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Yield Gaps, Production Losses and Technical Efficiency of Selected Groups of Fish Farmers in Bangladesh

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INTRODUCTION

With a total land area of 147, 570 sq. km Bangladesh is characterised by high population (129.2 million; 2001 estimate), rapid population growth (1.76 per cent per annum since 1990), high population density (about 800 persons per sq. km or only 0.57 ha per head) and low per capita income US$ 386 per year. Bangladesh is one of the low-income countries in the world where the majority of the population suffer from food insecurity; a growing population demands ever more food. Traditionally, people in the country have fish with rice for most of their meal and fish ranks as the second staple in their diet. Agriculture sector plays a vital role in the economic development of the country, which contributes 31.55 per cent to the gross domestic product (GDP) (BBS, 1999). Within the agriculture sector, fisheries play a very important role in the socio-cultural and economic life of Bangladesh. No sub-sector in this sector in this country illustrates the development potentials more clearly than fisheries. The contribution of fisheries sub-sector to GDP increased from 2.82 per cent in 1992-93 to 3.44 per cent in 1998-99. Except livestock sub-sector, the contribution to GDP declined over the years but the trend is increasing for the fisheries sub-sector. The country's total production of fish was 1,622 thousand tonnes in 1998-99 of which 1,307 thousand tonnes were from inland sources and 315 thousand tonnes from the marine source. The growth rate of the production during the last two decades on an average was 5.32 per cent. However, the per cent growth rate is quite encouraging which is in fact 8.7 per cent per year (Table 1).

Yield gap is an important aspect as it affects production. This is more important for a country where production falls short of domestic requirement. Yield differs considerably from region to region. Even within regions, yield gap is substantial as a large majority of the farmers are producing much less than many of the promising farmers whose productivity is very high with similar technology. Thus minimising yield gaps can increase the availability of fish. Likewise, several biotic and abiotic factors cause quite considerable production losses.

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Fish farming is a relatively new technology as compared to crop farming. It has been expanding very fast in Bangladesh. Among the different components of fisheries, the growth of production of culture (farming) has been the highest varying between 7 to 9 per cent per annum. In spite of increasing fish production the domestic demand is not met. Moreover, for earning foreign exchange, production needs to be increased as well. Although, the technology has improved over the years yet the production is lower as compared to countries like Thailand, Philippines and China. Productivity gain can be achieved by minimising yield gaps and production losses. There are several biotic, abiotic and socio-economic factors that cause yield gaps and production losses. Once the factors causing yield gaps and production losses and the level of technical efficiency of the farmers are known it will be easier for the planners and scientists to decide what action are to be taken to resolve the problems. So far no study has yet been undertaken in Bangladesh to assess these gaps and losses. Some however exist for rice crop. Therefore, a study on yields gaps, production losses, and technical efficiency is timely and very important for the farmers and for the nation.

TABLE 1. STATISTICAL STATEMENT OF WATER RESOURCES AND FISH PRODUCTION OF BANGLADESH

('000 tonnes)

Plan period	Year	Inland water resources: Open water (4047316 ha) Production	Inland water resources: Closed water (292378 ha) production	Total	Marine water resources: Trawling industry	Marine water resources: Artisan fishery	Total	Grand total	Average growth
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2nd Five Year Plan (1980-85)	1980-81			525			125	650	3.70
	1981-82			556			130	668	
	1982-83			583			141	724	
	1983-84	472	117	589	14	150	164	753	
	1984-85	463	124	587	12	175	187	774	
3rd Five Year Plan (1985-90)	1985-86	442	145	587	12	195	207	794	2.13
	1986-87	431	166	597	12	205	207	814	
	1987-88	424	176	600	10	217	227	827	
	1988-89	424	184	608	10	223	233	841	
	1989-90	442	193	617	11	228	239	856	
4th Five Year Plan (1990-95)	1990-91	443	211	654	9	233	242	896	6.51
	1991-92	479	77	706	10	236	246	952	
	1992-93	532	238	770	12	238	250	1,020	
	1993-94	573	264	837	12	241	253	1,090	
	1994-95	591	317	908	12	203	265	1,173	
1995-97	1995-96	609	379	988	12	258	270	1,258	5.58
	1996-97	600	432	1,032	14	261	275	1,307	
5th Five Year Plan (1997-2002)	1997-98	620	570	1,190	34	268	302	1,492	8.70
	1998-99	639	668	1,307	39	276	305	1,622	
	1999-2000	658	778	1,436	45	283	328	1,764	

Sources: Fishery Statistical Year Book of Bangladesh, F.R.S.S. Directorate of Fisheries, Bangladesh Bureau of Statistics, Statistical Year Book of Bangladesh.

METHODOLOGY

The research was confined to Rajshahi district of Bangladesh, which contributes significantly to the total production of fish. On the basis of higher concentration of fish production Putia Upazilla of Rajshahi district was selected for this research. Three sets of farmers have been included in the sample. These are credit and technical advice receiving farmers (CTR), training receiving farmers, (TR), and normal fish farmers (TCNR). A list of these farmers was collected from Bangladesh Rural Advancement Committee (BRAC) and Upazilla Fisheries Office of this area. These lists served as the population of the study. From each of the population lists, 30 fish farmers were randomly chosen, so that the total sample for the present study became 90. The stratified random sampling procedure was followed in selecting the samples.

Technical Efficiency Analysis

Technical efficiency refers to the ability of a firm to produce the maximum possible output from a given set of inputs and given technology. A technically efficient firm will operate on its frontier production function.

Farrell's (1957) seminal article on efficiency measurement led to the development of several approaches to efficiency and productivity analysis. Among these, the stochastic frontier production (Aigner *et al.* 1977, Meeusen and van den Broeck, 1977) and Data Envelopment Analysis (DEA) (Charnes *et al.*, 1978) are the two principal methods. As noted by Coelli *et al.,* (1998), the stochastic frontier is considered more appropriate than DEA in agricultural applications, especially in developing countries, where the data are likely to be heavily influenced by measurement errors and the effects of weather conditions, diseases, etc. This also applies to the application of frontier techniques to fish culture, including carp culture. Thus following Aigner *et al*. (1977) and Meeusen and van den Broeck (1977), the stochastic frontier production with two error terms can be modelled as:

$$Y = f(X_i, \beta) \exp(V_i - U_i) \qquad \text{.... (1)}$$

where Y_i is the production of the i-th-farm (i=1,2,3--------n), X_i is a (1xk) vector of functions of input quantities applied by the i-th farm; β is a (kx1) vector of unknown parameters to be estimated. V_is are random variables assumed to be independently. N(O, δ^2 v) and independent of U_is and the U_is are non-negative random variables, associated with technical inefficiency in production assumed to be independently and identically distributed and truncations (at zero) of the normal distribution with mean $Z_i\delta$ and variance σ^2u (|N($Z_i\delta$, σ^2u)|); Z_i is a (1xm) vector of farm-specific variables associated with technical inefficiency, and *δ* is a (mx1) vector of unknown parameters to be estimated (Battese and Coelli, 1995).

Following Battese and Coelli (1995), the technical inefficiency effects, U_i in equation (1) can be expressed as:

$$U_i = Z_i\delta + W_i \qquad \text{.... (2)}$$

where W_i are random variables defined by the truncation of the normal distribution with zero mean and variance $\sigma^2 u$, such that the point of truncation is $Z_i\delta$, i.e. $W_i \geq -Z_i\delta$. Besides the farm-specific variables, the Z_i variables in equation (2) may also include input variables in the stochastic production frontier (1), provided that the inefficiency effects are stochastic. If Z variables also include interactions between farm-specific and input variables, then a Huang and Liu (1994) non-neutral stochastic frontier is obtained.

The technical efficiency of the i-th sample farm, denoted by TE_i is given by:

$$TE_i = \exp(-U_i) = Y_i / f(X_i\ \beta) \exp(V_i) = Y_i/Y_i^* \quad \text{…. (3)}$$

where $Yi^* = f(X_i, \beta) \exp(V_i)$ is the farm-specific stochastic frontier. If Y_i is equal to Y_i^* then $TE_i = 1$, reflects 100 per cent efficiency. The difference between Y_i and Y_i^* is embedded in U_i (Dey *et al*., 1999). If U_i=0, implying that production lies on the stochastic frontier, the farm obtains its maximum attainable output given its level of input. If U_i>0, production lies below the frontier - an indication of inefficiency.

The maximum likelihood estimate (MLE) of the parameters of the model defined by equations (1) and (2) and the generation of farm-specific TE defined by (3) are estimated using the FRONTIER 4.1 package (Coelli, 1994). The efficiencies are estimated using a predictor that is based on the conditional expectation of exp (-U) (Battese and Coelli, 1993; Coelli, 1994). In the process, the variance parameters σ^2_u and σ^2_v are expressed in terms of the parameterisation:

$$\sigma^2 = (\sigma^2_u + \sigma^2_v) \quad \text{…. (4)}$$

and

$$\gamma = (\sigma^2_u / \sigma^2_u + \sigma^2_v) \text{ or}$$

$$\gamma = (\sigma^2_u / \sigma^2) \quad \text{…. (5)}$$

In terms of its value and significance, γ is an important parameter in determining the existence of a stochastic frontier; rejection of a null hypothesis, $H_0{:}\gamma = 0$, implies the existence of a stochastic production frontier. The value of γ ranges from 0 to 1 with values close to 1 indicating that the random component of the inefficiency effects makes a significant contribution to the analysis of the production system (Coelli and Battese, 1996) Similarly, $\gamma = 1$ implies that all the deviations from the frontier are entirely due to technical inefficiency (Coelli *et al.,* 1998).

Frontier Efficiency Model

The frontier production function approach has some obvious advantages over the traditional mythologies and its use is, therefore, becoming increasingly widespread. It is more closely related to the theoretical definition of a production function which relates to the maximum output attainable from a given set of output, the method lies in the fact that the estimated technical or production efficiency of a firm in the sample may be obtained by comparing the observed output with the predicted output. Derivations from the frontier have acceptable interpretations as measures of the inefficiency, which economic units have attained. This approach provides a benchmark against which one can measure the relative efficiency of a firm.

The stochastic production function for the sample fishpond farmers is specified as:

$$InYi = \beta_o+\beta_1 ln(X_1) +\beta_2 ln(X_2) +\beta_3 ln(X_3) +\beta_4 ln(X_4) +\beta_5 ln(X_5) +\beta_6 ln(X_6) +\beta_7 ln(X_7) +\beta_8 ln(X_8) +\beta_9 ln(X_9) +\beta_{10} ln(X_{10}) +\beta_{11} ln(X_{11}) +\beta_{12} D_1 +\beta_{13} D_2+V_i-U_i$$

where, In = Natural logarithm,
Y = Observed farm output (kg/ha),
X_1 = Pond size (decimal),
X_2 = Number of labour (man-days/ha),
X_3 = Rice/wheat bran (kg/ha),
X_4 = Oil cake (kg/ha),
X_5 = Urea (kg/ha),
X_6 = TSP (kg/ha),
X_7 = Lime (kg/ha),
X_8 = Cowdung (kg/ha),
X_9 = Fingerlings (No/ha),
X_{10} = Water depth (feet),
X_{11} = Medicine,
D_1 = Dummy for soil type (1=Sandy, 0 otherwise),
D_2 = Dummy for pond type (1=Perennial, 0 otherwise).

The technical inefficiency effects, U_i are defined as:

$$U_i = \delta_o + \delta_j Z_i + W_i$$

where, Z_1 = Age of the operator (measured in years),
Z_2 = Water colour (1=Greenish, 0 otherwise),
Z_3 = Species combination,
Z_4 = Culture period,
Z_5 = Annual income of the respondent.

where Z_i are various farm-specific variables, defined earlier and δ_j are unknown parameters to be estimated.

Sample Characteristics

Description and the mean values of output, input and farm-specific variables involved in the stochastic production frontier and technical inefficiency model for pond fish culture are presented in Table 2. Mean output per hectare was the highest (4,560 kg) for the farmers who received only training. This is followed by the farmers CTR and the TCNR farmers. Fish produced per hectare by the CTR and the TCNR farmers were 3,630 kg and 3,290 kg respectively. The farmers stocked different types of carp and non-carp species such as rui, catle, mrignal, calbasu, silvercarp, mirror carp, commom carp, silverbarb, tilapia and pangus.

TABLE 2. DESCRIPTION AND MEAN VALUES OF OUTPUT AND OTHER FARM SPECIFIC VARIABLES

Variables	Description	Farmer categories		
		CTR	TCNR	TR
(1)	(2)	(3)	(4)	(5)
Output kg/ha (Y)	Aggregated quantity of farm specific fish production measured in kg	3,630	3,290	4,560
Pond size (decimal) (X_1)	Actual size of the pond used for fish culture, measured in decimals	101	82	142
Labour (man-day)/ha (X_2)	Use of human labour in fish production, measured in man-days	280	240	305
Feed kg/ha (X_3)	Aggregated quantity of rice and wheat bran applied in pond, measured in kg	1,840	1,750	1,950
Oil cake kg/ha (X_4)	Actual quantity of oil cake applied in pond, measured in kg	950	915	890
Urea kg/ha (X_5)	Actual quantity of urea applied in pond, measured in kg	480	415	510
TSP kg/ha (X_6)	Actual quantity of TSP applied in pond, measured in kg	330	260	405
Lime kg/ha (X_7)	Actual quantity of lime applied in pond, measured in kg	660	630	535
Cowdung kg/ha (X_8)	Actual quantity of cow dung applied in pond, measured in kg	9,900	10,400	11,300
Fingerling No./ha (X_9)	Number of fingerlings released in the pond, measured in number	14,650	16,950	13,310
Water depth (feet) (X_{10})	Average water depth of the pond, measured in feet	5.5	6.36	6.5
Medicine Tk/ha (X_{11})	Money spent for medicine (Rs.)	4,600	5,200	5,650
Soil dummy (D_1)	Value 1 if the pond bottom is sandy, 0 otherwise			
Pond type (D_2)	Value 1 if the pond is perennial, 0 otherwise			
Age (Z_1)	Age of the operator, measured in years	48	41	46
Water colour (Z_2)	1 if the water colour is greenish, 0 otherwise			
Species combination (Z_3)	Different types species stocked, measured in number	1,46,650	16,950	13,310
Culture period (Z_4)	Total time period measured in number of days	254.00	256.00	245.00
Income (Z_5)	Annual income of the operator, measured in Taka	1,66,713	1,49,783	1,96,713

Source: Field survey, 2001.

EMPIRICAL RESULTS

The maximum-likelihood estimates of the parameters for the stochastic production frontier model and those for the technical inefficiency model for the fish production are presented in Table 3 for the different categories of farmers.

In case of TR farmers (Table 3), most of the slope coefficients of the stochastic meta-production frontier or output elasticity of inputs for TR farmers have expected signs. As far as production is concerned seven variables, namely, fingerling pond size, feed/bran, labour, cowdung, lime application and water depth were significant. Output elasticity of input was the highest for fingerling (0.66), followed by pond size (0.60), cowdung (0.578), feed (0.515), cowdung (0.510), lime (0.336) and water depth (0.23). Water colour, culture period and income had a positive impact on technical efficiency. The gamma parameters was estimated to be 82 per cent and significant also indicating the existence of technical inefficiency. The mean technical efficiency was estimated to be 86 per cent implying that these farmers' production efficiency is 14 per cent less than the potential frontier production.

As far as the CTR farmers (Table 3), feed, labour, oil cake, pond size and fingerling were found to be the most important variables of fish production. There are mixed signs against the parameters three of which are expected.

TABLE 3. MAXIMUM-LIKELIHOOD ESTIMATES OF STOCHASTIC PRODUCTION FRONTIER AND TECHNICAL INEFFICIENCY MODELS FOR DIFFERENT GROUP OF FISH FARMERS

Production frontier		Farmers' categories			Farmers' categories		
Variables	Parameters	Coefficient			T-ratio		
		TR	CTR	TCNR	TR	CTR	TCNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	β_0	3.990	1.990	4.740	4.96	7.05	4.83
ln X_1 (pondsize)	β_1	0.600	0.170	0.076	2.06	1.56	0.087
ln X_2 (labour)	β_2	0.578	0.320	0.368	2.05	3.37	1.622
ln X_3 (feed)	β_3	0.515	0.480	1.679	3.95	4.56	3.15
ln X_4 (oilcake)	β_4	0.085	0.080	1.241	0.59	1.57	2.42
ln X_5 (urea)	β_5	0.016	-0.0025	1.221	0.89	-0.63	2.95
ln X_6 (TSP)	β_6	-0.032	0.020	-0.407	- 0.54	0.49	-0.42
ln X_7 (lime)	β_7	0.336	-0.014	2.030	3.82	-0.31	2.32
ln X_8 (cowdung)	β_8	0.510	0.022	0.203	2.36	1.34	1.29
lnX_9 (fingerling/seed)	β_9	0.660	0.084	0.521	2.70	1.75	2.01
ln X_{10} (water depth)	β_{10}	0.231	0.005	0.275	3.005	0.19	2.31
ln X_{11} (medicine)	β_{11}	0.432	-0.013	-0.075	1.71	-0.99	-0.606
Soil dummy	β_{12}	0.054	0.003	-0.236	0.37	0.13	-2.21
Pond dummy	β_{13}	0.055	-0.019	-0.073	0.716	-1.67	-5.38
Constant	δ_0	0.628	0.050	1.880	1.59	0.31	2.19
Age	δ_1	0.003	0.004	0.041	0.72	2.6	8.44
Water colour	δ_2	-0.100	0.029	-0.258	-1.93	1.25	-1.24
Species combination	δ_3	0.010	-0.014	0.003	0.33	-1.04	0.052
Culture period	δ_4	-0.002	-0.001	0.006	-1.13	-1.1	1.283
Income	δ_5	-0.01	-0.025	-0.001	-1.15	-1.3	-1.12
Variance parameter	σ^2	0.49	0.22	0.39	13.97	7.9	5.39
	γ	0.823	0.62	0.561	22.48	59	0.25
Mean efficiency		TR fish farmers 86 per cent		CTR fish farmers 69 per cent		TCNR fish farmers 61 per cent	

Most of the slope coefficients of the stochastic frontier or output elasticities of input had expected sign. The coefficients with pond size, labour, feed and fingerlings were highly significant. Output elasticity of input was the highest for feed (0.480) followed by labour (0.32), pond size (0.17), fingerlings (0.084) and oilcake (0.08) regarding the technical inefficiency parameters only age and water colour were significant. Species combination, culture period and income had a positive impact on technical efficiency water colour as well as age of operator had unexpected signs on CTR fish farmers. The gamma parameter was found to be 0.62 and significant indicating that inefficiency effect is significant.

The technical efficiency of the CTR farmers was 69 per cent. This implies that they are producing about 31 per cent lower than the production frontier. Age of the operator had a negative impact on technical efficiency.

As for TCNR farmers, (Table 3) most of the variables had expected signs. These are pond size, labour, oilcake, urea, fingerling and water depth, etc. Output elasticity of input was the highest for feed (1.66), followed by oilcake (1.24), and urea (1.22). Here also there were some variables with unexpected signs. Soil type and pond type were also very important, as these were statistically significant. In terms of the inefficiency model age were significant variables in explaining inefficiency. The mean technical efficiency was 61 per cent indicating that these farmers produce 39 per cent below than the frontier production.

Concept of Yield Gaps

Yield gap is an important concept of research for fisheries production because it affects the availability of fish for consumption and other uses. Yield gap affects the production potential. If the yield gap is more, then production achieved is less than potential. The concept of yield gap applied in the present study refers to the gap in fish production per unit of area between the highest yield (constant) achieved within the sample and yields achieved by the sample fish farmers. The extent of yield gaps by the sampled fish farmers is presented in Table 4. It is shown in the table that the overall yield gap of the sampled fish farmers was 1,481 kg per hectare. This gap constituted about 24 per cent of the highest yield in the overall sample indicating that per hectare production is 24 per cent lower than the highest yield achieved by the farmers in the sample. This implies that many farmers are producing less than they could have produced had there been proper practice of the technology among them.

In regard to the specific categories of fish farmers, it is clear from Table 4, that the yield gap is the highest for the TCNR fish farmers. Their per hectare yield gap is about 1,593 kg which is about 31 per cent lower than of the highest yield obtained by at least one of the farmers in the group. The second highest yield gap was for the farmers who received both credit and technical advice. Their yield gap was estimated to be 1,434 kg constituting about 23 per cent of the highest production within the sub-sample. The lowest yield gap was for the farmers who received only training. The

TABLE 4. YIELD GAP BETWEEN HIGHEST (POTENTIAL) YIELD AND REALISED YIELD ACCORDING TO FARMER CATEGORIES

Categories (1)	Highest yield per hectare (kg) in the sample (2)	Per hectare yield gap (kg) (3)	Gap as a per cent of highest yield (4)
TR fish farmers	6,890	1,416	20
CTR fish farmers	6,125	1,434	23
TCNR fish farmers	5,115	1,593	31
All farmer categories	6,043	1,481	24

Source: Field survey, 2001.

extent of yield gap per hectare for the TR fish farmers was only 1,416 kg, which is about 20 per cent of the highest production of the group. It is clear from the above discussion, that yield gap is quite substantial which implies that the farmers could increase their production and realise more income had they been adequately familiar with the technology.

Production Losses

The farmers were asked to report for the production losses occurred due to various factors. They were also asked to report in regard to the extent of production loss caused due to different factors. The different broad factors were water quality, water quantity, diseases, soil and temperature. Production loss was estimated using three pieces of information namely, (a) Probability of occurring of a constraint (hazard), (b) Proportion of fish affected and (c) Actual production loss for the affected species in the pond.

The farmers were asked to report on the frequency of occurrence of a hazard during the last five years. Thus the probability of occurrence was defined as the number of occurrences divided by number of years under consideration. Farmers provided the information on the proportion of fish affected and actual quantity of fish affected in the year under consideration. Normalised production loss was then calculated by multiplying a, b and c (per hectare converted production loss). High turbidity was a problem for each of the last five years. So, a probability of 1 was assigned against the fish farmers.

The normalised production losses were estimated to be 63.41 kg per hectare for TR fish farmers, 87.44 kg for the CTR fish farmers and 110.00 kg for the TCNR fish farmers. Water quality and disease were the important parameters that caused most production loss. Taking all the categories of farmers together, the average per hectare production loss was estimated to be 86.95 kg Normalized production loss (per cent) of TCNR, CTR and TR fish farmers are shown in Table 5.

CONCLUSIONS

The following suggestions are put forward in the present study:

* Training is an important element for the farmers for boosting up fish production from aquaculture. Even if credit is made available, farmers might not be able to perform well in the absence of training.

* Farmers still have the belief that more fingerlings result in increased production. A tendency of overstocking is still present among the farmers. This belief should be removed from the farmers' mind.

* Considerable amount of technical inefficiency exists with the farmers of the study areas. Training can make farmers familiar with aquaculture and can help to reduce technical inefficiency.

TABLE 5. NORMALISED PRODUCTION LOSSES FROM DIFFERENT CONSTRAINTS IN FISH PRODUCTION

Constraints	Probability of occurrence (a)			Percentage of fish affected (b)			Yield loss for affected species (c)			Normalized yield loss kg/ha		
	TR	CTR	TCNR	TR	CTR	TCNR	TR	CTR	TCNR	TR	CTR	TCNR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
❖ Water quality												
i) High turbidity	1.00	1.00	1.00	0.05	0.12	0.15	62	71	75	3	8.52	11.25
ii) Plankton bloom	0.40	0.45	0.48	0.11	0.29	0.20	65	70	82	2.86	9.10	7.87
iii) Low dissolve oxygen	0.50	0.51	0.60	0.12	0.15	0.18	80	75	85	4.8	5.73	9.18
iv) Filamentous algae/weed	0.44	0.46	0.54	0.28	0.12	0.15	73	75	80	8.99	4.14	6.48
Sub-total		19.65				27.49				34.78		
❖ Water quantity												
i) Shortage	0.60	0.60	0.60	0.12	0.15	0.20	65	72	78	4.68	6.48	9.36
ii) Flooding	0.20	0.40	0.20	0.35	0.32	0.36	72	82	86	5.04	10.49	12.38
Sub-total		9.72.				16.97				21.74		
❖ Diseases	0.60	0.67	0.69	0.40	0.45	0.30	70	72	79	16.8	21.7	16.35
i) Bacteria												
ii) Parasite												
iii)Virus												
Sub-total		16.8				21.70				16.35		
❖ Soil problem	0.49	0.56	0.56	0.35	0.21	0.42	50	76	78	8.57	8.9	18.34
i) Acidity												
ii) Seepage												
iii) Other												
Sub-total		8.75				8.9				18.34		
❖ Temperature												
i) High	0.80	1.00	0.80	0.25	0.20	0.25	30	45	46	6.00	9.00	9.20
ii) Low	0.40	0.30	0.60	0.15	0.12	0.33	45	47	49	2.7	3.38	9.70
Sub-total					8.7				12.38			18.90
TOTAL		**63.41**				**87.44**				**110.00**		

Source: Field Survey, 2001.

* There may be a good potential to enhance productivity through the improvement in technical efficiency at the farm level and technological progress at the national as well as regional levels, such as the development of modern technologies and improvement in the genetic make-up of fish species.

* Substantial yield gaps exist in the field of aquaculture. Some farmers are very promising in the sense that their production is very high as compared to majority of the farmers. Necessary training and proper input use will help reduce yield gaps.

* Although production losses are very significant, proper management and care can help reduce production losses. The farmers should be made aware of the importance of water quality for fish production and necessary practical demonstrations in the rural areas should be carried out to make farmers aware of the water quality management and other aspects of aquaculture practice. Likewise, specialist services should be made available to take proper care of the production losses causing due to diseases.

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