AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Ind. Jn. of Agri. Econ.
Vol. 62, No.1, Jan.-March 2007

Economics and Determinants of Fish Production and Its Effects on Family Income Inequality in West Tripura District of Tripura

Kehar Singh*

I

INTRODUCTION

Fish has long been an important source of food for people all over the world. The importance of fish as a source of high quality, balanced and easily digestible proteins, and essential amino acids is well understood. Fisheries sector occupies a very important place in the socio-economic development of India. It has been recognised as a powerful source of income and employment generator as it stimulates growth of a number of subsidiary industries. This sector provides livelihood to seven million fishers, is a prime mover of coastal economy and is a good source of foreign exchange earnings.

Fish is an important item of food to almost all the people (about 95 per cent) of Tripura (Sarkar, 2002). The aqua-resources of Tripura include reservoirs, lake, river and rivulets (10,000 ha), ponds/tanks (9,072 ha) and mini barrages (4,270 ha). All these aqua-resources comprise only 2.22 per cent of the total geographical area of the State. There were about 93,870 fish farmers in the State during 2001-02.

The paucity of reliable economic information on fish production is felt all over the world. To quote Pillay (1990), "Despite the basic importance of economic viability, a very little attention has been paid to this aspect and the promotion of aquaculture has suffered considerably for lack of appropriate data and documentation of relevant evaluation".

The present study is an attempt to fill in the information gap to some extent. This study was undertaken in West Tripura district of Tripura during the period 2003-04 with the following objectives:(i) to study the cost and return structure of fish production in Tripura; (ii) to find out the determinants of fish production in the study area, and (iii) to assess the effects of income from fish production on family income inequality.

*Assistant Professor (Fisheries Economics), College of Veterinary Sciences and Animal Husbandry, Selesih–796 014 (Aizawl), Mizoram.

II

COVERAGE AND DATA

The study is confined to West Tripura district of Tripura. This district makes the highest contribution to the fish production in the State of Tripura. The fish farming households were selected for the study by using multi-stage random sampling method. Out of sixteen rural development blocks of West Tripura district, three development blocks namely Melahgarh, Bishalgarh and Mohanpur were selected for the study. Three villages from each of the selected development block were chosen randomly from the list of villages having at least 5 hectares area under fish culture. Ultimately a sample of 40 fish farming households for each selected block, proportionately allocated to the villages (marginally adjusted), was obtained from the list of fish farmers prepared for the selected villages. A specifically designed and pre-tested schedule was utilised to collect the required data. Due to the inadequacy of data, some of the fish farming households were excluded from the sample. The final block wise distribution of sampled fish farming households is given in Table 1.

TABLE 1. BLOCK WISE DISTRIBUTION OF SAMPLED FISH FARMING HOUSEHOLDS

Particulars (1)	Number (2)	Per cent (3)
Melahgarh block	35	34.66
Bishalgarh block	32	31.68
Mohanpur block	34	33.66
Total	101	100.00

The sampled fish farming households have been divided into two categories on the basis of pond area by using cumulative cube root frequency method. The category wise distribution of the households is given in Table 2.

TABLE 2. CATEGORY WISE DISTRIBUTION OF SAMPLED FISH FARMING HOUSEHOLDS

Pond size category (1)	Number (2)	Per cent (3)
Category I (pond area ≤ 0.6 acre)	74	73.27
Category II (pond area >0.6 acre)	27	26.73
Overall	101	100.00

The most common unit of measurement of area in the study area is '*cannie*' (1 *cannie* = 0.4 acre) and for the present study 'acre' has been used.

III

FISH PRODUCTION SYSTEM IN TRIPURA

In India, many fresh water aquaculture production systems are being followed to grow carps and other species, a high-yielding polyculture production system better known as composite fish culture system is the most widely adopted technology among the Indian fish farmers (Sinha, 1991). In this system, ponds are stocked with compatible indigenous and exotic carps, which have different feeding habits. Therefore, this system gives comparatively a far greater output of fish than those that are stocked with an equal number of either indigenous species or exotic species (Srivastava *et al.*, 1990).

Preponderance of sampled fish farmers (98 per cent) was pursuing polyculture of carps in the study area. About 2 per cent were following polyculture of carps and prawns. Rohu followed by mrigal, catla, common carp, and silver carp were, in that order, the preferred fish species cultured in the study area. Additional imperative fish species were grass carp (34 per cent households), bighead (11 per cent households) and japani punti (8 per cent households). A few uncommon fish species namely gania, tilapia, calbasu, bata and pangas were found to be cultured by less than 2 per cent sampled fish farming households. The species mix and the stocking rate are two important determinants of economics of pisciculture. The ratio of fish species stocked (on the basis of fingerlings stocked) under different species mix along with percentage of fishing households following them and average stocking rate (fingerling No. per acre) are shown in Table 3.

TABLE 3. PERCENTAGE OF FISHING HOUSEHOLDS, RATIO OF FISH SPECIES STOCKED UNDER DIFFERENT SPECIES MIX AND STOCKING RATE, WEST TRIPURA, 2003-04

Species mix	Per cent households	Rohu	Catla	Mrigal	Common carp	Silver carp	Grass carp	Bighead	Stocking rate (fingerling No./acre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	26	0.20	0.08	0.15	0.40	0.14	0.03	…	7800
2.	30	0.21	0.10	0.50	0.14	0.05	…	…	9200
3.	21	0.32	0.18	0.21	0.30	…	…	…	5400
4.	6	0.18	0.06	0.17	0.31	0.16	0.01	0.11	10500
5.	3	0.52	0.11	0.37	…	…	…	…	1000
6.	12	Polyculture of carps plus one or two indigenous fish species (japani punti, gania, tilapia, calbasu, bata, pangas, etc.)							
7.	2	Polyculture of carps and prawns							
Scientific species mix*		0.30	0.25	0.15	0.20	0.10	…	…	3000

* *Anonymous (2002).*

The key fish species mix were (i) Rohu + catla + mrigal + common carp + silver carp + grass carp (26 per cent households), (ii) Rohu + catla + mrigal + common carp + silver carp (30 per cent households), (iii) Rohu + catla + mrigal + common carp (21 per cent households) and (iv) Rohu + catla + mrigal + common carp + silver carp + grass carp + bighead (6 per cent households) (Table 3). On the basis of the percentage share in total seed stocked by the sampled households, mrigal (33.11 per cent), common carp (24.78) and rohu (24.36) were the dominant fish species. The comparison of the existing ratio of fish species mix and the recommended one revealed the deviations from scientific fish culture in the study area.

The stocking rate was found to be very high in the existing production system as compared to the scientific composite fish culture in the study area (Table 3). The stocking rate was estimated at the level of 8404, 6359 and 7245 in the case of Category-I, II and Overall situation, respectively.

The farmers were utilising multi-sources for procuring fish seed. Fish traders/commission agents emerged as the most important source, as 61 per cent of the farmers were procuring fish fingerlings from this source. The private hatcheries (18 per cent fish farmers), government hatcheries (11 per cent fish farmers) and own hatcheries (7 per cent fish farmers) were the other sources of fish fingerlings.

Although the fingerlings were stocked throughout the year, more than 56 per cent fish farmers were found to stock the fingerlings during March to May. The size of fingerlings stocked varied over the fish species and the source of fingerlings. The most recurrent average size, i.e., mode of average size (average over the species) stocked was 6 cm, the average size stocked, i.e., arithmetic mean of average size was 6.99 cm with the minimum average size of 3.4 cm and the maximum average size of 7.18 cm.

Lime, cow dung, rice bran and oil cake were the vital inputs used by 79, 82, 72 and 68 per cent of the fishing households. Chemical fertilisers were used by 14 per cent of the sampled households. The important fertilisers applied were urea and single super phosphate. Pellet feed was used by 8 per cent of the farmers and 11 per cent were found incurring expenses on healthcare/disease control. Only 6 per cent of the fishing households were reported to be using none of the inputs except seed.

The mainstream of the fish ponds (90 per cent) were perennial having average depth 1.62 m with average minimum depth 1.04 m (standard deviation = 0.41m and range = 2.44 m) and average maximum depth 2.20 m (standard deviation = 0.64 m and range = 3.81 m). Archetypical fish farmers (about 87 per cent) were found to practice fish culture in ponds owned by them, a few (about 8 per cent) in leased-in ponds and the rest in both types of ownership. The private regime was the most important (about 82 per cent fish farms) followed by share regime (9 per cent fish farms) and co-operative regime (8 per cent fish farms). The other fishing households were operating under more than one regime.

On the basis of production rohu was the most dominant fish species constituting more than 25 per cent to total fish produced followed by mrigal (about 23 per cent), common carp (about 18 per cent), catla (about 17 per cent) and silver carp (about 16 per cent).

The marketed surplus was found on an average to be 50 per cent of the total fish produced in case of farms having pond area ≤ 0.6 acre (73.27 per cent of the sampled fish farms) and 74 per cent for farms having pond area > 0.6 acre (26.73 per cent of sampled fish farms). Overall the marketed surplus was about 69 per cent of the total produce. The bulk of the fish farmers in the study area were culturing fish mainly for home consumption, but they were selling the produce only to cater to their monetary needs. About 80 per cent of the Category I fish farmers had not excavated ponds with the purpose to culture fish, but they dug out the soil for making mud houses.

IV

COSTS AND RETURNS FROM FISH PRODUCTION

The average pond area and average fish production per fish farming household along with average fish yield are given in Table 4. The average yield per household in Category I was lower than that of Category II (the mean difference was statistically significant at 5 per cent level of significance). Overall, the average fish yield in the study area was very low (i.e., 583 kg per acre) as compared to the scientific composite fish culture (i.e., 1000 kg per acre) (Anonymous, 2002). The average pond area and average fish production per fish farming household were obtained at the levels of 0.58 acre and 338 kg, respectively, in the study area.

TABLE 4. AREA, PRODUCTION AND YIELD (AVERAGE) OF FISH, WEST TRIPURA, 2003-04

Pond size category (1)	Average pond area per household (acre) (2)	Average fish production per household (kg) (3)	Average fish yield* (kg/acre) (4)
Category I	0.34	184	535
Category II	1.23	748	610
Overall Category	0.58	338	583

*Average yield for scientific composite fish culture = 1000 kg per acre (Anonymous, 2002).

To test whether the difference between average yields of both the categories was statistically different, the sample statistic ‘t’ which possesses a t-distribution with $\nu = n_1+n_2-2$ *df* was computed (by assuming equal variances). Pooled variance was found equal to 30485.25 kg, t calculated equal to 2.05, t critical (two tail) at α=0.05 equal to 1.987 and *df* = 101.

In order to assess the profitability of fish production in the study area, the costs and returns structure was studied. Due to the inadequacy/unavailability of appropriate data on fixed capital investment, fixed costs could not be computed. But to fulfill the requirement of the study, following Singh *et al.* (2001) the fixed cost was assumed to be 26.29 per cent of the total cost. Total variable cost, gross returns, net returns over variable cost and net returns on farm, area and quantity basis have been computed for both the categories as well as for the overall situation. The results have been presented in Table 5.

The most essential component of variable cost was labour (hired as well as family labour) (Table 5). The other vital components of variable cost were seed, cow dung and feed. Net returns per farm were found to be positive for all categories and estimated about 336 per cent higher in case of Category II as compared to Category I. However, net returns per acre of pond area and per kilogram of fish produced were about 20 and 14 per cent, respectively, higher for Category II as judged against Category I.

TABLE: 5 COSTS AND RETURNS FROM FISH PRODUCTION IN WEST TRIPURA, 2003-04

(Rs./farm)

Item	Category I		Category II		Overall Category	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
I. Total working capital (a to h)	5098	*93.02*	18319	*93.02*	8581	*93.02*
(a) Seed expenditure	1133	*20.67*	3658	*18.58*	1808	*19.60*
(b) Feed expenditure	614	*11.20*	3660	*18.59*	1428	*15.48*
(c) Lime expenditure	296	*5.40*	1148	*5.83*	526	*5.70*
(d) Manure (Cow dung)	962	*17.55*	2559	*12.99*	1389	*15.06*
(e) Fertiliser expenditure	27	*0.49*	553	*2.81*	168	*1.82*
(f) Hired labour use	750	*13.69*	3024	*15.36*	1352	*14.66*
(g) Imputed value of family labour	876	*15.98*	1890	*9.60*	1020	*11.06*
(h) Other working expenses	440	*8.03*	1827	*9.28*	890	*9.65*
II. Interest on working capital @	382	*6.98*	1374	*6.98*	644	*6.98*
III. Total Variable Cost (I+II)	5480	*100.00*	19693	*100.00*	9225	*100.00*
IV. Total Fixed Cost*		1955		7024		3290
V. Total Cost (III+IV)		7435		26717		12515
VI. Gross returns ***		9200		34408		15886
VII. Net Returns (OVC)** (IV-III)		3720		14715		6661
VIII. Net Returns (VI-V)		1765		7691		3371
IX. Benefit-cost ratio (VI÷V)		1.24		1.29		1.27
(a) Average cost per kg (Rs.)		41		36		37
(b) Average cost per acre (Rs.)		21868		21721		21577
(c) Gross returns per acre (Rs.)		27059		27974		27390
(d) Gross returns per kg (Rs.)		50		46		47
(e) Net returns per acre (Rs.)		5191		6253		5813
(f) Net returns per kg (Rs.)		9.13		10.39		9.99

Note: Figures in italics are percentages to total variable cost.

*Total fixed cost was assumed to be 26.29 per cent of total cost following Singh *et al.* (2001), **OVC –Over Variable Cost**,** @ interest on working capital has been computed @ 15 per cent per annum for six months.

*** Gross returns = average size of farm (acre) x average fish yield per acre (kg) x average price per kg (Rs.).

The benefit–cost ratio was found to be 1.24, 1.29 and 1.27 in case of Category I, II and overall category farms, respectively. The sampled fish farmers were earning (net returns) Rs. 5,813 per acre and about Rs. 10 per kilogram from this endeavour (overall situation).

Thus, from the results of costs and returns analysis, it may be concluded that fish production was a remunerative venture for the farmers of the study area. But, the net returns were very low as compared to scientific composite fish culture because of the gap between existing technologies and recommended one for scientific fish culture.

V

DETERMINANTS OF FISH PRODUCTION

The cost-return analysis is static. Consideration should be given to some of the interactions of the factors affecting production and profit. The productivity can be increased through one or combination of its determinants – the technology, the quantities and the types of resources used and the efficiency with which the resources are used (Goyal *et al*., 2006). Thus, it is important to answer the questions like: What are the determinants of output and their extent of influence on output (i.e., the physical and marginal relationships between output and a host of explanatory variables)? Which inputs are significant in explaining variation in output?

To answer the above listed question, multiple linear regression analysis was carried out. The average and marginal productivities of factors of production, elasticity of production and returns to scale were worked out.

The dependant variable Y (fish production per fishing household in kg) was regressed on the following factors:

X_1 = Pond area (acre), X_2 = Age of pond (Yrs), X_3 = Seed expenditure (Rs.), X_4 = Feed expenditure (Rs.), X_5 = Lime expenditure (Rs.), X_6 = Manure expenditure (Rs.), X_7 = Fertilisers expenditure (Rs.), X_8 = Average size stocked (cm), X_9 = Experience of the operator (yrs.), X_{10} = Education of the operator (yrs. of schooling), X_{11} = Hired labour use (man days), X_{12} = Farm income (Rs.), X_{13} = Non-farm income (Rs.), X_{14} = average depth of the pond (cm), D_1 = Source of fingerlings (if trader/commission agent then '1' otherwise '0'), D_2= Training in fisheries (if trained then '1' otherwise '0').

The regression equation was estimated by using 'Ordinary Least Square' method. Stepwise procedure with criteria: Probability-of-F-to-enter ≤ .150, Probability-of-F-to-remove ≥ .160), was followed. The estimates of the regression coefficients and corresponding standard errors are given in Table 6.

TABLE 6. 'ORDINARY LEAST SQUARE' ESTIMATES OF THE LINEAR REGRESSION EQUATION, WEST TRIPURA, 2003-04

	Category I		Category II		Overall Category	
Explanatory Variables (1)	Coefficient (2)	Standard Error (3)	Coefficient (4)	Standard Error (5)	Coefficient (6)	Standard Error (7)
Constant	~~0.559~~^{NS}	~~18.6333~~	~~-0.167~~^{NS}	~~45.5341~~	~~-74.676~~^{NS}	~~45.5341~~
Pond area (X_1) in acre	…	…	368.388*	53.6025	409.523*	53.6025
Pond age (X_2) in Yrs.	…	…	9.796**	1.4118	2.16^{NS}	1.4118
Seed (X_3) in Rs.	0.048*	0.0084	…	0.0055	0.010***	0.0055
Feed (X_4,) in Rs.	0.050*	0.0164	…	…	…	…
Lime (X_5) in Rs.	0.036**	0.0179	0.294*	0.0322	0.143*	0.0322
Manure (X_6) in Rs.	0.029**	0.0120	…	0.0154	0.043*	0.0154
Fertilizer (X_7) in Rs.	0.185*	0.0634	…	…	…	…
Hired labour (X_{11}) in Rs.	0.916**	0.3801	-2.133**	0.5055	-1.011**	0.5055
Dummy for seed source (D_1)#	51.15**	24.0141	…	…	…	…
	Adjusted R^2	0.729	Adjusted R^2	0.743	Adjusted R^2	0.745
	F(7, 66)	29.109	F(4, 22)	16.011	F(6, 94)	49.747
	N	74	N	27	N	101

Model: $Y = a + \sum b_i X_i + \sum D_i + \mu_i$, Y = Fish production per fish farming household (kg);
*, ** and *** indicate 1, 5 and 10 percent level of significance, respectively, whereas NS indicates non-significant coefficients up to 0 .10 level of significance; # if trader/commission agent then '1' otherwise '0'.

In case of Category I farms, the expenditures incurred on seed, feed and chemical fertilisers (i.e., X_3, X_4 and X_7 variables, respectively) has exhibited positive and highly significant (1 per cent level of significance) effects on fish production per farm (Y), whereas the effects of the variables namely lime expenditure (X_5), manure expenditure (X_6) and hired labour use (X_{11}) were also found positive and significant at 5 per cent level of significance. The fish production was also significantly higher on the farms procuring fish fingerlings from the traders than those farms purchasing fish seed from other farms. The reason may be the services of the traders like technical advice given to their customers. These variables explained 72.90 per cent variation in fish production per farm.

The coefficient of pond area (X_1) was positive and highly significant in case of Category II and Overall category. It is consistent with the findings of the study done by Awoyemi *et al.* (2003) in Oyo State in Nigeria. On the farms belonging to Category II, other significant variables contributing positively towards fish production in the study area were age of pond ($X_{2)}$ and expenditure on lime (X_5). For the overall farm situation, amongst the variables entered in the model apart from pond area (X1), expenditure on seed (X3), lime (X5) and manure(X6) exhibited significant positive effects on the fish production. The effects of the expenditure on hired labour (X_{11}) were found negatively significant. Singh *et al.* (2001) while studying the dynamics of fish production in North Bihar (India) found coefficient of human labour negative but non-significant. Awoyemi *et al.* (2003) observed the effects of labour use on fish production as insignificant due to low use of labour. The variables entered in the regression analysis in case of Category II and Overall category explained 74.30 and 74.50 per cent of variation in the dependent variable, respectively.

From the above discussion and the insight of Table 6, it may be concluded that expenditure on seed, feed, lime, manure, chemical fertilisers and hired labour, and pond area were the important determinants of fish production in the study area. However, their effects on the fish production varied across the category. Such type of findings have also been made by Yadav (1990), Mollah *et al.* (1991) and Awoyemi *et al.* (2003) while studying input-output relationship in fish production in Bangladesh, Nepal and Nigeria, respectively.

The average and marginal physical productivities (APP_x and MPP_x) of the determinants of fish production alongwith their elasticity of production (e_p) in the study area have been given in Table 7. The production elasticity, which is equal to the ratio of MPP_x and $APP_{x,}$ were found positive but less than zero for all the inputs entered in the regression analysis except pond area and hired human labour in case of Category II and Overall category farms. This implied that the farmers were operating in the second stage of production with respect to these inputs. The physical returns to farm size, given by marginal physical product of pond area, was found greater than one in Category II farms and Overall category, however, in case of Category I farm, this variable did not enter in the regression analysis. The elasticity of production with respect to hired human labour in Category II and Overall category farms was estimated to be negative, which signified the irrationality in decision making by the farmers. Increasing returns to scale, which is the sum of production elasticity of the determinants of fish production, were observed in all the categories of fish farmers in the study area.

TABLE 7. AVERAGE AND MARGINAL PHYSICAL PRODUCTIVITIES, ELASTICITY OF PRODUCTION AND ECONOMIC RETURNS TO SCALE

	Category I			Category II			Overall category		
Input (1)	APP_{Xi} (2)	MPP_{Xi} (3)	e_p (4)	APP_{Xi} (5)	MPP_{Xi} (6)	e_p (7)	APP_{Xi} (8)	MPP_{Xi} (9)	e_p (10)
Pond area (X_1) in acre	…	…	…	336.86	368.39	1.09	217.63	409.52	1.88
Pond age (X_2) in Yrs.	…	…	…	36.42	9.80	0.27	…	…	…
Seed (X_3) in Rs.	0.08	0.05	0.60	…	…	…	0.19	0.01	0.05
Feed ($X_{4,}$) in Rs.	0.19	0.05	0.27	…	…	…	…	…	…
Lime (X_5) in Rs.	0.45	0.04	0.08	0.46	0.294	0.64	0.55	0.14	0.26
Manure (X_6) in Rs.	0.12	0.03	0.24	…	…	…	0.22	0.04	0.20
Fertiliser (X_7) in Rs.	5.19	0.19	0.04	…	…	…	…	…	…
Hired labour (X_{11}) in Rs.	7.34	0.92	0.12	19.32	-2.133	-0.11	14.82	-1.01	-0.07
Returns to Scale			1.19			1.89			2.39

In order to examine the effects of physical inputs, which has exhibited significant effects on fish production, marginal costs (MC) and returns (MR) have been computed and presented in Table 8. It was profitable to invest an additional rupee on all inputs entered in the analysis (because MR>MC) in Category I farms except human labour, where MC>MR. In case of Category II farms, the profitability from fish production could be increased by incurring more expenditure on lime, whereas in the overall situation it was profitable to spend money on seed, lime and manure. The profitability in these categories could further be increased by cutting expenditure on hired human labour.

TABLE 8. MARGINAL COSTS AND MARGINAL RETURNS FROM PHYSICAL INPUT USE

	Category I		Category II		Overall Category	
Explanatory variables (1)	MC (Rs.) (2)	MR (Rs.) (3)	MC (Rs.) (4)	MR (Rs.) (5)	MC (Rs.) (6)	MR (Rs.) (7)
Seed (X_3)	1	2.40			1	0.50
Feed (X_4)	1	2.50				
Lime (X_5)	1	1.80	1	13.52	1	6.70
Manure (X_6)	1	1.45			1	2.00
Fertiliser (X_7)	1	9.25				
Hired labour (X_{11})	60	45.8	60	-98.10	60	-47.50

**MR – Marginal returns (regression coefficient x average price per kg, which was Rs.50, 46 and 47, for Category I, II and Overall, respectively). MC – Marginal Cost.

VI

EFFECTS OF FISH PRODUCTION ON FAMILY INCOME INEQUALITY

The analysis of income distribution has remained an area of intense research since the publication of the seminal works of Kuznets (1966) and Chenery *et al.* (1974). Several methods to measure inequality are available in literature. Their properties and characteristics have been analysed and discussed by different authors (Kakwani, 1980; Champernowne, 1972; Dasgupta *et al.*, 1973). The use of Gini index is not simply acceptable, it is desirable (Shorrocks, 1982). Although Gini index is more sensitive to mean income than to income inequality (Sharma *et al.*, 1994), but this measure of inequality (but not variance based measures like coefficient of variance) permit one to form the necessary conditions for stochastic dominance.

Shorrocks (1982) has demonstrated that there exists no unique way of decomposing inequality. He derived what he calls "natural decompositions" of the Gini, in which each source's contribution to inequality equals the product of its share of total income and the pseudo-Gini. Lerman and Yitzhaki (1984) developed an approach for decomposition of Gini, which views each source's contribution as the product of its own inequality, its share of total income, and its correlation with the rank of cumulative total income, appears more compelling and less arbitrary than other specifications of natural decomposition (where a source's contribution is the product of the income share and pseudo-Gini).

Keeping in view the advantages and usefulness of the approach developed by Lerman and Yitzhaki, the same has been utilised to meet out the objectives of the present study. The mathematical form of the approach adopted from Lerman and Yitzhaki (1984) is:

$$G = \sum_{k=1}^{k} [R_k \times G_k \times S_k];\ R_k = \text{cov}\,(y_k, F) \div \text{cov}\,(y_k, F_k);$$

$$G_k = 2\text{cov}\left(y_k, F_k\right) \div m_k\ ;\ \text{and}\ S_k = m_k \div m$$

Where, G = Overall/conventional *Gini*; G_k = Relative *Gini* component of k-th income source; R_k = '*Gini* correlation' of k-th income component with the rank of cumulative family income, which has the properties similar to Pearson's and the rank correlations; S_k = component of k-th source's share in total income; y_k = k-th component of family income, F = rank of cumulative distribution of family income (obtained after arranging in ascending order); F_k = rank of cumulative distribution of k-th income source (obtained after arranging in ascending order); m_k = share of k-th income source in the family income, m = total family income.

The income source's inequality contribution (I), relative income inequality (RII) and relative marginal effect (RME) for the k-th source of family income are obtained as follows:

$I_k = R_k \times G_k \times S_k \div G$; $RII_k = I_k \div S_k$; and $RME_k = I_k - S_k$

Where, Rk, G_k, S_K and G have the meaning defined earlier.

In the present study, the non-farm family income sources, namely, private job, government job, self-employment and labour, and the farm income sources, namely, fish production, paddy, vegetables, fruits and milk production have been considered. Income from the sources like pensions/transfer payments, piggery, poultry, farm labour, fish seed production, etc. was included under the 'others' head of income source.

The estimates of the decomposition analysis are presented in Table 9. The fish production was the most important source of family income (overall 32 per cent). The contribution of fish production to the family income of the Category II households was very high (48 per cent) when compared to Category I (14 per cent). High positive Gini correlation (R_k) between the income from fish production and the rank of the cumulative family income was observed in Category II and overall situation fish farming households. In Category I, the Gini correlation was positive but very low. The family income distribution (given by overall Gini) was relatively even in case of Category I households as compared to the overall situation as well as Category II households.

TABLE 9. EFFECTS OF FISH PRODUCTION ON FAMILY INCOME INEQUALITY, WEST TRIPURA, 2003-04

Category (1)	Measure (2)	Govt. Job (3)	Self-employment (4)	Hired out Labour (5)	Fish Production (6)	Paddy (7)	Vegetables (8)	Fruits (9)	Dairy (10)	Others (11)	Total (12)
Category I	R_k	0.45	0.20	-0.01	0.09	0.18	0.16	0.05	0.00	0.48	
	G_k	1.36	1.29	1.59	0.41	0.87	1.10	1.66	1.48	1.19	**0.3500**
	S_k	0.25	0.13	0.04	0.14	0.15	0.06	0.01	0.01	0.22	1.00
	I_k	0.43	0.10	0.00	0.01	0.07	0.03	0.00	0.00	0.36	1.00
	RII_k	1.74	0.75	-0.03	0.10	0.46	0.49	0.25	0.01	1.62	-
	RME_k	0.18	-0.03	-0.04	-0.13	-0.08	-0.03	0.00	-0.01	0.14	-
Category II	R_k	0.41	0.21	-0.20	0.83	0.12	0.23	-0.25	0.13	0.56	
	G_k	0.96	1.45	1.51	0.62	0.90	1.12	1.49	1.46	1.21	**0.4488**
	S_k	0.22	0.06	0.03	0.48	0.05	0.02	0.00	0.00	0.14	1.00
	I_k	0.19	0.04	-0.02	0.55	0.01	0.01	0.00	0.00	0.21	1.00
	RII_k	0.88	0.69	-0.66	1.15	0.23	0.58	-0.82	0.43	1.51	-
	RME_k	-0.03	-0.02	-0.05	0.07	-0.04	-0.01	0.00	0.00	0.07	-
Overall	R_k	0.46	0.19	-0.02	0.77	0.13	0.15	-0.04	0.02	0.47	
	G_k	1.24	1.35	1.58	0.70	0.88	1.12	1.63	1.48	1.21	**0.4479**
	S_k	0.23	0.09	0.03	0.32	0.10	0.04	0.00	0.01	0.18	1.00
	I_k	0.30	0.05	0.00	0.38	0.02	0.01	0.00	0.00	0.23	1.00
	RII_k	1.28	0.57	-0.09	1.21	0.25	0.36	-0.15	0.07	1.27	-
	RME_k	0.07	-0.04	-0.04	0.07	-0.07	-0.02	0.00	-0.01	0.05	-

Figures in bold in the last column (Total) is G (Overall Gini) = $\sum R_k \times G_k \times S_k$.

The distribution of income from fish production was relatively even as compared to distribution of income from other sources considered for all the categories as the value of G_k was the lowest. The contribution of income from fish production towards overall family income inequality was relatively low in Category I households as compared to other categories, due to the very low degree of *Gini* correlation (G_k) and low share (S_k).

The relative measures offer more appropriate comparisons. The relative income inequality (RII_k) of fish production in case of Category I fish farming households was 0.10, which implies that with the increase in the share of income from fish production in family income by 100 per cent, its share in family income inequality would increase by 10 per cent. Also the relative marginal effect (RME_k) of this source of income was negative for Category I, which means that inequality can be reduced by increasing the share of income from fish production in family income. The estimates of RII_k and RME_k were found greater than 1 and 0, respectively, for Category II and Overall situation households.

VII

CONCLUSIONS

The results of the present study have demonstrated that composite culture of carps was followed in the study area. All the carps were cultured in different combinations and proportions. But, the fish production in the study area was not commercialised in general, despite the fact that this was a profitable venture.

The important determinants of fish production were expenditure on seed, feed, lime, manure and chemical fertiliser, hired human labour and pond area. The farmers were found to be operating in the second stage of production with respect to inputs namely seed, feed, lime, manure and fertiliser. But, Category II and the overall category farmers were found operating in irrational stages of production with respect to factors namely pond area (I stage of production) and hired human labour (III stage of production). The marginal costs and returns analysis showed that the profitability from fish production, in general, could be increased by increasing expenditure on physical inputs namely seed, feed, lime, manure and fertiliser, and cutting down expenditure on hired human labour.

The family income inequality analysis showed that the fish production played a pivotal role in family income inequality in the study area. This source of income has shown positive correlation with total family income of the fish farmers. The distribution of income earned from fish production among the fish farming households was also relatively better as compared to other sources except non-farm labour income. But income from fish production was one of the most important sources of the family income inequality in the study area. Thus fish production has a pivotal role to play in order to make the family income distribution more equitable among the fish farming households in the study area.

Received June 2004. *Revision accepted July 2006.*

REFERENCES

Anonymous (2002), *Perspective Plan for Attaining Self-Sufficiency in Fish Production in Tripura 2002-2012 A.D*, Department of Fisheries, Government of Tripura.

Awoyemi, T.T.; J.O. Amao and N.C. Ehirim (2003), "Technical Efficiency in Aquaculture in Oyo State, Nigeria", *Indian Journal of Agricultural Economics*, Vol.58, No.4, October-December, pp. 812-819.

Champernowne, D.G. (1972), "A Comparisons of Measures of Inequality on Income Distribution", *The Economic Journal,* Vol.84, No.336, pp. 787-816.

Chenery, Hollis; Montek S. Ahuwalia; Clive Bell; John H. Duloy and Richard Jolly (1974), "*Redistribution with Growth"*, Oxford University Press, New York.

Dasgupta, Partha, Amartya Sen and David Starrett (1973), "Notes on the Measurement of Inequality", *Journal of Economic Theory,* Vol.6, No.2, pp. 180-187.

Goyal, S.K.; K.S. Suhag and U.K. Pandey (2006), "An Estimation of Technical Efficiency of Paddy Farmers in Haryana State of India", *Indian Journal of Agricultural Economics*, Vol.61, No.1, January-March, pp. 108-122.

Kakwani, N.C. (1980), *Income Inequality and Poverty,* Oxford University Press, New York.

Kuznets, Simon (1955), "Economic Growth and Income Inequality", *American Economic Review*, Vol.45, March, pp.1-28.

Lerman, Robert I. and Shlomo Yitzhaki (1984), "Income Inequality Effects by Income Source: A New Approach and Applications to the United States", *The Review of Economics and Statistics*, pp. 151-159.

Mollah, A.R.; Chowdhary, S.N.I. and M. Ashanhabib (1991), "Input-output Relationship in Fish Production under Various Pond Size, Ownership Pattern and Constraints", *Bangladesh Trade and Development,* Vol.3, No.2, pp. 87-101.

Pillay, T.V.R. (1990), *Aquaculture Principles and Practices,* Fishing News Books, Oxford, p. 253.

Reynolds, Morgan and Eugene Smolensky (1977), *Public Expenditure, Taxes and the Distribution of Income,* Academic Press, New York.

Sarkar, S.K. (2002), "Status of Fisheries Development in Tripura", *Fishing Chimes*, Vol.22, No.1, pp. 72-73.

Sharma, R.K., R.K. Sharma and Brij Bala (1994), "Inequality in the Distribution of Farm Assets in Himachal Pradesh: A Decomposition Analysis", *Indian Journal of Agricultural Economics*, Vol.49, No.4, October-December, pp. 601-608.

Shorrocks, A.F. (1982), "Inequality Decomposition by Factor Components", *Econometrica,* Vol.50, No.1, pp. 193-211.

Singh, R.K.P.; K.K. Prasad and S.K. Singh (2001), "Dynamics of Pisciculture in North Bihar, India", *Journal of Fisheries Economics and Development*, Vol.4, No.1, pp. 21-34.

Sinha, V.R.P. (1991), "Aquaculture Research and Development in India", in *Aquaculture Productivity,* Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Srivastava, U.K.; B.H. Dholakia; S. Srinivasa Rao and S. Vathsala (1990), "Evaluation Study of Fish Farmers Development Agency – Programme for Fresh Water Aquaculture in India", Indian Institute of Management, Ahmedabad, p. 109 (mimeo.).

Yadav, R.K. (1990), "Fish Production in Nepal: Problems and Prospects – A Case Study of Krishnapur Village Panchayat of Siraha District*", Economic Journal of Nepal*, Vol.13, No.3, pp. 67-74.