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Research Paper

Techno-Socio-Economic Analysis of Carp Culture Practices By the Tribal and Non-Tribal Farmers of Tripura State In India

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Abstract
Carp culture is the most prominent activity practiced throughout India and most of the aquaculture production of the country is contributed by this group of fishes. Tripura is a small state located in the Northeastern part of the country and rice and fish form the staple diet of people. Carps are widely cultured and consumed within the state. As an adequate quantity of fish is not produced locally, a large portion of the State demand is met through importation. Hence, this study was undertaken to examine the existing aquaculture practices in the state and explore ways to increase productivity by understanding the technical issues impairing productivity and social issues that are hampering farmers to derive the best economic benefits from the aquaculture activity. In addition, the study also attempted to carry out an economic analysis and suggest ways to improve productivity by improving the technical efficiency of farmers.
The data gathered from 1083 farmers was used for analysis. The majority of surveyed farmers belonged to the non-tribal community, who were mostly Bengalis. Overall, farmers possessed less than a hectare of land and owned a fish pond of about 900 m^2. Most of the ponds (86%) had single owners. Farmers were found to stock more than three times the recommended level of seed, which is easily available in the State. The ponds were fertilized with both organic manures and inorganic fertilizers and fish were fed with feed at a very low level. The non-tribal farmers were found to obtain a production of 1822 kg/ha as compared to tribal farmers, who could get only 1064kg/ha, because of higher amounts of inputs used by the former than latter coupled with other management strategies. Participation of women in aquaculture activities as well as provision of training had a positive impact on productivity.
Though there is a huge demand for fish in the market and there is a potential to increase the productivity from the current level substantially, the fear of poaching and poisoning is hindering several farmers to undertake the risk as many of them belong small farmer category. Yet, if the opportunity cost of land and labour is not included even at the current level of production, farmers were found to be happy by the good returns obtained on investment. The estimates of technical efficiency revealed that it could be possible to increase production by 49% at the same level of input and this opportunity could be used by the Department to improve productivity by helping farmers technically.

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I. Background

Tripura is a land-locked State, surrounded by Bangladesh on its north, south, and west. The length of its international border is 856 km (84 percent of its total border), while it shares a 53 km-long border with Assam and a 109 km-long border with Mizoram. Tripura is connected with the rest of India by only one road, which runs through the hills to Cachar District in Assam. The terrain of the State is hilly and forested: over 60 percent is hilly, and around two-thirds of the land area is classified as forest land.

In the Census of 2011, Tripura had a population of 36.74 lacs. The population of Tripura is characterized by social diversity. Specifically, people of the Scheduled Tribes (STs) comprise about one third of the population. People from nineteen tribes are represented in the population of the State, the two largest tribes being the Tripuri and the Reang. There is also a plurality of languages and dialects: the two official languages of the State are Bengali and Kokborok. Among the eight districts, Dhalai is the only one where people of the STs

constitute more than one-half of the population. There is also a rural–urban divide: the overwhelming majority of the tribal people reside in rural areas. Human development among the tribal people is thus very closely tied to the fate of the rural economy.

The total area of the State is 10,492 sq. km. About 60% of the land is under forest. The agriculture system is totally rainfed. The fisheries sector plays an important role in the state of Tripura providing income, employment, and food security to the people. The existing total aquatic resources of the State are estimated to be 36,682.15 ha. The fishermen population in the state is estimated to be 1.90 lakhs. Fish is the staple diet of more than 95% of the population of Tripura. The total production of fish in the State during 2019-20 was about 77,003.09 metric tones. The average per hectare production from aquaculture was estimated to be 2,717 kg in the year 2019-20. To fulfill the huge gap between demand and local supply, fish is imported from other parts of the country, resulting in the drainage of resources. To reduce the gap between demand and supply and to achieve fish self-sufficiency in the State, importance is given to exploring the vertical expansion in fish production, as the scope for horizontal expansion is limited in the State.

The present study was undertaken to examine the existing aquaculture practices in the state and explore ways to increase productivity by understanding the technical issues impairing productivity and social issues that are hampering farmers to derive the best economic benefits from the aquaculture activity.

II. Methodology

Tripura is divided into 8 districts, and 23 subdivisions and these subdivisions are divided into 58 rural developmental blocks for administrative convenience. Each block has several grassroots level administrative setups known as Gram Panchayats / Village Councils and these are 1176 in number. West Tripura District was selected for the present study. The district has 9 blocks and 170 Gram Panchayats / Village Councils. Department of Fisheries maintains data on each village and this information was used to select the villages from each block. From each block, 25% of the total Gram Panchayats were selected based on the weighted average of three indicators viz., number of fish farmers (20% weight), pond area (30%), and productivity (50%). Based on this weighted average, Panchayats were ranked as the best, medium and least performing categories. From each category, an equal number of panchayats were selected. From the selected village, three percent of the total fish farmers or a minimum of 30 farmers whichever was more were surveyed. Altogether, data was collected from 1083 families.

III. Results and Discussion

Socioeconomic Status of Farmers

1.1 Age Distribution of Farmers

Average age of farmers was found to be 45 years. If we look into the age distribution of farmers, it is found that only 14 percent farmers were below 30 years of age, 55 percent farmers were of the age group 31 to 50 years and 31 percent were above 50 years (Table 1) This indicates that farmers were mainly representing the middle age group. Much difference in the age distribution of farmers was not evident between the tribal and non-tribal farmers

1.2 Religious Pattern of Farmers

As expected, farmers were mainly from Hindu families (89%) and a few were from Muslim (8%) and Christian (3%) families (Table 1). All the Christian farmers under the study were found to be from the tribal community. This finding under the study is very much in affinity with the religious distribution of the population of the State. As per Census 2011, 83.40 percent of the total population of the State are Hindus, 8.60 percent are Muslims and 4.35 percent are Christians.

1.3 Family Size of Farmers

As per Census 2011, the mean household size in Tripura is 4.29. The present study finds the average family size of the surveyed farmers on a higher side which is 5.79. This is slightly lower in tribal farmer families (5.64) than in their non-tribal counterparts (5.91) (Table 1).

1.4 Literacy and Educational Level of Farmers

In terms of literacy and the educational status of the population, Tripura occupies a respectable place in India. As per Census 2011, literacy rate in the state was reported to be 87.22 percent which was higher than that of India as a whole (74.04 percent). The present study also had the reflection of this. 84.5 percent of the farmers under the study were literate. Percentage of literates among the non-tribal farmers (87%) was more than their tribal counterparts (81%). If we look into the formal educational status of farmers, it is found that around 65 percent farmers under the study underwent at least secondary level of education and among them, 42 percent attained at least higher secondary level of formal education (Table 1).

1.5 Occupational Status of Farmers

In spite of tremendous potentiality both from demand side and supply side, aquaculture was found to be still a neglected occupation in the State of Tripura. The present study was conducted with the farmers who were

involved in aquaculture, but interestingly it was observed that only 3.26 percent of them considered aquaculture to be their primary occupation. This was more dismal among the tribal (1.96%) than the non-tribal (4.23). Agriculture was the primary occupation of majority of farmers (50.19%) followed by government service (17.60%), wage labour (12.94%) and business (11.36%). This pattern was more or less similar in both tribal and non-tribal farmers under the present study (Table 1).

1.6 Land Holdings and Water Area

Average land holding of the farmers under study was found to be 0.95 ha. Tribal farmers were having average land holding (1.12 ha) more than their non-tribal counterparts (0.83 ha). Average water area of the farmers under the present study was 0.09 ha, which was only 10 percent of the total land holdings occupied by the farmers on average (Table 2).

1.7 Ownership of Assets

Ownership of assets in a family may be considered as an indicator of economic status of that family. In view of this, data were collected from the farmers under the present study to have an alternative look into their economic wellbeing. Mode of entertainment in the form of TV, Radio, Tape Recorder or VCD was found very common in farmer families both tribal and non-tribal. 60 percent of the families had atleast a Television set to get them refreshed after a day-long toil. It is also the main source of information of the farmer families. Refrigerators were rarely found (only 8%) in the families. But increasing pattern of use of mobile was noticed. 14 percent families were either having a landline telephone connection or a mobile connectivity. Bi-cycle was the main source of self transportation. 65 percent families had atleast one bi-cycle and 10 percent families were found having either a scooter or a motor bike to move around (Table 3).

1.8 Per-capita Income

Average per capita income of the farmer families under the present study was estimated to be Rs. 10,452/- per annum which indicates that the farmers under study belong to lower income group in the State. In terms of average per-capita income, the tribal farmer families with average per-capita income of Rs. 10,776/- per annum was found to be more economically well off than their non-tribal counterparts with average per-capita income of Rs. 10,212/- per annum (Table 2).

1. Profile of Pond for Aquaculture

2.1 Size of Water Body

Average size of water area of the farmers used for aquaculture under the present study was found to be 0.09 ha (Table 6). It was the same both for the tribal and non-tribal farmers. The size of water area is based on actual measurement taken from the field.

2.2 Water Level

Maximum and minimum water level of the surveyed water bodies was found to be 1.88 metre and 0.93 metre respectively (Table 6). These water levels were calculated based on the data collected from the farmers on their own measurement.

2.3 Age of Water Body

Water bodies under the present study were on an average 23 years old as informed by the farmers. It was more or less the same in case of both tribal and non-tribal farmers (Table 6).

2.4 Purpose of Excavation

The farm's history unearths that out of the surveyed water bodies, 73 percent were excavated exclusively for the purpose of fish cultivation and the rest 27 percent for multipurpose activities like water storage, bathing and land elevation etc. besides aquaculture (Table 5).

2.5 Ownership Pattern

Most of the water bodies (86%) were owned by single farmer. This single ownership was found for 95 percent tribal farmers and 79 percent non-tribal farmers. Around 13 percent of water bodies under the study had at least two owners (multiple ownership) and only 1.4 percent of the surveyed ponds were found to be leased in. Multiple ownership was more common among non tribal farmers (20.5%) than the tribal farmers (2.4%) whereas leasing in was practiced more by the tribal farmers under the study (2.4%) than their non-tribal counterparts (0.6%) (Table 7)

2. Aquaculture Practices by the Farmers

2.1 Stocking

Majority of the ponds under study were stocked by composite carp culture i.e indigenous and exotic. Indigenous major carp culture includes fish species namely, Rohu, Catla, Mrigal, minor carp and cat fishes, whereas exotic carp culture includes culture of exotic species viz, Common Carp, Silver Carp and Grass Carp. Seeds were basically purchased locally either directly from the seed growers, seed markets or from vendors. Size of seeds ranged between fry to large size fingerlings.

Average stocking density of the surveyed ponds was found to be 37,853 per ha per annum which is almost 4 times higher than the recommended level. When all the recommended culture practices like provision of

adequate feeds, fertilizers etc are adopted, stocking density up to 10,000 per ha is followed. The average stocking density of non-tribal farmers (41,643 per ha per annum were at the higher side than the tribal farmers (32,818 per ha per annum) (Table 8)

2.2 Inputs used by the Farmers

2.2.1 Lime

Lime is mainly used to increase the alkaline nature of water. In North Eastern part of the country soil pH is low and hence application of lime is found to be very essential. Fish farmers under the present study also opined that it facilitates hygienic environment in ponds for protecting fish from water borne diseases.

Average application of lime under the present study was found to be 202 kg per ha per annum. Generally, under the North Eastern situation an amount of 500 kg per ha per annum is recommended. Among the two groups of farmers, tribal farmers were found to apply on average 110 kg per ha per annum and the non-tribal farmers applied 270 kg per ha per annum which is more close to the recommended level (Table 8).

2.2.2 Manures

Manure in the form of cow dung, poultry manure and pig manure was found commonly applied in the ponds under study. Total manure found to be applied in the water bodies under study was 6,549 kg per ha per annum on average out of which almost 95 percent is cow dung and the rest is poultry manure and pig manure. Application of manure by the tribal farmers was very less. Where application of manure by the non-tribal farmers was 9,836 kg per ha per annum it was only 2,148 kg per ha per annum by the tribal farmers (Table 8)

2.2.3 Fertilizers

Chemical fertilizer used by the farmers consists of urea, super phosphate and some other types of chemical fertilizers. Application of chemical fertilizer was not very common in the project area. Average use was found only 54 kg per ha per annum. The usage was 87 kg by the non-tribal farmers and only 9 kg by the tribal farmers (Table 8).

2.2.4 Supplementary Feed

Supplementary feed is very much essential for the growth of fish as it cannot be expected the water to contain enough natural feed at the present level of manure application practiced by the farmers under the project area. Rice bran and Mustered Oil Cake (MOC) are mostly used as supplementary feed which were found to be more than 90 percent of the total supplementary feed applied to the ponds. The rest were fish meal, dry fish and wine extract. Rice bran and MOC used by the farmers under study were 775 kg and 402 kg per ha per annum respectively. Significant difference between tribal and non-tribal farmers in terms of use of these supplementary feed was noticed. Rice bran and MOC used by the non-tribal farmers were 993 kg and 554 kg respectively whereas it was only 482 kg and 197 kg respectively for the tribal farmers. Other sorts of supplementary feed were found rarely being used by the farmers. Wine extract were found being used by the tribal farmers as supplementary feed (Table 8).

2.3 Use of Labour

Aquaculture in the project area was found to be practiced using mostly the family labour (90%). It was found that where 134 mandays per ha were utilized by the contribution of family members, only 15 mandays per ha were hired from outside. Significant difference between use of labour by the tribal and non-tribal farmers were also observed. Per ha utilization of labour was 204 mandays by the non-tribal farmers whereas it was only 77 mandays by the tribal farmers (Table 8).

2.4 Fish Harvesting

With all these inputs fish harvest per ha per annum in the surveyed ponds were reported to be 1,498 kg on average. For non-tribal farmers with use of relatively higher inputs production was 1,822 kg per ha whereas it was only 1,064 kg for their tribal counterparts (Table 8).

3. Economics of Fish Production

3.1 Variable Cost

Variable cost mainly include cost of fingerlings, manure, chemical fertilizer, feeds, medicines, labour and others i.e all the means of production, use of which varies with the scale of production in the short run (Table 9).

In the present study, it was found that expenditure on seed was Rs. 20,904/- per ha which contributed the major portion (38%) of the total cost per ha of the farmers. As the stocking density was higher in the ponds of non-tribal farmers than their tribal counterparts, naturally the expenditure involved in case of non-tribal farmers was also higher (Rs. 23,667/-) than the tribal farmers (Rs.17,204/-).

Manures were mostly used by the farmers from their own farm. Expenditure on manure was calculated based on the imputed cost at the prevailing market price. It was calculated to be Rs.1,310/- per ha per annum on average. For non-tribal farmers the expenditure was Rs. 1,967/- per ha and for tribal farmers it was only Rs. 429/- per ha (Table 9).

Chemical fertilizers were rarely used by the farmers under study. Hence, the expenditure on chemical fertilizer was negligible (Rs. 323 per ha per annum) (Table 9)

Expenditure on supplementary feed reported to be constituted 13 percent of the total cost of production. Average expenditure on feed was Rs. 6,981/- per ha per annum. The expenditure was more than double in case of non-tribal farmers (Rs. 9,433/- per ha per annum) than their tribal counterparts (Rs. 3,697/- per ha per annum) (Table 9).

Expenditure on lime, being used as a soil and water quality conditioning agent, was reported to be Rs. 2,021/- per ha per annum on average (Table 9).

As it was already reported that 90 percent of mandays used for aquaculture was the contribution of family members, hence there was no cost involved directly with that, but of course a significant amount of opportunity cost was involved with the involvement of family labour. If this imputed cost is taken into consideration at the prevailing market price of labour, labour cost becomes the second largest contributing factor (22%) after cost of seed in the total cost of production. In doing so, average expenditure on mandays including both family labour and hired labour was estimated to be Rs. 11,944/- per ha per annum. This expenditure was Rs. 16,262/- for non-tribal farmers and Rs. 6,162/- for tribal farmers under the present study. Other variable costs involved were on medicine and motor pump for water replacement etc. These contributed very negligible amount in the total cost of production (Table 9).

3.2 Fixed Cost

Fixed costs are those cost which does not vary with the scale of production in the short run. In the present study two costs viz, opportunity cost of land for the water body and depreciation cost of netting materials have been considered as fixed cost. Opportunity cost of land or pond was calculated using prevailing flat bank interest on the anticipated capital investment for the land or water body in question. It was estimated to be Rs. 8,198/- per ha per annum. Depreciation of netting materials was estimated assuming the average lifespan of the materials to be 3 years. Average depreciation of fishing materials was calculated to be Rs. 2,523/- per ha per annum. Hence, total average fixed cost of the farmers under present study was estimated to be Rs. 10,721/- per ha per annum (Table 9).

3.3 Total Production Cost

Total production cost is the sum of fixed cost and variable cost of production. In the present study average total production cost was estimated to be Rs. 56,541/- per ha per annum. Due to the difference in variable costs, average total production cost of tribal and non-tribal farmers were significantly different. For non-tribal farmers it was estimated to be Rs. 68,571/- per ha per annum and in contrast, for tribal farmers it was only Rs. 40,431/- per ha per annum (Table 10}.

3.4 Total Revenue

Total Revenue was calculated multiplying the firm gate price with the total production. From the survey it was noticed that the non-tribal farmers were getting almost double revenue (Rs.87,820/- per ha per annum) compared to their tribal counterparts (Rs.48,848/- per ha per annum). This is due to more production and getting better market price than the tribal farmers. Inaccessibility of market was one of the major reasons for tribal farmers of their low value of the product (Table 10).

3.5 Profitability

Net profit is calculated by deducting the total cost (variable cost and fixed cost) from the total revenue. The net profit of the non-tribal farmers was Rs.19,249/- per ha per annum which was more than twice of the net profit earned by the tribal farmers (Rs.8,417/- per ha per annum).If we deduct only variable cost of production and ignore the fixed cost of production then also the non-tribal farmers are found to be getting more profit (Rs.32,234/- per ha per annum) than the tribal farmers (Rs.20,143/- per ha per annum), but the profit gap between two community was little. This was because in both cases the anticipated fixed cost of production was almost similar, but there was a big difference in variable cost of production (Table 10).

3.6 Benefit Cost Ratio

To find out the sustainability of any production system there needs to check some economic indicator of the production; benefit cost ratio is one of the most important tools of that. It shows the return per unit of investment in percentage. From the survey it revels that the non-tribal farmers under study were getting Rs.1.28 for every one rupee investment where as tribal farmers were getting Rs 1.21 for one rupee of investment. From the survey one interesting observation comes out that if we do not consider the family supplied labour and opportunity cost of land in calculating the benefit cost ratio, then the profitability from their production was more than 85% in both cases. This implies that though the productivity level of the fish farmers of Tripura was low, people were sustained in fish culture in this state (Table 10).

3.7 Break Even Analysis

Break even production is the level of production in which the farmers are able to realise at least the cost of production. Here it was came out that to meet the cost of production there was need of only 880.7 kg of fish production per hectare for tribal farmers, whereas in case of non-tribal farmers it was 1422.6 kg of production.

As the amount of investment by the tribal farmers is very low their break even production is also low comparing to non-tribal people. If we consider the break even price, it revels that in both cases this was almost same (Rs.38/-).The low productivity of the tribal farmer does not give them to take the benefit of low break even production (Table 10).

4. Women Involvement in Aquaculture

Involvement of women in aquaculture activities was carefully observed in the present study. Interestingly it was found that though the intensity of involvement of women in aquaculture in the study area was very low (45 percent for tribal, 63 percent for non-tribal and 55 percent in case of overall farmers) due to different social, cultural and psychological factors, but their involvement had positive impact on the productivity. In case of non-tribal and overall categories of farmers women involvement increased the productivity significantly (Table 11).

5. Impact of training

Training may be considered as a means of transfer of technology from laboratory to field. Unless the farmers are provided training on regular basis, all efforts in the laboratory will go in vain. In the present study though 78 percent of farmers were found to be having some sort of training, bringing cent percent farmers under the training programmes on continuous and regular basis needs to be prioritized as it was clearly observed from the analysis of the field level data that training had significant positive impact on the productivity of the farmers under study. (Table 12)

6. Impact of visit of extension officer

Besides imparting training to farmers for transfer of technology, extensive visit of extension officers to the farms and conducting necessary counseling to the farmers is equally important to help farmers solve their day to day problems of cultivation and generating awareness in different related issues. In the present study 89 percent household reported that during the previous year of the study no extension officer could make a visit to their farm. Average productivity of the farm visited by the extension officers was interestingly significantly higher than that of the farms not visited by the extension officers in case of all categories viz., tribal, non-tribal and overall farmers (Table 13)

7. Frontier production function results:

Based on the methods described by Aigner *et al.*(1977), and Meeusen and Van den Broeck (1977) maximum likelihood estimation (MLE) techniques were employed to estimate the parameters of the production function using frontier version-4.1 software package. Cobb-Douglas stochastic frontiers were estimated separately for tribal, non-tribal as well as for overall farmers.

From the Cobb-Douglas frontier function results (Table 16) it was found that most of the coefficients of the maximum likelihood estimates (MLE) of the stochastic production function had the expected sign. Overall it was seen that the seed has highest impact on production (co-efficient 0.20) followed by chemical fertilizer (0.17), feed (0.12), lime (0.11), addition of water to maintain the water level (0.11), which were also statistically significant. In case of tribal farmers seed, chemical fertilizer, feed and hired labour had positive impact on fish production. Where as in case of non tribals seed, manure, chemical fertilizer and lime had positive impact on fish production.

The result of the generalized likelihood ratio test for the presence of technological inefficiency effect is presented in Table 16. The computed chi-square ($\chi 2$) was 10.28 in case of tribal farmer indicating that there was no technical inefficiency in production process. The value of chi-square ($\chi 2$) both in case of non tribal farmers and overall farmers (tribal and non-tribal) was 97.84 and 160.98 indicating that technical inefficiency effect present in the production process.

The value of gamma both in case of non-tribal and overall farmers was significant. This implies that the variation in fish production in the surveyed area were due to technical inefficiency effect. 77% of production variation in case of non tribal farmers was due to technical inefficiency effect and in case of overall it was 48%. Regarding the technical inefficiency parameter, the water area has negative impact on efficiency of both non-tribal and overall categories of farmers. Regular fish selling by the farmers and experience in fish production had positive impact on their efficiency of production process in case of overall and non-tribal farmers. It is also seen that poaching or poisoning problem has negative impact on efficiency of the overall farmers (Table 16).

The technical efficiency of the overall farmers in the study area was 51% (Table 17). This implies that they were producing about 49% lower than the production frontier. This reflects the good scope for the farmers to increase their productivity by 49% by proper and efficient use of inputs and technology used at the present level. On the other hand the non-tribal farmers were operating with 56% efficiency level, so there is also possibility to increase their production by 44% by efficiently using the same amount of inputs. These results

clearly reflect that the farmers were technically inefficient in the study area and this indicates that productivity level can be improved by helping farmers to use their resources more efficiently.

IV. Conclusion

From the present study it was found that with the use of relatively higher inputs, the non-tribal farmers under the study area were found to be having higher productivity than their tribal counterparts. In terms of efficiency in inputs usage, the tribal farmers were found relatively efficient than the non-tribal farmers implying the scope of increase in productivity with more judicious utilization of the same level of inputs. Intensive involvement of women in aquaculture though was lacking but the involvement implied enhanced productivity. Technology transfer through training also had positive bearing on productivity. Visit of extension officers to the farms though was not very common but had significant impact on the productivity of the farmers.

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ANNEXURE

Table 1. Socio economic indicators

Indicators	Tribal people (%)	Non-tribal (%)	Overall (%)
Distribution of sample by age group			
Up to 30years	12.30	14.70	14.00
31 to 40years	24.00	25.50	25.10
41 to 50years	32.20	28.90	30.00
Above 50years	31.50	31.00	30.80
Average age	45.87 years	44.61 years	45.07years
Religious status of the farmers			
Hindu	91.60	86.90	88.80
Muslim	0.20	13.10	8.00
Christian	8.20	0.00	3.20
Distribution of the farmer's family by family size			
Less than 5	52.90	51.60	52.50
5 to 7 persons	31.10	30.20	30.00
More than 7	16.00	18.20	17.50
Average	5.64	5.91	5.79
Educational Level of the Fish farmers			
Illiterate	19.0	12.9	15.5
Primary	23.4	17.4	20.0
Secondary	21.6	23.1	22.5
Above Secondary	35.9	46.5	42.0
Primary occupation of the Fish farmers			
Agriculture	57.17	44.95	50.19

Aquaculture	1.96	4.23	3.26
animal husbandry	0.00	0.49	0.28
business	5.00	16.12	11.36
Govt. Service	20.43	15.47	17.60
Private service	1.09	1.79	1.49
Wage labour	13.70	12.38	12.94
Others	0.65	4.56	2.89

Table 2: Socio-economic indicator of Fish farmer's family of West Tripura District

Indicator	Tribal people	Non-tribal	Overall
Average water area (in ha.)	0.09(±0.10)	0.09(±0.11)	0.09(±0.10)
Average family size	5.64(±2.09)	5.91(±2.58)	5.79(±2.38)
Average land holding (in ha.)	1.12(±1.13)	0.83(±0.86)	0.95(±0.99)
Per capita income	898(±747)	851(±773)	871(±762)
People below poverty line	38.9	24.4	30.3

Figures in parenthesis indicate standard deviation.

Table 3: Assets owned by the farmers

Assets owned by the family	Tribal people (%)	Non-tribal (%)	Overall (%)
TV	50.0	67.2	59.9
Radio	32.7	22.9	27.1
Tape recorder	15.2	17.9	16.7
VCD	18.0	17.8	17.9
Refrigerator	6.5	8.7	7.8
By cycle	55.2	72.2	64.9
Scooter / Bike	8.4	11.8	10.4
Telephone	9.5	17.4	14.1

Table 4 : The per capita fish consumption of the surveyed fish farmers

Indicator	Tribal people	Non-tribal	Overall
Per capita fish consumption (kg/year)	10.6(±12.0)	22.6(±14.6)	17.4(±14.8)
Per capita dry fish consumption (kg/year)	0.16(±0.10)	0.10(±0.09)	0.13(±0.10)

Figures in parenthesis indicate standard deviation

Table 5: Purpose of building the pond

Percentage of each group total

Purpose	Tribal people (%)	Non-tribal (%)	Overall (%)
Fish cultivation	80.8	66.7	72.7
Multipurpose (Fish cultivation, water storage, bathing, land elevation etc)	19.2	33.3	27.3

Table 6. The average area of ponds and average water depth

Indicator	Tribal people	Non-tribal	Overall
Average water area (in ha.)	0.09(±0.10)	0.09(±0.11)	0.09(±0.10)
Average water depth Max	1.68(±0.58)	2.03 (±0.73)	1.88(±0.69)
Average water depth Min	0.75(±0.44)	1.07(±0.51)	0.93(±0.51)
Age of pond	23.6(±21.3)	23.2(±17.2)	23.4(±19.1)

Table 7: Ownership Pattern of the pond of the fish farmer

Ownership Pattern	Tribal people (%)	Non-tribal (%)	Overall (%)
Single	95.2	78.9	85.9
Multiple	2.4	20.5	12.8
Lease	2.4	.6	1.4

Table 8: Input uses by the fish farmers

	Tribes		Non-tribes		Total	
Indicator	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Water area (in ha)	0.09	0.1	0.09	0.11	0.09	0.1
Seed (in no/ha/year)	32818	33213	41643	48329	37853	42707
Organic fertiliser						
i) Cow dung (in kg/ha/year)	2064	5487	9327	17088	6222	13886
ii)Poultry manure (in kg/ha/year)	71	840	452	2217	289	1775
iii)Pig manure(in kg/ha/year)	13	126	57	1028	38	783
Total manure(in kg/ha/year)	2148	5532	9836	17550	6549	14274
Chemical fertiliser						
i)Urea (in kg/ha/year)	6	92	29	117	19	108
ii)Super phosphate (in kg/ha/year)	3	28	30	147	18	113
iii)Others chemical fertiliser (in kg/ha/year)	0	0	28	156	17	83
Total Chemical fertiliser (in kg/ha/year)	9	99	87	627	54	480
Feed						
i)Rice bran (in g/ha/year)	482	1046	993	1926	775	1629
ii)MOC (in kg/ha/year)	197	581	554	909	402	805
iii)fish meal (in kg/ha/year)	12	112	39	368	28	288
iv)dry fish (in kg/ha/year)	1	14	20	187	12	142
v)Wine extract (in kg/ha/year)	157	599	9	113	73	408
Total feed (in kg/ha/year)	849	1456	1615	2386	1288	2075
Lime (in kg/ha/year)	110	277	270	383	202	351
Medicine						
i)Cifax (in ml/ha/year)	3	44	280	1054	161	809
ii)Salt (in kg/ha/year)	1	14	28	272	16	207
iii)Ash (in kg/ha/year)	4	52	39	159	24	126
iv)Turmeric (in kg/ha/year)	1	20	4	54	3	43
v)KMnO4 (in kg/ha/year)	48	463	314	4084	200	3107
Family labour (in man days/ha/year)	73	100	180	417	134	326
Hired labour (in man days/ha/year)	4	17	24	47	15	38
Water addition (in Rs/ha/year)	8	155	534	3055	309	2328
Production (in kg/ha/year)	1064	890	1822	1381	1498	1253

Table 9: Input cost

(Rs./Year)

		Tribal people	Non-tribal	Overall
Variable Cost	Expenditure on seed /ha.	17204	23667	20904
	Cost of Manure/Ha.	429	1967	1310
	Cost of Chemical fertiliser /Ha.	55	524	323
	Cost of total feed/Ha.	3697	9433	6981
	Cost of lime /Ha.	1105	2704	2021
	Cost of Medicine /Ha.	46	495	303
	Cost of family labour/ Ha.	5867	14360	10729
	Cost of Hired labour / ha.	295	1902	1215
	Pump cost/ha	8	534	309
	Total variable cost /Ha.	28706	55586	44095
Fixed cost	Opportunity cost of land/Ha.	8204	8194	8198
	Depreciation of netting materials/ha.	2524	2521	2523
	Total fixed cost	10728	10715	10721

Table 10: Economics of fish production

	Tribal people	Non-tribal	Overall
Total revenue/ha.	48848	87820	70736
Total production cost (FC+VC)/ha.	40431	68571	56541
Profit over variable cost/ha.	20143	32234	26641
Net profit /ha.	8417	19249	14195
Selling price Rs./kg	45.91	48.2	47.22

Benefit cost ratio	1.21	1.28	1.25
Benefit cost ratio*	1.85	1.91	1.88
Break even production Kg/ha.	880.7	1422.6	1197.4
Break even price Rs./kg	38.0	37.6	37.7

* BCR calculated not to taking consideration of family supplied labour and opportunity cost of land.

Table 11: Impact of Woman involvement in different communities on fish production

Women involvement	Tribal people (%)		Non-tribal(%)		Overall (%)	
	% of total	Average production/ha.	% of total	Average production/ha.	% of total	Average production/ha.
Not involved	54.68	1054a(±1027)	36.61	1650a(±1275)	44.66	1325a(±1183)
Involved	45.32	1106a(±732)	63.39	1886b(±1453)	55.34	1601b(±1295)

Figures with same superscript are not significantly different.

Table12: Impact of training in different communities on fish production

Training	% of total	Average production/ha.	% of total	Average production/ha.	% of total	Average production/ha.
Not attended	14.8	994a(±720)	26.7	1807a(±1393)	21.6	1430a(±1201)
Attended	85.2	1453b(±1473)	73.3	1860a(±1363)	78.4	1741b(±1405)

Figures with different superscript are significantly different at 1% level

Table13 : Impact of visit of extension officer in different communities on fish production

Visit of extension officer	% of total	Average production/ha.	% of total	Average production/ha.	% of total	Average production/ha.
Not visited	90.1	1064a(±887)	87.9	1764a(±1365)	89.0	1443a(±1221)
Visited	9.9	499b(±509)	12.1	2243b(±1459)	11.0	2197b(±1468)

Figures with different superscripts are significantly different at 1% level

Table14: Major problems faced by the farmers

	Tribal	Non-tribal	Total
Lack of technical assistant	77.60%	72.10%	74.40%
Poor economic condition	72.90%	71.80%	72.30%
High seed cost	60.90%	45.40%	51.80%
Poching	62.70%	41.40%	50.20%
High cost of inputs	66.60%	36.60%	49.10%
Poisoning	57.50%	32.00%	42.60%
Water turbidity	45.70%	40.50%	42.60%
Lack of quality seed	54.60%	31.00%	41.10%
Slow growth	58.00%	23.70%	38.00%
Shortage of water	46.70%	29.00%	36.30%
Flood	22.20%	38.90%	32.00%
Difficulty in obtaining credit	28.90%	15.60%	21.10%
Lack of marketing facility	38.20%	7.80%	20.50%
High mortality	15.60%	16.80%	16.30%
Problem creating by the the middle man	24.60%	8.20%	15.00%

Table15: Description of the variables used for Production Frontier Model analysis.

Stochastic Frontier Model	
Variables	Description
Output(Y)	Aggregated quantity of fish production (in kg/ha)

Inputs	
Ln Seed(X_1)	Total number of fish seed stocked (in no. of pieces/ha)
Ln Manure(X_2)	Total amount of organic manure used (in kg/ha)
Ln Chemical fertilizer(X_3)	Total amount of chemical fertilizer used (in kg/ha)
Ln Feed(X_4)	Total amount of feed used in culture (in kg/ha)
Ln lime(X_5)	Total amount of lime used (in kg/ha)
Ln Medicine(X_6)	Total amount of Medicine used (in Rs/ha)
Ln Family labour(X_7)	Total amount of family labour engaged (in mandays/ha)
Ln Hired labour(X_8)	Total amount of hired labour engaged (in mandays/ha)
Ln addition of water(X_9)	Total amount of water filled (in Rs/ha)
Feed dummy (D_1)	Value 1 if feed used in culture, 0 otherwise
Chemical fertilizer dummy (D_2)	Value 1 if chemical fertilizer used in culture, 0 otherwise
Manure dummy (D_3)	Value 1 if manure used in culture, 0 otherwise
Medicine dummy (D_4)	Value 1 if medicine used in culture, 0 otherwise
Lime dummy (D_5)	Value 1 if lime applied in culture, 0 otherwise
Addition of water dummy (D_6)	Value 1 if water filled to maintain the water level, 0 otherwise
Technical inefficiency model	
Farmer's experience (Z_1)	Experience in aquaculture of the farmer (in years)
Farmer's education (Z_2)	Educational level of farmer (years of schooling)
Training (Z_3)	Value 1 if the farmer attended any aquaculture related training program, 0 otherwise
Poaching or poisoning problem (Z_4)	Value 1 if poisoning /poaching occurred or there was a phobia of these, 0 otherwise
Woman involvement (Z_5)	Value 1 if woman was involved in culture, 0 otherwise
Flood occurance (Z_6)	Value 1 if flood occurred in that culture period, 0 otherwise
Ownership (Z_7)	Value 1 if pond is owned/operated by single person, 0 otherwise
Type of water body (Z_8)	Value 1 if water body is seasonal, 0 otherwise
Average water dept (Z_9)	Average water dept (in feet)
Regular feeding to fish (Z_{10})	Value 1 if there was regular feed application in culture, 0 otherwise
Management index (Z_{11})	Total no. of Management practice used
Water turbidity (Z_{12})	Value 1 if pond water was very turbid, 0 otherwise
Visit of extension agent (Z_{13})	Number of visit of extension agent during the year
Schedule tribe (Z_{14})	Value 1 if pond owner is a schedule tribe, 0 otherwise
Regular fish sale (Z_{15})	Value 1 if farmer used to sale the fishes regularly, 0 otherwise
Water area (Z_{16})	Total water area (in ha)

Table16: Maximum likelihood estimates (MLE) of C-D Production frontier function and the technical inefficiency model.

	Tribal		Non-tribal		Overall	
Stochastic Frontier model	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
Constant	3.96	4.17*	5.53	16.07*	5.43	17.62*
Ln Seed(X_1)	0.27	2.79*	0.20	6.50*	0.20	9.18*
Ln Manure(X_2)	0.14	1.55	0.06	2.67*	0.08	4.69*
Ln Chemical fertiliser(X_3)	0.38	2.03**	0.15	2.53**	0.17	3.42*
Ln Feed(X_4)	0.20	2.15**	0.12	4.40*	0.12	5.15*
Ln lime(X_5)	0.16	0.80	0.13	2.53**	0.11	2.93*

Ln Medicine(X_6)	0.01	0.08	0.01	0.25	0.00	-0.18
Ln Family labour(X_7)	0.04	1.52	0.00	0.04	0.02	1.98**
Ln Hired labour(X_8)	0.09	2.94*	0.01	0.72	0.02	1.42
Ln addition of water(X_9)	0.13	0.49	0.09	1.16	0.11	2.10**
Feed dummy (D_1)	-1.17	-1.67	-0.67	-3.29*	-0.71	-4.26*
Chemical fertiliser dummy (D_2)	-2.20	-2.22*	-0.83	-2.59*	-0.95	-3.36*
Manure dummy (D_3)	-1.07	-1.52	-0.40	-1.97**	-0.63	-4.35*
Medicine dummy (D_4)	-0.13	-0.11	-0.01	-0.05	0.11	0.64
Lime dummy (D_5)	-0.69	-0.66	-0.62	-2.00**	-0.53	-2.30*
Addition of water dummy (D_6)	-1.02	-0.87	-0.50	-0.78	-0.75	-1.68
Technical inefficiency model						
Constant	0.11	0.10	2.46	4.90*	2.28	9.74*
Farmer's experience (Z_1)	0.00	-0.07	-0.07	-2.07**	-0.02	-1.57**
Farmer's education (Z_2)	-0.03	-0.18	-0.04	-0.31	-0.07	-1.22
Training (Z_3)	-0.10	-0.14	-0.07	-0.47	-0.07	-0.73
Poaching or poisoning problem (Z_4)	0.04	0.11	0.14	1.07	0.11	1.61*
Woman involvement (Z_5)	0.02	0.06	-0.05	-0.37	0.01	0.15
Flood occurrence (Z_6)	-0.03	-0.07	-0.04	-0.30	-0.05	-0.69
Ownership (Z_7)	0.13	0.12	-0.01	-0.06	-0.02	-0.23
Type of water body (Z_8)	-0.04	-0.06	0.22	0.96	0.08	0.88
Average water dept (Z_9)	0.22	0.46	-0.02	-0.08	-0.02	-0.27
Regular feeding to fish (Z_{10})	-0.07	-0.07	-0.08	-0.45	-0.10	-0.98
Management index (Z_{11})	-0.08	-0.11	-0.11	-1.18	-0.03	-0.60
Water turbidity (Z_{12})	0.01	0.03	0.22	1.58**	0.06	1.12
Visit of extension agent (Z_{13})	0.02	0.41	0.01	0.71	0.00	0.83
Schedule tribe (Z_{14})	-	-	-	-	0.23	2.69*
Regular fish sale (Z_{15})	-0.20	-0.87	-0.87	-3.10*	-0.56	-5.51*
Water area (Z_{16})	-0.10	-0.16	0.50	2.96*	0.33	5.33*
sigma-squared	0.31	7.99*	0.58	4.94*	0.34	12.09*
gamma	0.15	1.41	0.77	11.61*	0.48	3.90*
Log-likelihood function =	-342.11		-499.51		-862.19	
X^2(Chi-square)	10.28		97.84		160.98	

*significant in 1% level
**significant in 5% level

Table17: Technical efficiency of the farmers

Efficiency level	Schedule tribe (% of total)	Non-tribal (% of total)	All (% of total)
0-25%	0%	5%	5%
26-50%	1%	26%	43%
51-75%	14%	47%	44%
76-100%	86%	22%	8%
Overall efficiency	83%	56%	