ADOPTION GAP IN SCIENTIFIC FISH PRODUCTION PRACTICES AMONG FISH FARMERS IN TRIPURA

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Aquaculture is an important economic activity in Tripura, both from an economic and nutritional point of view. The current level of fish production in the state is not able to meet the burgeoning demand and hence large amount of fish is being brought from other states of India. Therefore to identify the adoption gap of improved production practices of carp among the farmers, this study was conducted out using *ex-post facto* research design in the purposively selected districts of South Tripura and West Tripura. Total two hundred fish farmers were selected for the study. The overall adoption index in the study area was found 59.74. Non adoption was more in five practices such as the use of aerators, feeding, liming, water exchange and quality monitoring and stocking. Majority of the fish farmers (20%) practiced the 5 species ratioof rohu+catla+mrigal+common carp+silver carp on the average ratio of 26.72:23.45:14.28:18.45: 17.1. Non adoption was more observed in use of aerators (54.25%) to control the oxygen deficiency in the pond. This was followed by supplementary feeding (51.15%), liming (43.31%), water exchange and quality monitoring (40.37%) and stocking (39.65%). The adoption score and index were not encouraging as both were low, which suggests that there are a lot of scope for extension system with regard to empowering the farmers educationally. Farmers may be encouraged for formation of farmer-group.

INTRODUCTION

Tripura is a landlocked hilly state in northeastern India with altitudes varying from 15 to 940 m above sea level. It is the second smallest state in area of around 10,492 sq. km. (after Sikkim), but second most populous state (after Assam), among the eight land-locked north-eastern states, is categorized as resource poor state with heavy pressure on land and low normal productivity because of its soil being mostly acidic. About 60% of the land is under forest and the remaining area comprising largely hilly land with small portion under valley. It constitutes 0.31% population of India and 8.18% of the North East. The state receives more than 2000 mm rainfall annually.

Fishery occupies an unique place in the socio-economic life of the people in Tripura. The Government of Tripura lays special focus on promoting fish farming as fish is the most important part of diet of 95% population and an important source of income and nutritional security for the rural population. Presently the state is blessed with a total area of 23,108 ha under aquaculture (2013-14). The current average productivity is 2,581 kg/ha/year but to meet the burgeoning need of the consumers in the state the target is set at 3200 kg/ha/year. Despite, the good number of fishery resources the state has to import around 11,886 MT fish on an average every year to meet the burgeoning demand in fish consumption. Presently around 1.70 lakhs people are engaged in fishery in the state. The scope for horizontal expansion in aquaculture is limited in the state due to hilly topography as well as wide coverage of forest area. Therefore, to reduce the gap between demand and supply and to achieve fish self-sufficiency in the state, importance is given to explore the vertical expansion in fish production.

The principle behind the scientific fish culture or improved practices for fish production is to produce maximum quantity of fish per unit area from a scientifically managed water body by stocking fast growing, economically important, compatible species having shortest food chain utilizing the all ecological niches of the water body. Though, fish culture is an age old practice in Tripura, but, the adoption behavior of fish farmers about improved production practices is not known. In fact, hardly any systematic research was done to explore these areas. Keeping in view the dearth of such studies especially in Tripura, the present study was undertaken to understand the adoption gap in recommended practices of Department of Fisheries andto identify the constraints in adoption of these practices, so that steps can be taken to remove the impediments in adoption.

MATERIALS AND METHODS

The study was conducted out using *ex-post facto* research design in the purposively selected districts i.e.; South Tripura and West Tripura. The basis for selecting the district was that both the district ranks first and second respectively in terms of culturable water area, fish production as well as in demand. Two blocks from each district were selected purposively and five villages were selected from each block using by simple random sampling method. However, before finally administering, the entire schedule was pre-tested in the field on a separate sample of farmers household. On the basis of pre-test, necessary additions, deletions and alterations were made in the schedule. Ten fish farmers were selected from each village using simple random sampling method. Thus, a total 200 fish farmer constituted the respondents for the study. Sixty improved practices of carp production were prepared with consultation of experts from Department of Fisheries and College of Fisheries (CAU), Tripura and grouped into some domain such as pond preparation, liming, manuring the pond, stocking, post stocking feeding and management, water exchange and quality monitoring, use of aerators, health monitoring and management, handling-storage & transportation. The final data was collected from the individual farmers through observation and personal interview with the help of structured interview schedule, keeping in view the objective and variables. The adoption index was used to ascertain the adoption level of all the recommended practices. A score 'one' was awarded for adopting the practice and 'zero' for non-adopting it. The "adoption index" was calculated with the help of formula as given below:

$$\text{Adoption index} = \frac{\text{Score obtained}}{\text{Maximum obtainable score}} \times 100$$

Further, the gap between the existing and recommended technologies was identified for each practice. The adoption gap between the existing and recommended technologies was measured in the line of Burman *et al*. (2010). To identify the technological constraints perceived by the fish farmers, items regarding software and hardware technologies were prepared and administered to the respondents. These statements were assigned 0, 1, 2 score as not serious, serious or very serious respectively. The total score for each constraint was calculated with the help of the responses received from all 200 respondents. The mean score for a particular constraint was worked out by dividing with the weighted score of the constraints with the total number of respondents. Afterwards, the ranking of constraints was done according to mean score of each statement.

RESULTS AND DISCUSSION

Average fish yield from the pond of the respondents

It was observed from the Table 1 that more than half of the sampled respondents (51.5%) had low to lower medium level of yield (up to 1281 kg/ha), followed by around 48 percent respondents obtained more than 1281 kg/ha yield in their pond. The average fish yield in the study area is around 1738 kg/ha as compared to the scientific composite fish culture (i.e., 2500 kg/ha) (Anonymous, 2002). The possible reason for this trend might be due to the fact that the sampled farmers did not adopt the improved practices of fish production. Singh and Pandey (2005) found the average yield in South Tripura was 1460 kg/ha. Therefore, it can be concluded that the average yield in the study area has been improving over the year.

Table-1. Average fish yield from the pond of the respondents

Sl. No.	Fish yield	Frequency	Percentage
1.	Low (upto 1283 kg/ha)	50	25
2.	Lower medium (1283-1656 kg/ ha)	53	26.5
3.	Higher medium (1656-1975 kg/ha)	49	24.5
4.	High(>1975 kg/ha)	48	24
	Total	**200**	**100**

Extent of adoption of improved production practices of carp

In this study, extensive fish culture was mostly found followed by semi-intensive culture system. The distribution of respondents based on their level of adoption of improved practices of carp culture is shown in Table 2. Majority of the respondents (29.5%) belonged to 'lower medium' category followed by 25.5%, 23% and 22% in 'low', 'upper medium' and 'high' categories of adoption of improved practices of carp culture, respectively. Around 45% of respondents were upper medium to high level of adopters, which might be due to the reason that most of the farmers have correct knowledge about many of the simple and basic practices of improved practices of carp culture. Although this is an encouraging trend, efforts are still required to promote large-scale adoption of this technology. This finding is in conformity with the results reported by Talukdar and Sontaki (2005).

Table 2. Distribution of respondents according to extent of adoption of recommended improved production technology of carp

Sl. No.	Variables	Level	Frequency	Percentage	Mean	SD
1.	Adoption	Low (up to 87)	51	25.5		
		Lower medium (88-93)	59	29.5		
		Upper medium(94-97)	46	23.0		
		High (more than 97)	44	22.0	91.34	8.94

The overall adoption index in the study area was 59.74.

Adoption gap of improved production practices of carp in the study area

The gap between the existing and recommended technologies was presented in Table 3. The non-adoption was more in use of aerators (54.25%) to control the oxygen deficiency in the pond followed by supplementary feeding (51.15%), liming (43.31%), water exchange and quality monitoring (40.37%) and stocking (39.65%).

Table 3: Adoption gap of the respondents regarding recommended practices of improved production technology of carp

Sl. No.	Selected practice	Selected practice	Rank
1.	Pond preparation	31.41	VIII
2.	Liming	43.31	III
3.	Manuring the pond	26.41	IX
4.	Stocking	39.65	V
5.	Supplementary Feeding	51.15	II
6.	Water exchange and quality monitoring	40.37	IV
7.	Use of aerators	54.25	I
8.	Health monitoring and management	37.28	VII
9.	Handling, storage and transportation	38.25	VI

Level of existing practice and gap in adoption of aeration in case of oxygen stress

The gap between the existing and recommended technologies was presented in Table 4. In case of severe oxygen stress the provision of aeration in pond by using of mechanical aerator was almost negligible. Only two per cent of the sampled households adopted mechanical aerator. Dissolved oxygen stress in pond reportedly understood by the respondents through the surfacing of fishes especially in the early hours of the day. During overcast weather condition, the dissolved oxygen of the water tends to go down and surfacing of the fishes were seen especially in the early hours of the day some of the farmers (63%) agitated the pond surface water with the help of bamboo poles without knowing the rationale of the practice. This traditional practice was used which brought water in contact with atmospheric oxygen. The application of $KMnO_4$ as well as provision for replenishing the water in case of oxygen stress was not followed in the study area. The lower level of pond water in the study area was the major limiting factor for water exchange arrangement.

Table 4: Level of existing practice and gap in adoption of aeration in case of oxygen stress

Sl. No.	Recommended Practice to reduce oxygen stress	Selected practice	Rank
1.	Artificial aerators and replenishing of water through water exchange arrangement in the pond.	2 per cent of the sample	Almost full gap
2	Agitates the surface with bamboo	Followed by 63%	Partial gap
3.	Application of KMnO4 @25 Kg /ha	Not followed	Full gap
4.	Stop application of fertilizers and restriction of the feed load.	Followed by 12.5%	Higher gap
5.	Application of lime	1.5 per cent of the sample	Almost full gap
6.	Frequent monitoring of dissolved oxygen level with water testing kits	Not followed	Full gap
7.	Monitor the fish pond water with light green in colour and also with a transparency up to one foot	Followed by 72%	Lower gap

*Gap between recommended and existing technologies

Level of existing practice and gap in adoption of recommended supplementary feeding of fishes

The existing, recommended technologies related to the feeding of fishes and the gap between the existing and recommended technologies was presented in Table 5. Mostly extensive to semi-intensive aquaculture that resembles a fishery where the volume of fish produced per unit area is low but input running costs are also very low has been practiced in the study area. The number of ponds using recommended supplementary feed for pond fish culture in the study area is significantly lower. The higher number of farmers (72%) used rice bran and sometime MOC because it is available within their home and also needs low price to buy. However, the ratio of 1:1 was not followed in many cases. Higher gap of appropriate doses and appropriate intensity was found in the study area. Most of the farmers applied kitchen waste such as boiled rice and vegetables residues in the pond. Higher gap was witnessed in incorporation of animal protein in the fish feed. Around 19 percent of the fish farmers applied dry fish in their pond but proper ratio of 25-30 per cent was not followed. Grass carps were not treated with appropriate feeding practices. In addition, grass carp

Table 5: Level of Existing Practice and Gap in Adoption of Recommended Supplementary Feeding of Fishes

Sl. No.	Recommended Feeding Practice	Existing Practice	Average Gap in the Study Area
1.	MOC/ GNOC and Rice bran in 1:1 ration in 1- 2 times daily	Mixture was followed by 72% of the farmers without proper ratio and frequency. 4.5 per cent followed palate feed. Kitchen waste applied in the pond.	Partial gap
2.	Examine of the availability of natural fish food by traditional practice	Followed taking the pond water in a clean glass and watched through against the sunlight to view of actively moving minute organisms and greenish to brownish green colour of the water. Merging the hand in pond water they could identify the natural food availability.	Nil
3.	Examine the availability of natural fish food in the pond with the help of plankton net	Nil	Full gap
4.	Application of daily ration in the pond according to the biomass estimation from monthly sampling	Not followed	Full gap
5.	Feed application through broadcasting, satiation, feeding trays or perforated gunny bags	Mostly broadcasting. Perforated gunny bags and feeding trays was followed by 8%	-
6.	Stop feeding the fishes if water colour becomes dark green or bluish green in colour	Followed	Nil
7.	Daily ration in two splits during morning and evening	Not followed	Full gap
8.	Duckweed/Hydrilla/finely chopped grasses (Napier) /soft vegetables leaves etc. in one or two fixed place of bamboo frame (3mx3m) on the water surface for in case grass	Only banana leaves and grasses are applied in few cases	Higher gap
9.	Supplementary feeding with 25-30% of animal protein	Dry fish applied by 19.5% of the farmers but not in appropriate dose.	Higher gap

*Gap between recommended and existing technologies

(*Ctenopharyngodon idella*), a common component of polycultures is commonly fed with on-farm vegetation such as grass, banana leaves. Application of duckweed, hydrilla, carrot leave, wolffia, azolla was not followed. The management of grass carp is very negligible in the study area. However, grass carp can be grown successfully in the study area with low cost feed with proper management. The rate of growth of grass carp was foundremarkable in the study area. Fertilization of fishponds with cattle manure stimulates the growth of plankton in the water and of microorganisms and invertebrate animals on the bottom. The plankton and benthic organisms serve as food for filter-feeding carps and bottom-feeding carps, respectively. Although manure is alternative used as a fuel and a crop fertilizer, many farmers were seen to use it as a pond fertilizer because of the profitability of fish farming.

Level of Existing Practice and Gap in Adoption of Liming

The third important gap has been found in application of liming (43.31%). As depicted in the table 6 more than two third of the farmers had knowledge and practice of lime application in their pond before stocking. However, higher gap was witnessed in the proper liming after ascertaining the pH value. Application of liming after stocking to maintain the pond environment was followed by 11.5 per cent of the sampled fish farmers who generally soak the lime overnight and spread by making uniform liquid on the water surface in case of ponds having fishes.

Table 6: Level of Existing Practice and Gap in Adoption of Liming

Sl. No.	Recommended Practice of Liming	Existing Practice	Average Gap in the Study Area
1.	Application of lime before stocking	78 % of the farmers adopted	Partial gap
2.	Application of lime in the pond after ascertaining the pH value of both the water and the bottom soil?	pH value was not ascertained before lime application	Almost full gap
3.	lime(CaO) @250-400 kg per hectare per year if soil pH is above 5 and below 7	Appropriate dose was not followed	Partial gap
4.	Application of lime @ 30% before stocking and rest per every three months after stocking	11.5 percent of the farmers adopted	Higher gap
5.	Rake the bottom several times after liming	5% of the farmers followed	Higher gap
6.	Soak the lime overnight and spread by making uniform liquid on the water surface in case of ponds having fishes	Followed by those farmers who applied liming every three months after stocking	Nil

*Gap between recommended and existing technologies

Fish species Mix and Stocking Rate Practiced by the Farmers

The species mix and the stocking rate are two important side of scientific fish culture. Selection of species ratio is generally depends on seed availability, market demand, nutrient status of pond, and management techniques. Average stocking rate and the ratio of different fish species stocked together in the pond along with percentage of sampled households following it is depicted in Table 7. It can be described from the Table that majority of the fish farmers (20 %) practiced the 5 species ration of rohu+catla+mrigal+common carp+silver carp on the average ratio of 26.72:23.45:14.28:18.45:17.1 followed by around 19 per cent farmers adopted 4 species ration of rohu+catla+mrigal+common carp on the average ratio of 32.25:38.26:16.25:13.24. The ideal species mix for composite fish culture i.e., rohu+catla+mrigal+silver carp+ common carp+ grass carp were practiced by 16 per cent of the sampled households in the ratio of 24.12:19.23:15.45:16.8:15.4:9 with average stocking density of 5107 fingerlings per acre. The species mixture such as rohu, catla and mrigal were stocked together. Silver carp was stocked later. This could be the reason for avoiding the completion of food between rohu and silver carp. Majority of farmers stocked the fingerlings in the early morning or evening hours. No farmers examine the toxicity of pond water prior to stocking of the fingerlings. However, some farmers reportedly followed the examination of plankton growth by their own method of experience that is by taking the pond water in a clean glass and watched through against the sunlight. Magnified view of actively moving minute organisms and greenish to brownish green colour of the water was indicated food availability. Sometime by merging the hand in pond water they could identify the natural food availability. However, the use of plankton is negligible among the sampled fish farmers. A few of farmers followed temperature acclimatization practices of seed before stocking. Around 2 per cent of sampled respondents practiced fresh water prawn 1200-1500/acre of 5-8 cm size with some carp species such as rohu+catla+silver carp+ grass carp. In that case they did not culture the species such as mrigal and common carp. It could be to avoid competition of food among the bottom feeder. Some farmers did not include common carp in the fish species mixture to avoid damage of the pond. The adoption of grass carp is lower as comparison to other fish species mainly because the lack of preference for the growers due to unavailability of fingerlings at the major season of stocking. The underlying reason might be due to the fact that breeding season of grass carp starts late of monsoon in the state and mortality rate between spawn to fingerlings is very high. However, the growth rate of grass carp in the state was reported to be high and it can be grown with lower cost feed such as grasses, duckweed, banana leave, carrot leave, azolla, hydrilla, wolfia etc. The consumers demand for grass carp is also reportedly increasing. Actually huge demand for live fish has been experienced in Tripura and the preference of species is not the limiting factor at the present situation. Therefore, the productions of grass carp need to be promoted in the state of Tripura by overcoming the barriers in its production.

Table 7: Percentage of Fishing households, Ratio of Fish Species Stocked under Different Species Mix and Stocking Rate

Species mix	% Households	Rohu	Catla	Mrigal	Common carp	Silver carp	Grass carp	Others	Stocking rate (fingerlings /acre)
I.	19	32.25	38.26	16.25	13.24	-	-	-	4865
ii.	14	34.38	37.8	27.82	-	-	-	-	5060
iii.	12	35.25	41.25	-	23.5	-	-	-	3864
iv.	20	26.72	23.45	14.28	18.45	17.1	-	-	4770
v.	16	24.12	19.23	15.45	16.8	15.4	9	-	5107
vi.	2	34.75	13.25	12.44	16.75	11.98	3.43	7.4	5218
vii.	8	24.35	18.6	15.65	22.4	8.5	-	9.5	3287
viii.	2.5	62.5	37.5	-	-	-	-	-	2100
ix.	2	34.65	-	-	25.24	30.11	-	10	4406
x.	3.5	31.22	21	17.44	25.64	-	-	4.7	4040
xi.	2	31.2	25.35	-	-	14.5	18.5	10.45	4860

Others->sarputi (*Puntius sarana*), Thai Sarpunti (*Puntius gonionotus*), gania (*Labeo gonius*), calbasu (*L. calbasu*), pangas (*Pangasius pangasius*), tilapia (*Oreochromis mossambicus*), freshwater prawn (*Macrobrachium rosenbergii*) etc.

Technological Constraints Perceived by Farmers in Adoption of Improved Production Practices of Carp

Technological constraints as mentioned in Table-8 were very important for immediate attention to promote diffusion of improved technology. These constraints according to the perception of respondents were lack of standard feeding for fish (2.605), shortage of water for grow out ponds (2.535), shortage of quality seed to stock in the ponds (2.41). Feed cost is the largest production expense in Tripura. Fish farmers of the study area need low cost balanced feed for fish production. Extension of technical knowledge among fish farmers and attempts to disseminate information on fish culture and follow up service was reportedly very weak. Many fishpond owners failed to culture fish because they stocked too small size of seed at too high density in ponds that were neither fertilized nor fed causing high mortality or the fry simply did not grow. A major requirement of pond fish culture is the knowledge of modern or appropriate technology. Lack of knowledge regarding scientific fish culture and its economic viability, on the part of the farmers is another constraint. One of the challenging aspects in extension activities of pond fish culture is the transfer of technology. A concerted effort, by different concerned organizations with trained man power, equipment and other facilities to gear up the fishery extension machinery is utmost important to overcome this constraint. Extension system need to be adopted participatory mode of technology generation and dissemination, which demonstrates and disseminates appropriate pond fish culture technology among farmers through method and result demonstration incorporating both individual and group methods of extension with regular weekly meetings, field demonstrations and other discussion session. A supply of quality seed is crucial and is often a major constraining factor for adoption of pond fish culture. Non availability of fish seed in time and also the mixture of undesirable species when fingerlings were brought from private dealers was a major constraint. Farmers further reported that non-availability of standard size fish seed is one of the biggest problems for fishpond culture. The fish seed brought from the vendors are mostly small in size and it is difficult for the farmers to identify the desirable species. On the other hand the bigger size fingerling is rather costly to buy. Moreover, seed of silver and grass carps are still scarce. Positive efforts of the government and private fish seed multiplication farms which can meet up the requirements of the farmers through popularization and utilization of induced breeding technique in areas of favourable ecological conditions are steps which need be given due emphasis to overcome this constraint. Lack of timely availability of other critical inputs, like manures, fertilizers and feed, in rural areas for fish culture poses problem in the development. Streamlining of a system of availability of these inputs through Gram Panchayats, development department, entrepreneurship development and cooperative societies is very essential. Inadequate training was identified as another major weakness in most of the operations, including the commercially orientated projects. All the farmers that were interviewed agreed that they required further training. For example, farmers were unaware of the effects of basic factors, such as the influence of water quality on the health of their fish, and feed requirements to different species, conversion ratio of different species of fish and feed formulation and requirement for optimal growth.

Table 8: Technological Constraints Perceived by Farmers in Adoption of Improved Production Practices of Carp

Sl. No.	Sl. No.	Severity	Rank
1.	Complexity of information provided by experts	1.25	VI
2.	Lack of timely availability of raw material/inputs	1.44	V
3.	Lack of standard feeding	2.60	I
4.	Lack of improved/location specific technology	0.66	VIII
5.	In adequate information and skill about scientific aquaculture management	1.65	IV
6.	Shortage of water for grow out ponds	2.53	II
7.	Shortage of quality seed to stock in the ponds	2.41	III
8.	Shortage of manure and fertilizer for ponds	0.90	VII
9.	Frequent occurrence of disease	0.63	IX

Conclusion

The study shows that the adoption score as well as the index were moderately low. Fisheries extension machinery of the state may embark on vigorous training drives. Systematic training and follow up is required to fill the gap. There is the need to jettison the top down system of technology transfer and capacity of the farmers should be developed through farmer-group and farmer field school approach which suits the present day dispensation. The strategy that has emerged to be effective in promoting the adoption of aquaculture technologies is to develop a technology relevant to the needs and resources of the farm households through on-farm research and consultation with farmers, which must further be supported by intensive information dissemination and training schemes. The widespread adoption of these aquaculture technologies would mean improving the standard of living of the resource-poor farm families in Tripura. Most of the farmers were seen lacking of entrepreneurial quality and lack of achievement motivation. Further study can highlight this area. The fisheries need to be considered on business perspective with achievement orientation. Therefore it is suggested that training is required to develop entrepreneurship quality and entrepreneurial motivation among the farmers.

Despite the good performance of growth and increased demand from consumers the adoption of grass carp among the farmers were lower as comparison to other fish species mainly because the lack of preference for the growers due to unavailability of fingerlings at the major season of stocking. The underlying reason might be due to the fact that breeding season of Grass carp starts late of monsoon in the state and mortality rate between spawn to fingerlings is very high. Therefore, the productions of grass carp need to be promoted in the state of Tripura by overcoming the barriers in its production.

Based on the findings of the study, it recommends that more awareness should be created among the fish farmers by the concerned authority especially in those technologies in which farmers' awareness level was low. Also, the low cost balanced feeds and quality fingerlings should be made available by the government to make them affordable to the fish farmers. Farm credit should be made available to the farmers to raise their capital base such that they can have the financial capacity to adopt and implement fishery technologies. Systematic water harvesting is needed to be followed in the rainy season to assure the water level in the pond in summer season.

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