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Gender Perspectives in Adoption of Technological Practices by Fishers and Fish Farmers in Tripura§

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Abstract

With the development of institutionalized form of income and the growing importance of fisheries in the agricultural development of Tripura, the role of women in socio-economic and cultural-political relationships has gained importance over time. Fisheries like other crops are also a function of adoption level of a technology. The study is based on a total of 180 fishers consisting 30 women and 30 men respondents that were randomly selected from each of the three major sectors, viz. aquaculture, reservoir and fish processing. For each sector, identified fisheries technologies were selected for the study. Factor analysis was carried out for identification of relationships between technologies and multiple regression analysis was performed to identify the factors that determined the adoption level. Subsector-wise analysis was also performed. The study has indicated commonality and divergence in the attitude between women and men fishers in respect of technology adoption. Thus, gender perspective is clearly visible in adoption of technological practices in Tripura.

Key words: Technology adoption, gender perspective, factor analysis, multiple regressions, women and men fishers, Tripura

JEL Classification: J16, J24, Q22

Introduction

Fisheries have a unique status in Tripura as fish is an integral part of the social and cultural life of the people in this state. Tripura has the highest per-capita annual fish consumption (13.1 kg) amongst inland states of India (Saha, 2011). In India, Tripura has the highest literacy level (94.65 %) (ToI, 2013). The women self-help groups are being promoted through DRDA in Tripura. With the development of institutionalized form of promoting enterprises and with the growing importance of fisheries in agricultural development of Tripura, the role of women in socio-economic and cultural-political relationships has gained importance over time.

Fisheries like other crops are a function of adoption levels of technology. Adoption and diffusion of technology are the two interrelated concepts describing the use and spread of a given technology among economic units over a period of time. Nell *et al.* (1998) have emphasized that a farmer as a rational decision–maker, normally transforms the better standard of living

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§ This paper is drawn out of the PhD (Fisheries Extension) thesis entitled, Gender perspectives in fisheries development in Tripura: Determinants, adoption behaviour and sustainable livelihoods, of the first author submitted to the Fisheries Economics, Extension and Statistics Division, Central Institute of Fisheries Education, Mumbai in 2015 and seeks ways of adopting new technologies. Adoption has been looked at in various perspectives by Velera *et al.* (1987), Koppel (1978) and Bala *et al*. (2006). Seenappa and Surendra (1988) have described that success of fish culture depends largely on the adoption of proven new technologies evolved for the purpose of obtaining higher yields and returns. Agarwal (2003) has described the circumstances under which women could not have access to resources as well as improved their farm performance by adoption of appropriate improved technologies. FAO (2001), Sadaf *et al*. (2005) and Gurumayum *et al*. (2005) have also emphasized on the gender disparities. There is a definite association between the level of education and reception to institutional changes. This study has addressed the interrelationship among various adopted technologies by the fishers/ fish farmers in Tripura and has identified the determinants of adoption of improved fisheries technologies from a gender perspective in Tripura.

Methodology

The study was conducted among both women and men fishers/ fish farmers in the state of Tripura. The participation of women in fisheries was observed mainly in three sub-sectors, viz. aquaculture, reservoir fisheries and fish processing. For each sector, 30 women and 30 men fishers were selected randomly constituting a sample size of 180 fishers. To study adoption of improved technologies for each sector, few technological practices were identified for the analysis. The study was carried out with 9 independent variables, namely, (i) Age (X_1), (ii) Education (X_2), (iii) Experience in fisheries (X_3), (iv) Total family income (X_4), (v) Income from fisheries (X_5), (vi) Participation in panchayats (X_6), (vii) SHG membership (X_7), (viii) Cooperative memberships (X_8), and (ix) Political memberships (X_9).

Interrelationships among Various Adopted Technologies: A Factor Analysis Model

The selected technologies were recommended by the scientists and adopted by the fishers of Tripura. A total of 21 technological practices were identified in the aquaculture sector[2], a reduction in dimensionality was desired without losing quality of information. For this reason, factor analysis was conducted. In matrix form, the factor analysis model can be written as Equation (1):

$$X - \mu = \phi F + e \qquad \ldots(1)$$

where, ϕ_{ij} is the loading of the ith variable on the jth factor; so ϕ is the matrix of factor loadings; ε_i is the error-term associated with the ith response Xi; F_i is the common factor which is unobservable; and μ_j is the mean of ith variable.

The assumptions in the model are that F and e are independent and E(F) = 0, Cov(F)= I, E(ε) = 0 and Cov(ε) = Ψ, where, Ψ is a diagonal matrix.

The information on adoption of these technological practices were collected based on a scale of three point: (i) never adopted, (ii) partially adopted, and (iii) highly adopted. The scores assigned for each adoption were: never adopted, 0; partially adopted, 1; and highly adopted, 2.

The extent of adoption was calculated by the adoption index (AI) as developed by Karthikeyan (1994) using formula (2):

$$AI = \frac{\text{Respondent's total score}}{\text{Total possible score}} \times 100 \qquad \ldots(2)$$

where,

Respondents' total score = Total number of practices adopted by farmers multiplied by respective practices weighted and summated, and

Total possible score = Total number of practices recommended multiplied by the respective weightage and summated.

This adoption index for each technological practice was used to perform the factor analysis. The number of factors was determined by judging the proportion of sample variance explained, subject matter

[2] 1. Monoculture, 2. Composite culture, 3. Integrated farming, 4. Ornamental fish culture, 5. Cage culture, 6. Pen culture, 7. Stocking density, 8. Balanced feed, 9. Pelleted feed, 10. Liming, 11. DO check, 12. Monitoring pH, 13. Medication, 14. Periodic water exchange, 15. Periodic drying, 16. Weedicide, 17. Fertilizer, 18. Improved stock, 19. Breeeding techniques, 20. Prawn seed production, 21. Improved craft and gear.

Table 1. Factor loading patterns of aquaculture sector among women respondents in aquaculture sector in Tripura

Aquaculture technologies	Factors			
	F-1	F-2	F-3	F-4
Factor-1 (F-1)				
Breeding technique	0.857	-0.231	0.121	-0.251
Fertilizer	0.839	-0.137	0.258	-0.092
Weedicide	0.815	-0.253	-0.156	-0.229
Periodic drying	0.754	-0.046	0.404	-0.116
Monitoring pH	0.736	0.083	-0.603	-0.046
Dissolved Oxygen check	0.736	0.083	-0.603	-0.046
Medication	0.588	0.050	0.290	0.528
Improved craft and gear	0.532	-0.194	0.403	0.469
Factor-2 (F-2)				
Liming	0.191	0.911	0.160	-0.230
Stocking	0.256	0.885	0.240	-0.169
Factor-3 (F-3)				
Periodic water exchange	-0.108	-0.165	0.405	-0.329
Factor-4 (F-4)				
Balanced feed	0.212	0.414	-0.207	0.589
Cumulative variation explained (percentage)	37.83	54.53	67.30	77.11

Extraction Method: Principal Component Analysis; 4 components extracted;
Rotation method: Varimax with Kaiser Normalization

knowledge and the reasonableness of results (Johnson and Wichern, 1982). Initially principal component analysis was performed without specifying the number of factors. After examining the proportion of variability explained by different factors, the choice of number of factors was narrowed down. Initial factor loadings were not clear for a number of adoption variables and so factors were rotated using Varimax option (Johnson and Wichern, 1982). It should be noted that factor rotation does not change the estimated covariance matrix.

Determinants of Adoption

The multiple regression analysis was carried out to find the effect and extent of influence of each of 9 independent variables contributing towards the dependent variables (Talukdar, 2000).

The regression model employed was:

$$F_k = \beta_0 + \beta_1 \text{ Age} + \beta_2 \text{ Education} + \beta_3 \text{ Experience} + \beta_4 \text{ Marital status} + \beta_5 \text{ Family size} + \beta_6 \text{ Participation in panchayet} + \beta_7 \text{ SHG} + \beta_8 \text{ Cooperative-society} + \beta_9 \text{ Political party membership} + \beta_{10} \text{ Total family income} + \beta_{11} \text{ Income from fisheries} + Uk$$

where,

F = Vector of the kth factor score,

β_i = The parameter estimates (i = 0,1..., 11), and

U_k = The error-term associated with the kth factor (index).

Results and Discussions

Interrelationships among Various Technologies

The 21 technologies identified either enabled production enhancement or cost reduction on its own strength or in conjunction with other technologies. Among these 21 technologies, 9 were commonly adopted by the women respondents. Therefore, the factor analysis results in Table 1 and Table 2 on rotated factor loading patterns are based on the 12 technologies which were adopted by the women and men respondents in different measures.

Table 2. Factor loading patterns of aquaculture sector among men fish farmers in Tripura

Aquaculture technologies	Factors			
	F-1	F-2	F-3	F-4
Factor-1 (F-1)				
Periodic water exchange	0.951	0.136	0.087	0.112
Periodic drying	0.951	0.136	0.087	0.112
Balanced feed	0.868	0.205	0.081	-0.019
Factor-2 (F-2)				
Monitoring pH	0.202	0.965	0.077	-0.022
Dissolved oxygen check	0.202	0.965	0.077	-0.022
Factor-3 (F-3)				
Medication	-0.146	0.065	0.856	-0.048
Breeding	0.385	0.096	0.821	0.121
Improved craft and gear	0.523	0.032	0.620	0.342
Factor-4 (F-4)				
Liming	-0.027	0.188	0.180	0.855
Stocking	0.209	-0.315	-0.066	0.716
Cumulative variation explained (percentage)	40.5	59	74	85

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Factor-1(F-1) has eight technologies, factor-2 (F-2) has 2 technologies and factor-3 (F-3) and factor-4 (F-4) relate to a single technology. It is obvious from Table 1 that F-1 and F-2 are being adopted by the fishers as a package and are not effective individually. These findings are consistent with other studies on technology adoption (Rauniyar and Goode, 1996).

A similar analysis was performed in respect of the responses of men fish farmers in aquaculture sector in Tripura. The analysis was done to understand the factors that bound the technologies into a package but also to understand the psychological underpinnings that make the concept of gender analysis complete.

In the case of men fish farmers, the factor F-1 had 3 technologies as against 8 in the case of women fish farmers. The mix of technologies in F-1 was quite different from those adopted by women fish farmers. The practices that were clubbed together as a package, except for periodic drying, were different in the case of all combinations in respect of men fish farmers in the aquaculture sector (Table 2). In the case of factor F-2, the men fish farmers included pH monitoring and dissolved oxygen (DO) check as important twin technologies, while women fish farmers had expressed their choice as liming and stocking. In the case of factor F-3, medication, breeding and improved craft and gear appeared together and liming and stocking were the technologies that were clubbed in factor F-4. It was also seen that in both F-3 and F-4 factors, the combination of technologies that emerged prominent among men adopters were quite distinct from the technologies that were adopted by women fish farmers. Therefore, these four factors could explain 85 per cent variation in adoption of practices by men fish farmers in aquaculture sector in Tripura.

Determinants of Adoption

Once the underlying interrelationships among management and technological practices were identified, the next step was identification of variables which could explain the adoption indices. Four ordinary linear regression equations were estimated using a set of 10 explanatory variables. The summary statistics for explanatory variables are given in Table 3 and the regression coefficients are reported in Table 4.

Like in factor analysis, a few technologies were not used for the regression analysis to study the impact of independent variables on technology adoption since

Table 3. Summary statistics of factors explaining adoption of management and technological practices in aquaculture sector by women and men fish farmers in Tripura

Socio-economic-political variables	Aquaculture women fishers		Aquaculture men fishers	
	Meanvalue	Standard deviation	Meanvalue	Standard deviation
Age (years)	37.25	11.25	38.57	12.48
Education (years)	2.00	0.95	2.60	1.07
Experience in fisheries (years)	13.93	7.77	12.47	8.15
Participation in panchayat (never=0, occasionally=1 and regularly=2)	0.10	0.31	0.6	0.50
SHG membership (never=0, occasionally=1 and regularly=2)	0.57	0.50	0.07	0.25
Participation in cooperative societies (never=0, occasionally=1 and regularly=2)	0.13	0.35	0.20	0.41
Political party membership (never=0, occasionally=1 and regularly=2)	0.10	0.31	0.13	0.35
Total family income (₹)	10700	4611	13500	9503
Income from fisheries (₹)	7620	4814	10600	8047

Table 4. Socio-economic-political determinants of adoption of technologies by women fish farmers in aquaculture sector in Tripura

Independent variables		Factors			
		F-1	F-2	F-3	F-4
Age (years)	β	-0.017	0.014	-0.055*	0.035
	t-value	-1.406	0.889	-3.219	1.656
Education (years)	β	-0.261	0.215	-0.13	0.971*
	t-value	-0.1882	1.221	-0.675	4.057
Experience in fisheries (years)	β	0.015	-0.027	0.01	-0.081**
	t-value	0.705	-1.026	0.351	-2.288
Participation in panchayat (never=0,	β	1.1**	-0.712	0.286	-0.414
occasionally=1 and regularly=2)	t-value	0.336	-1.431	0.527	-0.614
Cooperative society membership	β	3.197*	-4.01*	0.352	-0.412
(never=0, occasionally=1 and regularly=2)	t-value	5.229	-5.155	0.415	-0.39
Income from fisheries (₹)	β	-3.326E-5	2.32E-4**	-7.857E-5	6.69E-5
	t-value	-0.474	2.595	-0.806	0.552
R^2		0.847	0.752	0.705	0.542

Note: ** and * depict significance at 5 per cent and 1 per cent levels, respectively

there was a total unanimity in the response of 30 respondents with respect to those technologies. These technologies were: monoculture, composite culture, integrated fish farming, ornamental fish farming, cage culture, pen culture and prawn seed production. Among these, the first 3 technologies were being adopted by all the respondents and the last 4 technologies were not used by any of the respondents.

The basket of technologies contained in F-1 has been found significant in respect of respondents' active participation in cooperative societies and operation within the panchayat framework. This shows that group activities and institutional arrangements exert a positive influence on the level of adoption of package of practices. This is in conformity with Bala *et al.* (2006). Liming and stocking are the two technological practices

Table 5. Socio-economic-political determinants of adoption of technologies by men fishers in aquaculture in Tripura

Independent variables		Facotrs			
		F-1	F-2	F-3	F-4
Education (years)	β	0.168	-0.373**	0.313	0.054
	t-value	1.245	-2.817	1.366	0.212
Participation in panchayat	β	0.956**	-0.987*	0.23	0.26
(never=0, occasionally=1 and regularly=2)	t-value	2.773	-2.918	0.393	0.401
Cooperative society membership	β	1.201*	0.061	0.025	-0.045
(never=0, occasionally=1 and regularly=2)	t-value	3.624	0.188	0.045	-0.072
R^2		0.755	0.62	0.29	0.133

Note: ** and * depict significance at 5 per cent and 1 per cent levels, respectively

Table 6. Summary statistics of factors explaining adoption of processing technologies of women and men fishers in Tripura

Socio-economic-political variables	Women fishers		Men fishers	
	Mean value	Standard deviation	Mean value	Standard deviation
Age (years)	36.550	9.42	36.20	6.54
Education (years)	1.50	0.51	1.60	0.49
Experience in fisheries (years)	10.63	4.63	4.00	2.03
Total family income (₹)	7258	1692	9900	3117
Income from fisheries (₹)	5038	1877	2300	6512
Participation in panchayat (never=0, occasionally=1 and regularly=2)	0.00	0.00	0.60	0.49
SHG membership (never=0, occasionally=1 and regularly=2)	0.27	0.45	0.20	0.41
Membership of cooperative societies (never=0, occasionally=1 and regularly=2)	0.00	0.00	0.13	0.35
Political party membership (never=0, occasionally=1 and regularly=2)	0.00	0.00	0.67	0.48

which are significantly influenced by the income from fisheries. This could mean that such technological practices are adopted by the respondents only after attaining a threshold level of income (Chi and Yamada, 2002). These two technologies have depicted a significant negative expression under a cooperative institutional governance.

Experience and maturity of fishers have shown a greater role in the adoption of periodic water exchange (F-3). Therefore, F-3 has a negative relationship with the age of respondents at 1 per cent level of significance. This also indicates that with advancing age and maturity, the adopters of a particular technology also refine the package of practices they adopt without going for their blank adoption (Motamed and Singh, 2003; Rahman, 2007). The realization of adoption of best feed management practices has been found directly and positively related to the education level of respondents. The consciousness of the need to adopt appropriate balanced diet has also been expressed by OECD (2001), Rahman (2007), and Bolorunduro and Adesehinwa (2007). But, this factor has depicted a negative relationship with respondent's experience in fisheries. This may be due to the fact that respondents who are in aquaculture for a long time, learn that besides a balanced diet, there may be a number of factors that influence farm production. Nevertheless, this result shows the importance of education in adoption of appropriate practices.

Table 7. Results of multiple regression analysis of adoption of improved technologies with 3 selected independent variables in fish processing sector by women and men fishers in Tripura

Independent variables		Women fishers	Men fishers	
		Hygienic practices	Use of fish oil	Hygienic practices
Cooperative society membership	β	-	0.788**	0.212
(never=0, occasionally=1 and regularly=2)	t-value	-	-2.46	0.947
SHG membership	β	0.414**	-0.758**	0.106
(never=0, occasionally=1 and regularly=2)	t-value	2.276	-2.388	0.396
Political party membership	β	-	0.788**	0.439
(never=0, occasionally=1 and regularly=2)	t-value	-	2.141	1.64
R^2		0.744	0.642	0.672

Note: ** and * depict significance at 5 per cent and 1 per cent levels, respectively

Again, the factors that were responsible for the appearance of a set of technologies adopted by men fish farmers in F-1, influenced by institutional associations like cooperative societies (1% significance level) and panchayats (5% significance level), were significantly different from the practices that constituted different technologies under F-1 as expressed by women fish farmers. As against income that determined adoption of F-2 technologies by women fish farmers, it was education that controlled the adoption of F-2 technologies (at 5% significance level) and participation in panchayats (at 1% significance level) in case of men fish farmers.

As far as women and men fishers engaged in fish processing sector were concerned, the only two technologies that they were exclusively using were preparing the pots to store the processed fish with use of fish oil and maintenance of hygiene (Debnath, 2015). These two technologies were regressed against the socio-economic-political variables across women and men fishers engaged in fish processing activity in Tripura (Table 7). The use of fish oil was not found to be significantly influenced by any of the independent variables in respect of the female respondents, but the adoption of hygienic practices was found to be positively influenced by the women fishers' participation in SHGs.

For men fishers engaged in fish processing, the adoption of fish oil for pot preparation had a positive influence from their political association and a negative influence of their involvement in cooperative societies and SHGs. The independent variables were not found to have any significant influence on the adoption of hygienic practices.

In the reservoir sector, the adoption of improved craft and gear was analysed for both women and men fishers actively participating in the reservoir fisheries with 5 independent variables. The summary statistics of six independents variables for both women and men fishers have depicted in Table 8. The results show that for the women fishers, variables education and total family income had a negative influence on adoption of improved craft and gear (at 5% level of significance), whereas the variables income from fisheries and cooperative society membership had a positive impact (at 1% level). A total of 85.3 per cent of variation could be described by those five independent variables.

For the male fishers, political involvement had a negative relationship with the adoption process (at 5% level of significance), while cooperative society membership had a positive influence at (5% level of significance). A total of 92.3 per cent variation was described by these independent variables. Table 9 clearly shows that the cooperative societies significantly influence the technology adoption attitude of the members.

As in other sub-sectors, there is a divergence of factors that influenced the level of adoption of technologies by the gender groups. In the case of reservoir sector, though the institutional influence was on both women and men fishers, it was their association with the cooperative societies that finally determined their attitude to adoption of technologies.

Table 8. Summary statistics of factors explaining adoption of technologies of women and men fishers of reservoir sector in Tripura

Socio-economic-political variables	Women fishers		Men fishers	
	Mean value	Standard deviation	Mean value	Standard deviation
Education (years)	1.13	0.35	1.43	0.68
Total family income (₹)	9700	2641	9691	2401
Income from fisheries (₹)	6903	3019	6250	2465
Participation in panchayat (never=0, occasionally=1 and regularly=2)	0.27	0.45	0.50	0.51
Cooperative society membership (never=0, occasionally=1 and regularly=2)	0.33	0.48	0.80	0.41
Political party membership (never=0, occasionally=1 and regularly=2)	0.37	0.49	0.67	0.48

Table 9. Results of multiple regression analysis of adoption of improved technologies with 5 selected independent variables among both women and men fishers in fish reservoir sector in Tripura

Independent variables	Improved craft and gear			
	Women fishers		Men fishers	
	β	t-value	β	t-value
Education (years)	-0.312**	-2.169	-0.022	1.239
Total income (₹)	-8.33E-05**	-2.276	-3.81E-05	0.001
Income from fisheries (₹)	8.95E-05*	3.063	1.89E-05	0.732
Cooperative membership (never=0, occasionally=1 and regularly=2)	0.472*	3.317	0.625*	0.474
Political membership (never=0, occasionally=1 and regularly=2)	0.052	0.286	-0.436**	-0.653
R^2	0.853		0.923	

Note: ** and * depict significance at 0.05 per cent level and 0.01 per cent levels, respectively

Conclusions

The study has revealed that social participation of the respondents of both the genders has positive as well as negative significant influence on the adoption of the fisheries practices. The social and political institutions need to be better equipped and its members need to be trained better to avail of the maximum benefits of improved technological practices. It can also be noted from the study that the set of parameters that influence the adoption of technologies among women and men fishers were different. This may be attributed to not only a direct relationship between economic variables but also basic psychometric parameters that are inherently attributed to the gender differences. An understanding of the relationship among the practices and determinants is very important for better fisheries research and implementation of better extension policies for the development of both fishers and fisheries of Tripura.

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