable weed and pest management in the tropics. Crop Prot., 26: 424-429.

Mohanty RK 2002. Studies on soil fertility, productivity and ecosystem as influenced by introduction of fish and prawn in rice-fish integration system. In: Aquatic Environment and Toxicology. Daya Publishing House, Delhi: 63 – 69.

Ofori J, Abban EK, Otoo E and Wakatsuki T 2005. Rice–fish culture: An option for smallholder Sawah rice farmers of the West African lowlands. Ecol. Eng., 24: 235-241.

Saikia SK and Das DN 2008. Rice-fish culture and its potential in rural development: A lesson from Apatani farmers, Arunachal Pradesh, India. J. Agric. Rural Dev., 6(1&2): 125-131.

Yong Y, Hong-cheng Z, Xiao-jun H, Qi-gen D and Yang-jiang Z 2006. Characteristics of growth and yield formation of rice in rice-fish farming system. Agric. Sci. China. 5(2): 103-110.