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Estimation of Demand for Different Fish Groups in Tripura[§]

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Abstract

This paper has estimated the demand and income elasticity for different fish types in Tripura and has projected the demand of fish. Three-stage multiple budgeting framework of household was structured in simple way mitigating the drawback of limited sample size and aggregation problem. The coefficient of food and fish expenditure functions for urban, rural and overall Tripura have been found to be positive and significant, indicating that the response of food expenditure to income changes and fish expenditure to food budget changes are substantial. All the coefficients of specific fish consumption (local carps, local non-carps, inter-state non-carps and small weed fish) have been found to be significant, except for the coefficient of inter-state carps (IC) consumption function. Looking at the variability of income elasticities across the *Choiced Fish Groups (CFGs)*, all CFGs have substantial importance with respect to income change, except inter-state carps (IC) which is likely to have no relation with the change in income basket for the consumers. The income elasticity of demand for local carps in Tripura has been found highest among all the CFGs and is expected to play a dominating role in meeting fish demand. Demand for the fish under the baseline scenario (considering base year 2004) is likely to grow at an annual rate of 3.38 per cent for the state and at the rate of 3.95 per cent and 2.00 per cent for urban and rural areas, respectively between 2004 and 2015. The demand for fish by 2015 has been projected as 80,153 Mt shared by 62,910 Mt of carps (local and inter-state) and 17,243 Mt of non-carps. The demand for local carps has been projected to be nearly 50 percent (40,624 Mt) of total projected demand of fish in 2015.

Key words: Fish demand estimation, multiple-budgeting framework, income elasticity, demand projection

JEL Classification: C31, D12, R22

Introduction

Tripura has witnessed impressive growth in the fisheries sector, especially in the culture fisheries in recent past. However, the demand for fish is not being met from its own production. According to the data provided by National Sample Survey Organization, 98.6 per cent households in the rural and 95.8 per cent in the urban areas consume fish in Tripura (NSSO, 2007). During 2007-08, the fish production was estimated to be 32,823 Mt, whereas the reported requirement was of 43,280 Mt (GoT, 2009). This gap in supply and demand for fish attracted fish producers and fish traders from other states like Andhra Pradesh, and West Bengal and even from the neighbouring country Bangladesh (Nandeesha, 2008). The local fish producers have comparative advantage in terms of marketing and better prices for fresh fish. On the other hand, the inter-state fish producers have the advantage of higher productivity at low cost due to economies of scale (Upadhyay, 2008). The Department of Fisheries (Government of Tripura) has reported that requirement

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of fish is higher than the fish produced locally and the state procures fish from other states to meet its demand. Considering such a scenario, DoF (GoT) formulated and implemented a perspective plan to attain self-sufficiency in fish production by 2010-11. A crude estimation was made with the assumption that 95 per cent of the expected population would require 13 kg fish/capita/year. Based on this estimation, the fish production of 36,991 Mt in 2008-09 was to be increased to 43,280 Mt by 2010-2011. This projection though based on nutritional requirement, is only a crude estimation, whereas the actual fish demand in Tripura is a matter of research. With this background, this paper has estimated the demand for fish in Tripura and has projected its future demand also.

The available demand studies on the fisheries sector are limited by their high degree of aggregation, and lack of empirical basis for estimating the underlying elasticity of demand (Dey, 2000; Delgado *et al.*, 2003; Dey and Ahmed, 2005). A description of fish demand is imperative for rational and pragmatic planning for specific fish types. The disaggregated study would be useful for the development of fish production strategy, evaluation of impact of technology, prioritization of fish technologies and evaluation of management options to benefit both consumers and producers. Demand elasticities are of crucial importance for *ex-ante* and *ex-post* evaluation techniques, and for finding the current and future status of fisheries sector. In the available studies, fish has been treated as an aggregate commodity in the demand models (Paroda and Kumar, 2000; Kumar and Dey, 2004). Disaggregated analysis on fish demand was carried out at the country level by Kumar *et al*. (2005), but there has been virtually no published literature at disaggregated fish demand analysis.

Several methodologies for fish demand have been suggested by many economists and policy analysts. A multi-stage budgeting framework has been preferred for modelling the behaviour of fish-eating households in many studies (Blundell *et al*., 1993; Fan *et al*., 1995; Tiffin and Tiffin, 1999; Dey, 2000). The same approach was used for projecting household demand for fish in India by Kumar and Dey(2004) and for fish demand by species group by Kumar and Paraguas (2005). The disaggregated fish demand analysis based on such approach at the state level would be more credible and relevant as the state is the main authority for policy, planning and execution of programmes for fisheries development, as fisheries is a state subject. Based on the primary cross-sectional data, this paper has examined the fish demand by choiced fish groups (CFGs) for the state of Tripura across rural and urban areas. The demand parameters have been used to project the fish demand by CFGs to a medium-term time horizon.

Data and Methodology

Data

The study was conducted in Tripura where fisheries a play vital role in the economic development of the state. The monthly income and expenditure data of households were collected through primary survey during February to June, 2010. The data were collected covering all the four districts, viz. North, South, West and Dhalai, of Tripura following the stratified multi-stage random sampling method. Prior to the preparation of interview schedule, heterogeneous fish varieties of Tripura were clubbed under four categories or CFGs based on two criteria, viz. source of supply (local or inter-state), and type of species (carps or non-carps). Another CFG, small weed fish (carps or non-carps) which has different market orientation but could not be included in these categories/ CFGs, was regarded as another separate fish group. Finally, five *Choiced Fish Groups (CFGs)* were formed, namely Local Carps (LC), Local Non-carps (LNC), Inter-state Carps (IC), Inter-state Non-carps (INC) and Small Weed Fish (SWF). A list of fish species under each group is given in Table 1. These CFGs were identified through pilot survey and personal discussions with fisheries experts from DoF, GoT and the scientific community. A consumer interview schedule was prepared and pretested. A total of 407 fish consuming households (104 from urban and 303 from rural areas) were covered for demand analysis.

Demand Model and Estimation Procedure

A multi-stage budgeting framework, the details of which can be found in Deaton and Muellbauer (1980); Thomas (1987); Heien and Wessels (1990); Blundell *et al*. (1993); Mustapha *et al*. (1994); Fan *et al*. (1995); Gao *et al*. (1996); Tiffin and Tiffin (1999) and Dey (2000) was used to model the fish consumption behaviour of the households.In the first stage, the

Table 1. Fish species under different categories used in the study

Choiced fish groups	Fish species
Local carps (LC)	Catla (*Catla catla*), Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Grass Carp (*Ctenopharyngodon idella*), Common Carp (*Cypriprinus carpio*), Bata (*Labeo bata*), Gonius (*Labeo gonius*), Calabasu (*Labeo calbasu*) Reba (*Cirrhinus reba*), Big head (*Aristichthysnobillis nobilis*)
Inter-state carps (IC)	Mainly Rohu and Catla; and other inter-state carps
Local non-carps (LNC)	Magur (*Clarias batrachus*), Singhi (*Heteropneustesfossilis*), Koi (*Anabas testudineus*), Pangus (*Pangasius* sp.), Prawn (*Macrobrachium rosenbergii*), Pabda (*Ompok sp.*) Pacu (*Piaractus brachypomum*), Boal (*Wallago auttu*), Tilapia (*Oreochromis mossambicus*), Kuichya (*Amphipnous cuchia*)
Inter-state non-carps (INC)	Ilish (*Tenualosa ilisha*), Pangus (*Pangus sp.*), Pacu (*Piaractus brachypomum*) Tilapia (*Oreochromis mossambicus*) and other marine fish.
Small weed fish (SWF)	Moca (*Amblypharyngodon mola*), Tangra (*Mystus sp.*), Puti (*Puntius sp.*), Dharkina (*Esomus danricus*), Chela (*Oxyguster bacaila*) Butum (*Noemacheilus aurius*), etc.

consumer is assumed to allocate expenditures to broad groups of commodities; and in the second stage, he allocates expenditures within each broad group to smaller groups. The full demand system containing all the consumable commodities warrants a huge amount of own- and cross-price parameters that are impractical to estimate with the limited sample size. However, this study with limited sample size and strictly focusing on demand projections with respect to income growth, didn't consider price and other parameters to keep the study simplified.

The expenditure functions (for food and subsequently for fish) were specified at different stages of the model. The food expenditure function showed how households, given their total per capita income, allocate their budget to food commodities. On the other hand, the fish expenditure function showed how the fish budget of households was affected by the budget for food commodities, such as cereals, fish, meat, fruits, vegetables, etc. In the third stage, the functional model was specified to estimate the parameters of the demand system by examining how the quantity of specific fish type was affected by the total fish expenditure. Finally, demand parameters estimated from the above functional forms were used to workout income elasticity for each CFG. Income elasticity for each CFG could have been achieved by using single equation approach, but system approach was used to reduce the aggregation effect in the estimation.

First Stage (Food Expenditure Function)

Function: Food expenditure = f (Family income)

Equation: $\ln (FD_e) = \alpha_1 + \beta_1 \ln (F_i)$ …(1)

Second Stage (Fish Expenditure Function)

Function: Fish expenditure = g (Food expenditure)

Equation: $\ln (FI_e) = \alpha_2 + \beta_2 \ln (PRE_{FD})$ …(2)

Third Stage (Specific Fish Consumption Function)

Function: Specific fish consumption = h (Fish expenditure)

Equation: $\ln (PCQ_i) = \alpha_3 + \beta_3 \ln (PRE_{FI})$ …(3)

where,

α_1 = Intercept of food expenditure function (first stage, Equation 1),

α_2 = Intercept of fish expenditure function (second stage, Equation 2),

α_3 = Intercept of specific fish consumption quantity function (third stage, Equation 3),

β_1 = Coefficient of food expenditure with respect to income = e_f^{fd}

β_2 = Coefficient of fish expenditure with respect to food expenditure = e_{fd}^{fi}

β_3 = Coefficient of specific fish consumption (qty) to fish expenditure = e_{fi}^{QF}

FD_e = Per capita food expenditure,

F_i = Per capita family income,

FI_e = Per capita fish expenditure,

PRE_{FD} = Predicted per capita food expenditure from first stage function,

PCQ_i = Per capita quantity of fish consumption for the i^{th} CFG, and

PRE_{FI} = Predicted per capita fish expenditure from second stage function.

The equations of different stages were estimated by ordinary least square (OLS) method and the exercise was carried out separately for the urban and rural areas. But while estimating the functions for entire sample (combining rural and urban), regional dummy was imposed ('0' for urban and '1' for rural areas). The analysis was carried out using PASW 18 (Predictive Analytics Software 18). Predictive values of food expenditure from the first stage Equation (1) were used as explanatory variable in the second stage Equation (2) and then, the predictive values of fish expenditure from second stage Equation (2) were used as explanatory variable in third stage Equation (3). The Equation (3) was applied for each CFG separately for urban, rural and the whole sample. Income elasticity for each CFG was estimated by using the following relations:

$$e_I^{QF} = \left(e_{fi}^{QF}\right) \times \left(e_{fd}^{fi}\right) \times \left(e_I^{fd}\right)$$

$$= \left(\beta_3\right) \times \left(\beta_2\right) \times \left(\beta_1\right)$$

The occurrence of zero observations is one of the most pressing issues in applied demand analysis and other micro-econometric applications (Shonkwiler and Yen, 1999). The zero observation samples in fish consumption (even for a single fish type) were excluded from the estimation; but final estimation was rationalized by using correction factor for the probability of positive fish consumption in the state. This factor was multiplied with the estimated income elasticity for each CFG. So, final corrected elasticity of income was calculated using the following relation for each group of fish:

$$E_I^{QF} = \left[e_I^{QF}\right] \times \left[P_C\right]$$

$$E_I^{QF} = \left(e_{fi}^{QF}\right) \times \left(e_{fd}^{fi}\right) \times \left(e_I^{fd}\right) \times \left[P_C\right]$$

$$E_I^{QF} = \left[\left(\beta_3\right) \times \left(\beta_2\right) \times \left(\beta_1\right)\right] \times \left[P_C\right]$$

where,

E_I^{QF} = Corrected income elasticity for a specific CFG with respect to income,

e_I^{QF} = Estimated income elasticity for a specific CFG with respect to income,

e_{fi}^{QF} = Elasticity of specific fish consumption (qty) to fish expenditure,

e_{fd}^{fi} = Elasticity of fish expenditure with respect to food expenditure,

e_I^{fd} = Elasticity of food expenditure with respect to income,

P_C = Probability that positive fish consumption occurs,

β_3 = Coefficient of specific fish consumption function [third stage budgeting, Equation 3],

β_2 = Coefficient of fish expenditure function [second stage budgeting, Equation 2], and

β_1 = Coefficient of food expenditure function [first stage budgeting, Equation 1].

Results and Discussion

Summary Statistics

The summary statistics of variables used in the study are given in Table 2.The average values of all the variables were found to be higher for urban than rural Tripura. The average per capita annual income of Tripura was ₹24,114 which is close to the per capita annual income of ₹28,806 provided by the Directorate of Economics and Statistics, Government of Tripura (Annon, 2009). The annual per capita food and fish expenditures were ₹ 8,956 and ₹ 2,289, respectively for the Tripura state. The samples showed a high deviation from the mean values in per capita consumption of local non-carps in urban areas and of inter-state non-carps in rural areas. It could be due to the high price of local non-carps and *Hilsa* (high-value inter-state non-carp species) that their consumption varied with household income. A higher per capita

Table 2. Summary statistics of variables, Tripura: 2009-10

(Units: per capita per year, except family size)

Variables**	Urban Tripura (n = 104)	Rural Tripura (n = 303)	Tripura state (n = 407)
Family size (No.)	5.817 (0.2749)	4.960 (0.1049)	5.179 (0.1065)
Family income (₹)	30343.748 (1924.2143)	21975.999 (1086.0972)	24114.195 (962.3224)
Food expenditure (₹)	10123.274 (215.0326)	8551.666 (148.7073)	8956.478 (128.5577)
Fish expenditure (₹)	2720.741 (96.2495)	2136.380 (57.9203)	2288.921 (51.9549)
Consumption of LC (kg)	9.372 (0.4253)	6.880 (0.2495)	7.517 (0.2216)
Consumption of IC (kg)	6.140 (0.2005)	5.452 (0.1184)	5.628 (0.1029)
Consumption of LNC (kg)	1.100 (0.0901)	0.760 (0.0431)	0.848 (0.0401)
Consumption of INC (kg)	0.892 (0.0933)	0.737 (0.0429)	0.779 (0.0399)
Consumption of SWF (kg)	2.024 (0.1043)	1.671 (0.0499)	1.761 (0.0463)
Consumption of fish (kg)	19.539 (0.6968)	15.51 (0.3965)	16.543 (0.3551)

Note: Figures within the parenthesis are standard errors

annual fish consumption was observed in urban areas (19.54 kg) than in rural areas (15.51 kg). But, GoT has worked out the fish requirement for the state with the assumption of 13 kg/capita/year. Hence, self-sufficiency in fish production could not be achieved as targeted by GoT in 2008. It is necessary to revise the target for fish production to achieve self-sufficiency.

Estimation of Demand Model

The estimated parameters of three functional forms (from the three-stage budgeting framework, as explained in methodology) have been summarized in Tables 3 and 4. The explanatory variables included in the food and fish expenditure model explained 86.6 per cent and 62.9 per cent of the total variation, respectively. The corresponding adjusted R-squared values were 75.6 per cent and 50.2 per cent for urban Tripura; and 87.4 per cent and 62.2 per cent for rural Tripura. The adjusted R-squared value of specific fish consumption function varied widely with respect to different fish types. Explanatory variables of the overall fish consumption (quantity) function of Tripura state for local carps, local non-carps, inter-state non-carps and small weed fish could explain 59.7 per cent, 54.3 per cent, 41 per cent and 30.8 per cent of the total variation, respectively. The inter-state carp consumption (quantity) function showed low R-squared values (0.3 per cent for urban Tripura, 1.0 per cent for rural Tripura and 2.6 per cent for Tripura state).

The coefficients of food and fish expenditure functions for urban, rural and Tripura state were found to be positive and significant, indicating that the response of food expenditure to income changes and fish expenditure to food budget changes were substantial. All the coefficients of specific choiced fish consumption (LC, LNC, INC and SWF) were found

Table 3. Estimated parameters of food expenditure and fish expenditure system, Tripura: 2009-10

	Urban Tripura		Rural Tripura		Tripura state	
	Estimated value	t-value	Estimated value	t-value	Estimated value	t-value
Food expenditure = f (Family Income)						
Intercept	4.048	26.938	3.653	57.756	3.749	60.067
Coefficient	0.870	17.798	0.935	45.695	0.915	48.107
Dummy					-0.049	-2.557
Adjusted R-square	0.756		0.874		0.866	
Fish expenditure = f (Predicted food expenditure)						
Intercept	-2.842	-3.506	-4.048	- 9.849	-3.956	-10.327
Coefficient	0.709	10.140	0.788	22.237	0.784	24.395
Dummy					-0.025	-0.784
Adjusted R-square	0.502		0.622		0.629	

Table 4. Estimated parameters of different fish consumption systems, Tripura: 2009-10

	Urban Tripura		Rural Tripura		Tripura	
	Estimated value	t-value	Estimated value	t-value	Estimated value	t-value
LC Fish consumption (Quantity) = f (Predicted fish expenditure)						
Intercept	-7.581	-9.499	-7.836	-22.480	-7.684	-23.314
Coefficient	0.674	9.207	0.766	20.690	0.770	22.742
Dummy					-0.008	-0.226
Adjusted R-square	0.454		0.587		0.597	
IC Fish consumption (Quantity) = f (Predicted fish expenditure)						
Intercept	-1.174	-1.191	-1.407	-3.856	-1.282	-3.617
Coefficient	0.054	0.548	0.101	1.770	0.097	1.843
Dummy					-0.097	-1.850
Adjusted R-square	0.003		0.010		0.026	
LNC Fish consumption (Quantity) = f (Predicted fish expenditure)						
Intercept	-14.451	-9.689	-12.249	-25.836	-12.506	-26.058
Coefficient	0.619	7.970	0.748	19.538	0.752	20.836
Dummy					0.045	1.242
Adjusted R-square	0.384		0.560		0.543	
INC Fish consumption (Quantity) = f (Predicted fish expenditure)						
Intercept	-15.156	-9.811	-10.556	-20.368	-11.361	-21.951
Coefficient	0.620	7.071	0.646	14.593	0.681	16.552
Dummy					0.159	3.858
Adjusted R-square	0.384		0.417		0.410	
SWF Fish consumption (Quantity) = f (Predicted fish expenditure)						
Intercept	-6.870	-6.798	-6.348	-16.908	-6.384	-17.500
Coefficient	0.446	5.037	0.556	11.613	0.563	12.695
Dummy					0.023	0.523
Adjusted R-square	0.199		0.309		0.308	

to be significant at 5 per cent and 1 per cent levels of significance, except for inter-state carps consumption function. It indicates that the response of consumption of LC, LNC, INC and SWF to the fish budget changes was significant. But the response of quantity of IC consumption to fish budget changes was found to be meagre and insignificant. This may be due to the fact that the consumers of Tripura consider inter-sate carps to be an inferior fish, compared to other CFGs. This issue has been further analyzed in the next section.

Income Elasticity of Demand

The income elasticities of demand for different CFGs were summarized for urban and rural Tripura and also for the entire state (Table 5). These were positive and less than one for all the CFGs across rural and urban areas of Tripura. The income elasticities of demand for all the CFGs were higher in rural than urban Tripura. In other words, the response of fish consumption with respect to income changes was more substantial for rural than urban consumers.

It was found that all CFGs, except IC had substantial variability with respect to income change. The IC did not show variability with the change in income of the consumers in urban and rural areas or for the state in general. The income elasticity of demand for IC in the state was found to be the least (E_I^{QF} = 0.066) among all the CFGs, indicating the most inferior

Table 5. Income elasticity of specific CFG in urban, rural and state of Tripura: 2009-10 (P_c = 0.95)

CFGs	e_{fi}^{QF}	$E_I^{QF} = \left[\left(e_{fi}^{QF}\right)\times\left(e_{fd}^{fi}\right)\times\left(e_I^{fd}\right)\right]\times\left[P_C\right]$
	Urban Tripura	
Coefficients→	e_I^{fd} = 0.870	e_{fd}^{fi} = 0.709
Local carps (LC)	0.674	0.395
Inter-state carps (IC)	0.054	0.032
Local non-carps (LNC)	0.619	0.363
Inter-state non-carps (INC)	0.620	0.363
Small weed fish (SWF)	0.446	0.261
	Rural Tripura	
Coefficients→	e_I^{fd} = 0.935	e_{fd}^{fi} = 0.788
Local carps (LC)	0.766	0.536
Inter-state carps (IC)	0.101	0.071
Local non-carps (LNC)	0.748	0.524
Inter-state non-carps (INC)	0.646	0.452
Small weed fish (SWF)	0.556	0.389
	Tripura state	
Coefficients→	e_I^{fd} = 0.915	e_{fd}^{fi} = 0.784
Local carps (LC)	0.770	0.525
Inter-state carps (IC)	0.097	0.066
Local non-carps (LNC)	0.752	0.512
Inter-state non-carps (INC)	0.681	0.464
Small weed fish (SWF)	0.563	0.384

CFG across the urban (E_I^{QF} = 0.032) and rural (E_I^{QF} = 0.071) areas of Tripura.

The income elasticity of demand for local carps in Tripura was found highest among all the CFGs. Therefore, the demand for local carps is likely to be more than for any other CFG with income change in future. Local non-carps have also shown a positive and second highest elasticity of demand after LC.

Fish Demand Projection

The increase in availability of fish from local or inter-state sources will increase fish consumption in Tripura. The demand projections for different CFGs have been summarized for urban (Table 6), rural (Table 7) areas, and for Tripura state (Table 8) separately. The demand for fish in the baseline scenario is likely to grow at an annual rate of 3.38 per cent for the state and 3.95 per cent for urban and 2.00 per cent for rural areas by 2015. The highest growth in demand in Tripura state is projected for local carps (4.36%), followed by local non-carps (4.28%), inter-state non-carps (3.99%), small weed fish (3.51 %) and inter-state carps (1.58%). But on clubbing all carp species (LC and IC) and other fish species (LNC, INC and SWF), the growth in demand is expected to be higher for other fishes than carps. It may be because of lower expected growth in demand for inter-state carps. Overall, local carp is expected to play an important role in meeting the demand of fish in Tripura.

A look at the growth in fish demand in urban and rural areas of Tripura revealed that local non-carps (4.51 %) and inter-state non-carps (4.51 %) are expected to have a good demand growth in urban areas after local carps (4.71 %). It is due to the fact that high income group households of urban Tripura will demand more high-value local non-carps and inter-state non-carps (especially Ilisha). In the rural areas of Tripura, although local carps are expected to have the highest growth rate (2.5 %), fish species other than carps (local non-carps: 2.49%, inter-state non-carps: 2.28 % and small weed fish: 2.09 %,) are also expected to have a good growth in demand.

The demand for fish by 2015 has been projected as 80,153.25 Mt, comprising 62,910Mt of carps (local and inter-state) and 17, 243 Mt of non-carps. The demand for local carps has been projected to be nearly 50 per cent (40,624 Mt) of the total projected demand of fish by 2015.

Table 6. Demand for fish in urban Tripura

(in Mt)

Year	Population*	LC	IC	LNC	INC	SWF	TC	TNC	TF
				Baseline					
2004	5,86,000	5,492	3,598	645	523	1,186	9,090	2,353	11,443
				Projected					
2005	5,99,000	5,768	3,686	675	548	1,234	9,454	2,458	11,911
2006	6,13,000	6,059	3,780	708	574	1,285	9,839	2,568	12,406
2007	6,27,000	6,362	3,875	742	602	1,338	10,237	2,682	12,919
2008	6,42,000	6,657	3,975	775	628	1,390	10,631	2,793	13,424
2009	6,56,000	6,925	4,067	805	653	1,437	10,993	2,895	13,887
2010	6,71,000	7,224	4,167	838	680	1,489	11,391	3,007	14,398
2011	6,86,000	7,549	4,268	875	709	1,544	11,817	3,128	14,945
2012	7,02,000	7,911	4,376	915	742	1,606	12,287	3,263	15,549
2013	7,17,000	8,302	4,479	958	777	1,670	12,781	3,405	16,186
2014	7,33,000	8,739	4,590	1006	816	1,741	13,330	3,563	16,892
2015	7,49,000	9,224	4,703	1059	859	1,817	13,927	3,735	17,662
ACGR**	2.26 %	4.71 %	2.46 %	4.51 %	4.51 %	3.88 %	3.88 %	4.20 %	3.95 %

**Source* (Population data): NSSO (2007)

**ACGR = Annual Compound Growth Rate

Table 7. Demand for fish in rural Tripura

(in Mt)

Year	Population	LC	IC	LNC	INC	SWF	TC	TNC	TF
					Baseline				
2004	27,38,000	18,837	14,930	2,081	2,018	4,575	33,768	8,674	42,442
					Projected				
2005	27,67,000	19,642	15,152	2,168	2,094	4,730	34,794	8,993	43,787
2006	27,94,000	20,165	15,334	2,225	2,144	4,834	35,499	9,204	44,703
2007	28,22,000	20,705	15,521	2,284	2,196	4,942	36,227	9,422	45,648
2008	28,49,000	21,198	15,699	2,338	2,243	5,040	36,897	9,621	46,517
2009	28,76,000	21,642	15,872	2,386	2,286	5,130	37,514	9,802	47,316
2010	29,03,000	22,122	16,048	2,438	2,332	5,226	38,170	9,996	48,166
2011	29,30,000	22,642	16,227	2,495	2,382	5,328	38,869	10,205	49,074
2012	29,56,000	23,202	16,405	2,556	2,435	5,437	39,608	10,427	50,035
2013	29,83,000	23,816	16,593	2,622	2,493	5,555	40,409	10,670	51,078
2014	30,09,000	24,481	16,780	2,694	2,555	5,680	41,261	10,930	52,190
2015	30,35,000	25,208	16,971	2,773	2,622	5,816	42,179	11,212	53,391
ACGR	0.94 %	2.53 %	1.15 %	2.49 %	2.28 %	2.09 %	1.94 %	2.23 %	2.00 %

**Source* (Population data): NSSO (2007)

** ACGR = Annual Compound Growth Rate

Table 8. Demand for fish in Tripura

(in Mt)

Year	Population	LC	IC	LNC	INC	SWF	TC	TNC	TF
					Baseline				
2004	33,24,000	24,987	18,707	2,819	2,589	5,854	43,694	11,262	54,956
					Projected				
2005	33,66,000	26,273	19,035	2,961	2,711	6,094	45,308	11,766	57,074
2006	34,07,000	27,505	19,350	3,098	2,827	6,323	46,855	12,248	59,103
2007	34,49,000	28,797	19,673	3,240	2,949	6,561	48,470	12,750	61,220
2008	34,91,000	30,000	19,986	3,373	3,062	6,783	49,985	13,218	63,203
2009	35,32,000	31,091	20,282	3,494	3,164	6,985	51,374	13,643	65,017
2010	35,74,000	32,298	20,592	3,627	3,277	7,205	52,890	14,110	67,000
2011	36,16,000	33,630	20,910	3,774	3,401	7,445	54,540	14,621	69,161
2012	36,58,000	35,106	21,238	3,937	3,538	7,708	56,344	15,182	71,526
2013	37,00,000	36,746	21,576	4,117	3,688	7,995	58,322	15,801	74,123
2014	37,42,000	38,576	21,925	4,318	3,856	8,310	60,501	16,484	76,985
2015	37,84,000	40,624	22,287	4,543	4,042	8,658	62,910	17,243	80,153
ACGR	1.18 %	4.36	1.58 %	4.28 %	3.99 %	3.51 %	3.26 %	3.81 %	3.38 %

**Source* (Population data): NSSO (2007)

** ACGR = Annual Compound Growth Rate

Conclusion

The study has revealed that the income elasticities of demand for fish in Tripura vary substantially across different choiced fish groups (CFGs) and slightly between urban and rural areas of Tripura. The demand analysis has indicated that all the fish types are not homogeneous. Their consumer's preference vary by CFGs. Inter-state carp has been reported to be inferior than other fish types by the consumers of Tripura. Local non-carps have been observed to have high income elasticity of demand and are expected to be most important CFG among all the fish types in relation to population and income growth of Tripura. The study also identified the demand for non-carp CFG which needs to form an important and potential component of fisheries or aquaculture in the state.

The study has important policy implication for the development of fish culture sector of Tripura, as the state is undergoing a transitional phase and implementing mission mode programs to achieve self-sufficiency in fish production. The study outlined the growth in demand of different fish types in Tripura which would be helpful to prioritize fish production in the state. Till date, state has made a crude estimation on fish demand (rather it was the requirement based on nutritional assessment) based on the assumption of fish requirement of 13 kg/ capita/ year to plan many of the activities of DoF (GoT). This study would provide a new orientation to the planning of state fisheries development activities so as to improve local fish production by fish type. Further, outcome of the research is likely to serve as supportive information for the producers and traders of inter-state fish and consumers of Tripura. The study has the limitation of not including price factor and other related demand factors to make more credible or rational estimate of demand projection. The small cross-sectional data, problems of aggregation in estimation and insufficient information on price and other related parameters have limited the scope of the study. Nevertheless, it has achieved the overall objective of projecting fish demand by CFGs to a medium-term time horizon considering income and population growth of the state.

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References

Anonymous (2009) *Economic Review of Tripura 2008-09*.Directorate of Economics and Statistics, Planning (Statistics) Department, Government of Tripura. Available [online] at: http://www.destripura.nic.in/review20078.pdf [accessed on 5 January, 2011].

Blundell, R., Pashardes, P. and Weber G. (1993) What do we learn about consumer demand pattern from micro data? *American Economic Review*, **83**: 570-597.

Deaton, A.S. and Muellbauer, J. (1980)An almost ideal demand system. *American Economic Review*, **70**: 359-68.

Delgado, C.L., Wada, N., Rosegrant, M.W., Meijer, S. and Ahmed, M.(2003)*Fish to 2020: Supply and Demand in Changing Global Markets*.International Food Policy Research Institute, Washington, D.C. and World Fish Center, Penang, Malaysia.

Dey, M. Mohan and Ahmed, M. (2005) Aquaculture – Food and livelihoods for the poor in Asia: A brief overview of the issues. *Aquaculture Economics and Management*, 9: 1-10.

Dey, M.M. (2000) Analysis of demand for fish in Bangladesh.*Aquaculture Economics and Management*, **4** (1/2): 63-81.

Fan, S., Wailes, E.J. and Cramer, G.L. (1995) Household demand in rural China: A two-stage LES – AIDS model. *American Journal of Agricultural Economics*, **77** (1): 54-62.

Gao, X.M., Wailes, E. J. and Cramer, G.L. (1996) A two-stage rural household demand analysis: Micro data evidence from Jiangsu Province, China. *American Journal of Agricultural Economics*, **78**: 604-13.

GoT (Government of Tripura) (2008) *Modified Perspective Plan for Attaining Self-sufficiency in Fish in Tripura by 2011 A.D.(2008-2011)*.Department of Fisheries, Agartala.

GoT (Government of Tripura) (2009) *Tripura's March towards Self-sufficiency in Production of Fish: Performance of the Fisheries Department (April 2008 – March 2009).* Department of Fisheries, Agartala. 5p.

Heien, D. and Wessells, C.R. (1990) Demand system estimation with microdata: A censored regression approach. *Journal of Business & Economic Statistics*, **8**(1): 365-71.

Kumar, P. and M.M.Dey (2004) A study on modellingof household demand for fish in India.*Indian Journal of Agricultural Economics*, **59**(3): 465-475.

Kumar, P., Dey, M.M. and Paraguas, F.J. (2005) Demand for fish by species in India: Three – stage budgeting framework. *Agricultural Economics Research Review,* **18**: 167-186.

Mustapha, N. R.A., Ghaffar, R.A. and Poerwono, D. (1994)An almost ideal demand system analysis of fresh fish in Semarang, Indonesia. *Journal of International Food and Agribusiness Marketing,* **6**(3): 91-128.

Nandeesha, M.C. (2008) Andhra Pradesh carps contribute to nutritional security of North-Eastern India – Strategies of the trade. In: *Souvenir, National Workshop on Development of Strategies for Domestic Marketing of Fish and Fishery Products*, held on 7 – 8 Feb, 2008, at CoFSc., SVV University, Muthukur.

NSSO (National Sample Survey Organization) (2007)*Household Consumption of Various Goods and Services in India:* 2004 – 05: NSS 61st Round, (Report No. 509/61/1.0/2, Vol. II): Minor States and Union Territories. Ministry of Statistics and Programme Implementation, Government of India. Available [online]: http://mospi.nic.in/rept%20_%20pubn/ftest.asp?rept_id=509_P2&type=NSSO [accessed on 5 January, 2011].

Paroda, R.S. and Kumar, Praduman (2000) Food production and demand situation in south Asia. *Agricultural Economics Research Review,***13** (1): 1-24.

Shonkwiler, J. S. and Yen, S. (1999) Two-step estimation of a censored system of equations. *American Journal of Agricultural Economics,* **81**: 972-82.

Thomas, R.L. (1987) *Applied Demand Analysis.*Longman Group Limited, Harlow, England.

Tiffin, A. and Tiffin, R. (1999) Estimates of Food Demand Elasticitiesfor Great Britain: 1972 – 1994. *Journal of Agricultural Economics***50** (1): 140-147.

Upadhyay, A.D. (2008) Economic analysis of fish marketing in Tripura.*Journal of Fisheries Economics and Development,* **9** (2): 12-20.

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