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AGRONOMY

Integrated Rizi-Pisciculture: An approach towards livelihood and nutritional security for the tribal community of East Siang district, Arunachal Pradesh

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Abstract

An approach was made to evaluate the feasibility and economic viability of rice fish culture (RFC) by conducting trials in 8 different villages *viz.* Ngorlung, Niglok, Balek, Mirem, Sikatode, Ayeng, Rayang and Seren of East Siang district, Arunachal Pradesh during *Kharif* seasons of 2011 to 2014. In the multilocational trials on rizi-pisciculture survival rate of advanced fry was recorded between 44.5 % and 48.7 % with an average weight of 83 g to 91 g at the harvest. During the study period average total cost of cultivation of RFC and sole cropping of rice was calculated to be ₹ 42,700 and ₹ 26,612 respectively. Average gross income and net income increased by ₹ 61,937 and ₹ 44,849 respectively by practicing RFC over the sole cropping of rice and it also raised the benefit-cost ratio of the system (2.61).

Highlights

- Main advantage of RFC is proper utilization of land resources and irrigation water as well as securing extra income from fish without additional labour.
- Survival rate of advanced fry was recorded between 44.5 % and 48.7 % with an average size of 83 g to 91 g at harvest
- Benefit-cost ratio was higher in RFC (2.61) than that of the sole culture of rice (1.98).

Keywords: Rice fish culture (RFC), pisciculture, yield, economics

In Northeastern region of India, livelihood of majority of the rural communities depends on rice farming. The tribal population of the region traditionally practices shifting and terrace rice cultivation in hills and wet rice cultivation in the valleys. The core diet of the inhabitants of the region is rice, millers, pulses and a wide variety of local semi domesticated and wild plants (Yumnam, 2011). Tribal community of NE states including Arunachal Pradesh is predominantly non-vegetarian and protein requirements are supplemented with animal meat, bush meat including birds and fishes. Even though the fish is an integral part of their diet still the aquaculture activities in the region is in primitive stage. The major constraint for development of ponds and tanks for aquaculture in north eastern states is hill topography. Whereas, there is a high pressure on foothills for agriculture mostly riziculture and other agricultural allied activities. Under these circumstances, there is a need to switch over from traditional method of agriculture to technically sound integrated farming systems. Rice-fish culture is a type of farming system in which rice is the main enterprise and fish are taken as additional means for nutritional security and 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. Integration of farm enterprises provides better livelihood in terms of

increased food production, higher net income, reduced income imbalances and improved health, habitat, educational and social status (Harishkumar *et al.* 2016). Frei and Becker (2005a) opined that 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. The rice-fish ecosystem in an agro ecosystem, which is made up of two components, where rice and fish supports each other by utilizing different ecological niches. 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). Fishes are invariable living components of water bodies. These organisms are important food resources and good indicators of the ecological health of the water they inhabit (Sarkar *et al.* 2015). Frei and Becker (2005b) reported irrigated rice areas with appropriate infrastructure can potentially be used for concurrent fish production. Integration of two or more enterprises in irrigated situations enhances productivity, profitability and nutritional security of the farmer and sustains soil productivity through recycling of organic sources of nutrients from the enterprises involved there by their livelihoods can be sustained (Desai *et al.* 2013). 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/ha/year (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 within 3 months in addition to rice production.

Sen *et al*. (2012) reported that East Siang district of Arunachal Pradesh receives ample rain water during the monsoon season, during which rice culture is the major activity of the tribal community. As the region receives high rainfall, there is ample scope for producing fish along with rice in existing paddy fields. The ecology of rice fields of the district can be divided into upland terrace cultivation, lowland/ foothill rice ecosystems (*pani kheti*). Catching fish from rice fields is a common traditional practice among the villagers of the district. Keeping above facts in view, a multi-locational experiment on rizi-pisciculture was conducted to evaluate the feasibility and economic viability of rice fish farming in the prevailing agro-ecological situation of the district.

Materials and Methods

The present investigations were carried out in 08 different villages *viz.* Ngorlung, Niglok, Balek, Mirem, Sikatode, Ayeng, Rayang and Seren of East Siang district, Arunachal Pradesh during *Kharif* seasons of 2011 to 2014. The villages are located surrounding the district headquarters Pasighat (28°04′ N, 95°22′ E and 219 m altitude). One experimental unit at each location was prepared for rice-fish culture (RFC), while at Balek, Sikatode, Ayeng and Seren, another adjacent plot of rice sole cropping (control) was studied separately. Experimental area under study at each location ranged between 1000 and 2500 m^2 (Table 1). Around 7-13% of the total area was utilized for making the tranches and ditches for providing shelter to fishes during the dry spell and for easy harvesting of fishes while rest of the area was under rice cultivation and movement of fishes during the cropping season. Land preparation for rice cultivation was done by adopting traditional practice of the farmers.

Agricultural lime @ 50 kg/ha was applied in the experimental fields during the land preparation. Approximately one month old seedlings of local rice variety *Deku* were transplanted in the 2nd and 3rd week of July, in all the years at the spacing of 20-25 × 10-15 cm. After 15 days of transplanting when paddy roots holds the earth, advance fry of common carp (*Cyprinus carpio*), rohu (*Labeo rohita*) and mrigala (*Cirrhinus mrigala*) were released in the rice field @ 10,000/ha (Table 1) with a ratio of 3:1:1. In the inlet and outlet of water channel, bamboo made nets were 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 agrochemicals were used in the experimental fields. Rice-fish integration reduces the use of fertilizers as opined by Yong *et al.* (2006), pesticides and herbicides by Kathiresan (2007) in the field. Harvesting of rice and fish was done in the first fortnight of November in the different years. Pooled data of 2011 to 2014 were utilized for comparative study of the experimental findings.

Results and Discussion

In all the locations under study, survival rate of advanced fry was recorded between 44.5% and 48.7% with an average size of 83g to 91g at harvest (Table 2). A good harvest of rice ranging from 48.8q

Table 1: Total area (fish area), rice area, number of fish stocked and water quality parameters observed in various experimental units during 2011 to 2014

Village	Total Area/ Area under Fish (m^2)	Area under rice (m^2)	Number of advance fry stock	Water quality parameter	
				pH	Temperature (˚C)
		Year 2011			
Ngorlung (RFC)	2000	1860	2000	5.4	29.7
Niglok (RFC)	1500	1320	1500	5.2	27.8
Balek (RFC)	1000	920	1000	4.9	29.5
Mirem (RFC)	1500	1350	1500	5.5	30.7
WRC (Control) Balek	1500	1500	—	4.7	32.0
		Year 2012			
Rayang	1500	1380	1500	5.3	28.8
Sikatode	1000	900	1000	5.2	29.4
Mirem	1500	1300	1500	5.4	30.0
WRC (Control) Sikatode	2500	2500	—	4.9	31.2
		Year 2013			
Sikatode	1000	910	1000	4.8	29.7
Mirem	1500	1350	1500	5.7	31.7
Ayeng	1500	1300	1500	5.3	29.0
WRC (Control) Ayeng	1500	1500	—	4.8	30.1
		Year 2014			
Ayeng	2500	2275	2500	5.2	29.3
Mirem	2000	1800	2000	4.9	28.8
Seren	2000	1820	2000	4.9	30.2
WRC (Control) Seren	1500	1500	—	4.5	30.1

Table 2: Average Survival rate, recovery size of fish, gross harvest of rice and fish in various experimental units (pooled data of 2011 and 2014)

Year	Fish Survival %)	Average size of fish at harvest (g)	Rice harvest (kg/ha) (RFC)	Rice harvest (kg/ha) WRC (control)	Fish harvest per plot (kg)
Kharif 2011	44.5	88	4880	4700	398
Kharif 2012	47.7	84	4950	4300	379
Kharif 2013	45.4	91	5250	4600	367
Kharif 2014	48.7	83	5100	4400	386
Average	46.6	86.5	5045	4500	382.5

ha^{-1} to 52.5q ha^{-1} and from 46.0q ha^{-1} to 51.2q ha^{-1} was recorded in all RFC and rice sole cropping fields respectively. Fish harvest to the tune of 3.67q ha^{-1} to 3.98q ha^{-1} was recorded as an additional source of income and nutrition for the farmers (Table 2).

Total average cost of cultivation of RFC and sole cropping of rice was recorded to be ₹ 42,700 and ₹ 26,612 respectively (Table 3). Production of rice, straw and fish per field were computed for respective yield in q ha^{-1}. Average grain yield recorded in RFC fields (50.45 q ha^{-1}) was 4% higher than the control (45.0 q ha^{-1}). This might be attributed to increased oxyzen level by movement of fishes, supplementary soil nutrition by addition of their fecal material and control of insect pest of rice. Similar observations were also made by Mohanty, 2002 and Gupta *et al.*, 1998. Average Fish productivity from the RFC recorded was 3.83q ha^{-1}. Average gross

Table 3: Economics of Rice-Fish Culture and sole cropping of rice during the study period

Parameter (Average of different location)	RFC					Sole cropping of rice				
	2011	2012	2013	2014	Avg.	2011	2012	2013	2014	Avg.
Total Cost of production (₹ ha^{-1})	40,800	41,000	44,000	49,000	**42,700**	24,450	25,000	27,000	30,000	**26,612**
Yield of fishes (q ha^{-1})	3.98	3.79	3.67	3.86	**382.5**	—	—	—	—	
Rice yield (q ha^{-1})	48.8	49.5	52.5	51.0	**50.45**	47.0	43.0	46.0	44.0	**45.0**
Straw yield (q ha^{-1})	72.05	74.65	78.35	74.96	**75.00**	70.22	67.20	68.50	64.80	**67.68**
Income from fish	47,760	49,270	55,050	69,480	**55390**					
Income from rice grain	48,800	54,450	63,000	63,750	**57500**	47,000	47,300	55,200	55,000	**51125**
Income from rice straw	1,441	1,493	1,959	1,874	**1692**	1,404	1,344	1,713	1,620	**1520**
Gross income (₹ ha^{-1})	98,001	105,213	120,009	135,104	**114582**	48,404	48,644	56,913	56,620	**52645**
Net returns (₹ ha^{-1})	57,201	64,213	76009	86104	**70882**	23954	23644	29913	26620	**26033**
Benefit Cost ratio	2.40	2.56	2.73	2.76	**2.61**	1.97	1.95	2.11	1.89	1.98

- Sale price of fish per kg was ₹ 120, ₹ 130, 150 and ₹ 180; rice per kg was ₹ 10, ₹ 11, ₹ 12.0 and rice straw per kg was ₹ 0.20, ₹ 0.20, ₹ 0.25 and ₹ 0.25 in the year 2011, 2012, 2013 and 2014 respectively.
- Total cost of production includes cost of labour for pond preparation and management, fertilization application, liming, netting etc. and material cost like fish fingerlings, feed, fertilizer, lime etc.

Table 4: Average of Cost return analysis of RFC and sole cropping of rice during the study period

Parameter	RFC (₹ ha^{-1})	Sole cropping of rice (₹ ha^{-1})
Income from Paddy	57500	51125
Income from Paddy straw	1692	1520
Income from fish	55390	—
Gross Income	114582	52645
Cost of Production	42,700	26,612
Net Income	70882	26033
Benefit-Cost Ratio	2.61	1.98

income and net income in RFC was ₹ 1, 14,582 and ₹ 70,882 respectively, while in sole cropping of rice it was ₹ 52,645 and ₹ 26,033 respectively (Table 3). Integration of fish with rice culture increased the net profit of the system. This corroborates with the findings of Saikia and Das, 2008. Benefit-cost ratio was also recorded to be higher in RFC (2.61) than that of sole culture of rice (1.98).

Conclusion

Main advantage of RFC is proper utilization of land resources and irrigation water as well as securing extra income and nutritional security 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 optimum resource utilization and providing nutrition security of tribal community of region. Adoption of this technique will open new avenues for self-employment, supplement the income of the farmers and enhance fish production in the region.

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