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Participatory Fish Production in Dhalai District of Tripura, NE India

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ABSTRACT

Composite culture at a species composition of 40% catla (*Catla catla*), 30% rohu (*Labeo rohita*), 20% mrigal (*Cirrhinus mrigala*) and 10% grass carp (*Ctenopharyngodon idella*) in a combined stocking density of 5000 fingerlings ha^{-1} was demonstrated in participatory mode in Dhalai District of Tripura, NE India for three consecutive years (2009-10, 2010-11 and 2011-12) with an aim to see the production performance and economic benefit of the system over traditional culture system. Growth of the fish was higher in composite culture than traditional farming in all the locations. Grass carp dominated the size followed by catla, rohu and mrigal in all the ponds. Total production of fish in composite culture (934-1545 kg ha^{-1}) was higher than traditional farming (322-335 kg ha^{-1}). Gross profit in composite culture (Rs. 2,23,192 ha^{-1}) was higher than traditional farming (Rs. 58,386 ha^{-1}). Similarly, net profit in composite culture (Rs. 1,12,383 ha^{-1}) was higher than traditional method (Rs. 15,719 ha^{-1}). Benefit-cost ratio was 1.93 in composite culture and 1.36 in traditional culture. Overall, composite culture of fish was found as a viable option for enhancing fish production in Dhalai district of Tripura by 192-360%.

1. Introduction

Fish plays an important role in the economy of Tripura. More than 95% people of Tripura eat fish. The per capita fish consumption in the state is 20.07 kg which is highest among the inland states of the country. There is 1, 73,150 farmers depending on fisheries for livelihood. The total cultivable water area is 25,338 ha and total fish production is 61259 mt. Pond culture is the main form of fish production in the state. There is 6.6% annual increment in production of fish over the year, however, this do not meet the actual demand (80,153 mt) (Debnath et al. 2012). Improper stocking density, species composition, stocking ratio, fertilization and feeding strategies, non-availability of critical and quality inputs, poor water and soil quality, diseases etc are the major deterrents to the production of fish in Tripura. Tripura has eight districts of which socio-economically, Dhalai is the most backward district which still receives grants from the Union Government under the Backward Regions Grant Fund (BRGF). Here 76% people depend on agriculture and allied farming for livelihood.Fisheries also occupy a unique place in the livelihood. Total fish farmer is 22,015. Total area being used for fisheries is 1516 ha. Demand for fish is 3445.25 mt, however actual production is 2971.5 mt, hence there is a gap of 473.75 mt (Saha and Nath, 2013). This is due to non-adoption of technologies which are high-inputs oriented. Therefore, modification of technology according to local situations and needs is very much essential. Traditionally people grows different species of carps without following proper stocking density, species combination, stocking ratios, feeding, fertilization, water and soil quality management in the culture system. Cattle manure, lime, banana leaf, banana stem, rice bran, etc are used for pond fertilization and fish feeding, but the rates of application are very much inadequate. Methods followed during application of inputs are not appropriate. Stocking density of fish remains either above or below recommendation without proper combination of compatible species.

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As a result, productivity of the ponds is very low. There are various fish farming technologies of which, composite culture is the most profitable and sustainable.In this system, distinctive compatible species of Indian carps and exotic carps of dissimilar feeding habits are stocked and cultured together in the same pond so that all its ecological niches are utilized by the fishes. Present investigation is an attempt to quantify the yield advantages of composite culture over local traditional farming in Dhalai district of Tripura. Efforts have also been made to find out economic sustainability of the composite culture in the area for logical analysis and adoption of the technology by the fish growing community of the district.

2. Material and methods

The study was conducted during 2009-2012 as a part of National Agricultural Innovation Project (NAIP), Component-III, implemented by ICAR, Tripura Centre at Dhalai district of Tripura. The demonstration was carried out in four villages (Balaram, Moracherra, Kuchianala and Shivbari) located at Ambassa and Kamalpur sub-divisions in Dhalai. Fingerlings of catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and grass carp (*Ctenopharyngodon idella*) stocked, were procured from local vendors and ICAR. Fishes were stocked at a species composition of 40% catla, 30% rohu, 20% mrigal and 10% grass carp in a combined stocking density of 5000 fingerlings ha^{-1}. The management practices in composite fish farming were categorized into pre-stocking, stocking and post-stocking practices. Major steps followed in pre-stocking management were renovation of pond embankments, removal of shrubs, bushes etc in dykes, trimming of tree branches, clearance of aquatic weeds, eradication of predatory and weed fishes by using bleaching powder (350 kg ha^{-1}) and repeated netting, manuring by using cattle dung @ 10000 kg ha^{-1} (1/3rd applied as basal dose and rest applied at monthly interval) and liming with quick lime (@ 250 kg ha^{-1}) for regulating pH of the ponds. One third quantity of total amount of lime was applied as basal dose and rest was applied in split doses on monthly intervals after checking the pH of pond water. In stocking management, transportation of quality fingerling was one of the most important steps. In the present investigation, transportation of fingerlings was done in the early morning hours with oxygen packing from the ICAR farm of Tripura Centre located at West Tripura District. Acclimatization of the fingerlings was done for 18-24h before transportation. Before releasing the fingerlings in the ponds, polythene bags were allowed to stay in pond water for a period of 30 minutes for reducing the stress related to temperature fluctuation.

Then the bags were opened and fishes were allowed to swim-out slowly into the ponds without any disturbance. Supplementary feeding was followed on every alternate day with rice bran (14 kg ha^{-1}), mustard oil cake (7 kg ha^{-1}) and grass or leaves (17 kg ha^{-1}). Intermittent manuring and liming were done on monthly intervals to maintain the water quality of the ponds. Sampling for checking the health and growth of fish was done once in two months. After end of culture, the fish were harvested by repeated netting and production (kg ha^{-1}) of fish calculated.

Water quality parameters were analysed following the Standard methods (APHA 1998). Inorganic nutrients such as nitrite, nitrate, phosphate and silicate were measured in a spectroquant (Nova 60; Merck) using kits. Sediment samples analysed for pH, available nitrogen, available phosphorus and organic carbon following standard protocols.
The data were analysed through one-way ANOVA using SPSS, v11.2 to find out whether any difference existed among the means at 5% level of significance. A simple cost-benefit analysis was done to estimate the net profits.

3. Results and Discussion

The present study provided information on yield advantages of composite culture over traditional farming in Dhalai district of Tripura. The production of fish from composite culture in all the locations was much lower than earlier findings in this line, however, it was higher when compared with traditional methods of farming. This is due to supplementary feeding to the fishes as well as intermittent liming and manuring of the ponds in composite culture to produce optimum levels of phytoplankton and zooplankton (Pillay, 1995), which is affected in traditional methods in absence of proper feeding, fertilization and manuring strategies. Lower production in composite culture is due to lower rate of input application. To keep the technology affordable and sustainable by the farmers, application rate of inputs suggested was low. In traditional farming intense competition and overlapping of feeding niches among the different species of fish produced significantly low level of fish. Hossain et al (2013) also demonstrated more yield in composite culture than local practice of farming. Talukdar and Sontaki (2005) also described various advantages of composite culture. All fish varieties such as catla, rohu, mrigal and grass carp responded well in composite culture. The growth obtained over a period of one year of culture was highest in grass carps followed by catla, rohu and then mrigal. Higher growth of grass carp is due to regular supply of grass and leafy materials like Napier grass, banana leaves and stems etc.

Higher consumption of leaves by the grass carps provided more faecal inputs to produce more planktons for supporting higher in fish cohabiting with them in polyculture system (Haque et al. 1998). There was significant improvement in water and soil quality parameters of the ponds with the adoption of composite culture (Table 1). At all the locations, water and soil quality parameters were within the optimal ranges required for culturing fish (Debnath et al. 2015, Debnath et al. 2014, Debnath et al. 2013).

The fish production was more in composite culture than traditional farming in all the locations under study. The average productions were 934, 1294 and 1545 kg ha^{-1} in composite culture compared to 322, 328 and 335 kg ha^{-1} in traditional farming during 2009-10, 2010-11 and 2011-12, respectively (Table 2). This indicates 192%, 294% and 360% increments in production of fish during the respective aforesaid periods through composite culture which is due to adoption of proper pre-stocking, stocking and post-stocking management practices in the production system (Jena et al. 2002). Probably the cumulative effect of proper ratios of fingerlings with area and different layers of water bodies and regular supply of manure and feed accelerated better fish growth to produce more fish in composite culture (Yadav et al. 2013). Gradual increase in productivity of fish in composite culture over local practice might be due to the residual effect of incorporation of inputs like lime, manure and feed materials in the same ponds over the years (Murty et al. 1978, Yadava et al. 1992).Economic analysis of fish farming in composite culture and local practice showed profitability and sustainability of composite culture over local practice. The average cost of production of fish realized over the period of 2009-2012 was Rs. 1,15,461 ha^{-1} in composite culture and Rs. 42,666 ha^{-1} in local practice (Table 3). Variation in the cost of production in different years was due to variation as compared to the local practice due to adopting feeding, fertilization and management strategies in the former system. Average production of fish was 1261 kg ha^{-1} in composite culture and 328 kg ha^{-1} in traditional farming. Gross profit was Rs. 2,23,192 ha^{-1} in composite culture and Rs. 58,386 ha^{-1} in traditional farming whereas, net profit was Rs. 1, 12,383 ha^{-1} in composite culture and Rs. 15,719 ha^{-1} in traditional farming. Benefit-cost ratio was 1.93 in composite culture and 1.36 in the local practice. These findings reflect that production of fish is more profitable in composite culture than traditional practice which is because of adoption of better management practices.

Those farmers, who have a tendency to maximize their income from fisheries, were better motivated in producing fish under composite culture (Biswas et al. 1991). Hence, from this demonstration, it is clear that, composite culture is a beneficial venture for optimum utilization of land and water resources in Dhalai District of Tripura. Adoption and intensification of composite culture will generate more income and employment for the farmers. This can open new avenues for the self-employment of rural youths and women.

Table 1. Mean values (±SD) of water quality parameters, soil quality parameters and plankton volume of the ponds under composite culture and traditional farming

Parameters	Traditional farming	Composite culture
Temperature (^{0}C)	$28.72±0.35^a$	$28.8±0.20^a$
Transparency (cm)	$45±8.04^a$	$17.71±2.62^b$
pH	$6.34±0.35^a$	$7.17±0.12^b$
Dissolved oxygen (mgl^{-1})	$4.47±0.07^a$	$5.15±0.62^b$
Total alkalinity (mgl^{-1})	$36.0±4.93^a$	$64.5±12.12^b$
Nitrate-nitrogen (mgl^{-1})	$2.65±0.95^a$	$1.82±0.05^b$
Nitrite-nitrogen (mgl^{-1})	$0.10±0.12^a$	$0.04±0.007^b$
Phosphate phosphorus (mgl^{-1})	$0.72±1.05^a$	$1.37±2.07^b$
Silicate (mgl^{-1})	$1.89±1.25^a$	$5.15±0.60^b$
Soil pH	$6.34±0.16^a$	$6.5±0.17^a$
Soil avail. N	$14.18±1.53^a$	$19.85±2.70^b$
Soil avail. P	$1.92±0.40^a$	$3.25±0.55^b$
OC	$0.17±0.07^a$	$0.45±0.13^b$
Plankton (ml/50 L)	$0.47±0.19^a$	$2.2±0.74^b$

Figures in the same row having the same superscripts are not significantly

Table 2. Year-wise average production of fish (kg ha^{-1}) in composite culture and traditional farming

Year	Balaram	Moracherra	Kuchianella	Sbhibbari	Avg. yield	% increase
	Composite culture					
2009-10	945	943.4	935	950	943	192
2011-12	1275	1302	1310	1290	1294	294
2012-13	1540	1540	1577	1525	1545	360
	Traditional farming					
2009-10	305	340	310	335	323	
2011-12	342	318	333	320	328	
2012-13	297	332	333	380	335	

Table 3. Economics of fish farming in composite culture and traditional practice

Parameter (Average of different location)	Composite culture				Traditional farming			
	2009-10	2010-11	2011-12	Avg.	2009-10	2010-11	2011-12	Avg.
Total cost of production (Rs. ha^{-1})	98400	117600	130383	115461	38000	40000	50000	42666
Gross profit (Rs. ha^{-1})	141500	232950	309083	223192	48375	59100	67083	58386
Net returns (Rs. ha^{-1})	43100	115350	178700	112383	10375	19100	17083	15719
Benefit Cost ratio	1.44	1.98	2.37	1.93	1.27	1.47	1.34	1.36

Sale prices of fish during the periods of 2009-10, 2010-11 and 2011-12 were Rs.150/-, Rs. 180/- and Rs. 200/- respectively.

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