ECONOMICS OF SEWERAGE FEED MULTIVARIETAL FISH FARMING IN WEST BENGAL

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ABSTRACT

Sewerage feed fishing farming is being practiced in many parts of the world. In this type of fish farming domestic and industrial sewerage discharged from bug metropolis are utilized for fish farming. Utilization of sewerage for fish farming has been an alternative for treatment. As installation of sewerage treatment plants would be costly proposition considering the volume of sewerage discharge of a big metropolis. The entire sewerage of Calcutta metropolis is dis- charge in Bidydhari river, which flows along 24-Parganas (North) in West Bengal. If it had not been utilized for fish farming the entire sewerage would have been discharged in to Bay of Bengal. In rainy sea- son paddy is cultivation along the lands of river Bidyadhari. The river is separated from agricultural land by means of river bunds, which prevent from incursion of sewerage and saline water during paddy cultivation. It also helps in draining out of excess water due to high rainfall through sluice gates. After paddy harvest, the land is leased out for fish farming. Fish farmers lease large chunks of land in. The sewerage water is let in the paddy fields during high tides through the sluice gates. Different kinds of fish seedlings along with Talapia and Nylotica are released in required quantities. Seedlings of Nylotica and Talapia need not to be released as these varieties breeds by it. Different varieties include mallets, tiger prawns, Indian Major Carps etc. At the onset of monsoon in August the leased in land is again returned back to the owner for paddy cultivation. In view of the above the paper intends to explain the following objectives:

i) To study the tenurial arrangements in paddy-cum-fish farming;
ii) To study the costs and benefits of paddy-cum-fish farming.

Key Words: Sewerage feed fishery, multi-varietal fishes, West Bengal, India

Introduction:

Industrialization and urbanization has given birth to new environmental problem in both developed and developing countries – wastewater collection, disposal and its treatment. In many urban areas of the developing counties wastewater (sewage) is never treated and directly dumped in the river or sea. This in appropriate wastewater disposal has been one of the major issues of water pollution in urban areas. Kolkata in India has been one such city since time immemorial sewage water has been directly let off in the wetlands or rivers. The city, which has been more than three hundred years old, had been very rapidly growing crossing its city limits with the pressure of population. It has been one of metropolitan city of India has provided several benefits to the people including providing homes and space for industries As a result more and more new area is being required for housing. This partly planned and unplanned expansion has lead to serious water pollution problem in terms of sewerage. The entire untreated sewerage falls in Bidyadhari river flowing through 24-Pargana (North) district. The sewerage is discharged through canals directly to the river and through river the sewerage is suppose to fall to Bay of Bengal. Annually, 250 million tones of sewerage is discharged in the river. The proportion of domestic to industrial wastewater had been 75 and 25 per cent respectively. The sewerage water apart from bringing in silt also contains Nitrogen (in the form of nitrous, nitrate and ammonia), chemical oxygen demand (COD) and biological oxygen demand (BOD) that have been above standard. The main sources of manipulation in the Bidyadhari river are:
i) Life waste water from Kolkata metropolitan city;
ii) Run-off from fertilizers and pesticides used by the farmers along the sewer-age canals;
iii) Industrial wastewater from the factories in the city;

iv) Animal disposals;
v) Wastewater from hotels and hospitals in the city

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The waster thus falling in Bidyadhari river has been heavily polluted. The following Table 1 shows the water quality:

Table 1: Quality of sewerage water

Sl. no.	Element	Quantity Mg/l	Permissible limit Mg/l	Main problems
1.	DO	1.70	>3.00	Foul colour
2.	BOD	10.10	<6.00	Health effects
3.	NH_4-N	5.40	<2.00	Health effects
4.	COD	30-50	0	Health effects
5.	SS	9.75	<7.50	Asthetic impact

Source: Measured through study; SS = suspended solids

Of the total annual discharge of 250 million tones of sewerage entering in the river the Table 2 indicates the proportion of various pollutants. Of which chemical oxygen demand (COD) has been the highest about 71.73 per cent followed by biological oxygen demand (BOD) by 12.17 per cent Total nitrogen and phosphate comprises of 10.66 and 0.76 peer cent respectively. A major part of the pollutant falling in the river is being removed by sewerage feed fisheries and a part of it falls in the sea through tidal waves. The tidal waves play a major role in pushing the pollutants in the fisheries.

Table 2: Estimates of the pollutant load balance in Bidyadhari River

Sl. no.	Pollutants	Pollutant load tonnes/year		Remainder (tones/year)
		Entering river	Removed from river	
1.	COD	17932500.00 (71.73)	16662879.00 (92.92) *	1269621.00
2.	BOD	3042500.00 (12.17)	1902475.20 (63.53) *	1140024.80

Table 2: Estimates of the pollutant load balance in Bidyadhari River(Contd.)

Sl. no.	Pollutants	Pollutant load tonnes/year		Remainder (tones/year)
3.	Total Nitro-gen	2650000.00 (10.66)	2357175.00 (88.95) *	292825.00
4.	Total Phos-phate	190000.00 (0.76)	98743.00 (51.97) *	91257.00
5.	NO2-N	400000.00 (1.60)	394200.00 (98.55) *	5800.00
6.	NO_3-N	42500.00 (0.17)	425000.00 (100.00) *	NIL
7.	NO_4-N	705000.00 (2.82)	476791.50 (67.63) *	228209.00
	Total	24962500.00	22317263.70 (99.99) *	228209.00

Figures in percentage indicates percentage to total load of pollutants and with * indicates removed from each pollutants

Nature of sewerage feed fisheries

After paddy, fish is grown in the fields. All the paddy plots are leased in and formed into one shallow pond of 4-5 feet standing water. Water is let in through the sluice gates along with sewage to the paddy fields. The paddy-cum fish farming is of traditional nature where salt resistant paddy varieties are grown in rainy season without any application of fertilizers and pesticides. During heavy rains, salinity of the soil considerably drops enabling the paddy crop to grow. Just before harvest after maturity of paddy, water from paddy fields are drained out and brackish water along with larvae of fishes are let in. Various types of fish species such as nylotica, tilapia, mallets, Indian major carps and prawns grow well in brackish water and it is harvested with the start of summer season. Again before sowing of paddy for rainy season brackish water is let out and field is dried for preparation and sowing of paddy. This method is known as rice-cum-fish culture.

Review of literature:

The prawn farming is practiced in coastal areas under varying land–use options e.g. traditionally as paddy-cum-prawn culture, in leased-in land for natural prawn production, leasing out of land for prawn production, owner operated prawn production (Ramachandra Bhatta, 1998). There are evidences due to high profitability of the enterprise that land received as transfer from Government has been converted to prawn farms (Pawan G.Patil, 1997). But most of the leased-in land have been operated by the fish contractors (Ramchandra Bhatta, 1998) and also the size of farms varies from less than 1 ha. to a maximum 10 ha. (Pawan G.Patil, 1997). In addition to the small traditional farms, there are also farms owned by corporate houses (Naganthan 1995) who cultures mainly black tiger prawn, seeds are obtained from hatcheries by feeding them on imported compounded purchased feed. Whereas, under traditional mode of production the larvae are either caught from shoreline directly by the farmers or bought from larvae catchers and feed the stock are made from locally available resources. Under traditional paddy-cum-

prawn culture there is no need to supplement any feed because it is obtained directly from estuaries. The modern technology because of its capital-intensive nature, seed availability from hatcheries and imported feed has been only accessible to a small group, who belongs corporate houses? Whereas, a large section of fisher men whose mode of production has been either traditional or small-scale continued to operate with indigenous techniques and even worked for these modern farms owned by corporate houses. Mostly strikingly, these traditional farmers have not reaped the benefit of modern fishery technology and mechanization (Acharya and Acharya, 1995).

Environmental impact of prawn farming has been viewed in many ways in different studies and the extent of environmental degradation is also linked with the adoption of technology either traditional or non-traditional. The safest form of prawn farming has been the paddy-cum-prawn culture wherein during paddy production the level of salinity is considerably reduced due to heavy rains in monsoon season. Rather to say that the accumulated salts on topsoils are flushed down to the sub-soil by heavy rains. In this type of farming, there is no trace of chemical residues, as no fertilizers, insecticides and pesticides are used and the prawn grows well after harvest of paddy (Ramachandra Bhatta 1998). Land put to only traditional prawn culture for years cannot be brought back to normal paddy cultivation as the salinity increases considerably. Under this land-use options nutrient uptake by paddy plants has been reported to be poor due to presence of high salinity (Csavas, 1995). In places, after many years of prawn culture, the yield of paddy has been reported to drop from 3 tons/ha. to 0.5 tons/ha. (Gadgil et al, 1990). Thus conversion of lands to prawn farming could be regarded as non-trivial irreversibility (Kurtilla and Fisher, 1975).

The above review of literature suggests that paddy-cum-prawn culture has been traditionally practiced in many parts of India. But in West Bengal, it is paddy-cum-fish culture with multi species approach where prawn has been one of the components. Also in most places sewerage water is not used. But in West Bengal sewerage water is extensively used for cultivation of fish.

Objectives of the study:

The main objectives of the study had been as follows:

i) To study the tenurial arrangements in paddy-cum-fish farming;

ii) To study the costs and benefits of paddy-cum-fish farming.

Methodology

Private Cost Benefit:

The private cost benefit analysis has been done by working out B-C ratio internal rate of return (IRR) and net present value (NPV). The formulae for B-C ratio, IRR, NPV are as follows:

(i) Benefit-Cost ratio = $$\frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}}$$

Internal Rate of Return (IRR): The discount rate i such that

$$\sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t} = 0$$

(iii) Net Present Value (NPV) = $\sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t}$

For private cost benefit analysis, discount rate or internal rate has been taken as 6%. The duration of the project as per financial institutions i.e., commercial banks, central co-operative banks has been 5 years. But actually it has been observe that the project life paddy-cum-fish farms are more than 5 years. It generally extends up to 15 years. For analysis the private cost benefit ratio, IRR and NPV has been calculated for 5, 10, 15 years.

Sampling Design:

Selection of Sample households:

The extensive paddy-cum-fish farms are located in far away from seacoast and coastal tributaries in 24 Paraganas (North). These farms are situated along rivers, such as, Bidhyadhari, Matla, Gosaba, Muriganga, Harinbhanga, Kulti, Ichamati, Raimangal where saline water comes along with tidal water as the rivers fall into the sea i.e. Bay of Bengal. In 24 Parganas (North) paddy-cum-fish farms are situated in Haroa, Miankhan, Hasnabad, Basirhat and Hingalgunj Community Development Blocks (C.D.Blocks). Among these 5 C.D.Blocks Haroa had been selected purposively for the study. In Haroa C.D.Block 2 villages namely Teghoria (J.L No.48) and Makhla (J.L. No.49) have been selected as they are situated by the side of Bidhyadhari river had been purposively selected for study. Fig.1 gives the location of the villages in Haroa C.D. Block. All the households of Teghoria and Makhla had been house listed. After house listing all the households had been arranged in ascending order of operational holding comprising of own land, leased in land and leased out land). Through house listing schedule owned area under paddy-cum-fish farms and simultaneously leased in and leased out area by households had also been enumerated. After categorizing the house-holds into landless, marginal, small, medium and large, a total number of 100 house-holds had been selected randomly for study.

Table 3: Categorization of household as per house listing schedule:

Sl. No.	Name of the C.D. Block/village With Jl.no	Population (as per 1991 Census)	No. of households (as per 1991 Census)	No. of households (as per houseli sting)	Total number of households by types as per house listing schedule				
					Landless	Marginal farmeres	Small farmers	Medium farmers	Large farmers
1.	Haroa								
	Teghoria (JL.no 48)	1297	225	258	105	145	3	4	1
	Makhla JL. No. 49	683	115	196	100	86	10	-	-

Table 4: Details of sample households

Sl. No.	Type of farms	Number selected
1.	Landless agricul-tural labour	16
2.	Marginal farmers	68
3.	Small farmers	16
4.	Medium farmers	-
5.	Large farmers	-
	Total	100

Results and discussion

Tenurial system of crop farms:

The samples of paddy-cum-fish farms had been grouped into landless agricultural labourer, marginal, small, medium and large farmers. Of the 5 type of households, only marginal and small type of farms could be found. The average size of holding for marginal farmers is 0.49 ha comprising of 0.46 ha (93.88%) of own land and only 0.03 ha. (6.12%) of leased-in land. The average size of holding for small farmers had been 2.00 ha, entirely comprising of own land. The average size of holding comprising of all types of households is 0.51 ha., of which 0.48 ha. (94.12%) is own land and 0.03 ha.

Table 5: Operational holding of crop farms in paddy-cum-fish farm

(ha./household)

Sl. No.	Type of farms	Type of land			
		Own	Leased-in	Leased out	Operational holding
1.	Landless agril. labour	-	-	-	-
2.	Marginal farmers	0.46 (93.88)	0.03 (6.12)	-	0.49 (100.00)
3.	Small farmers	2.00 (100.00)	-	-	2.00 (100.00)
4.	Medium farmers	-	-	-	-
5.	Large farmers	-	-	-	-
	Total	0.48 (94.12)	0.03 (5.58)	-	0.51 (100.00)

(Figures in parentheses indicates percentage to total)

Tenurial system of paddy-cum-fish farms

Fish cultivation after harvesting of paddy in low saline water has been a lucrative enterprise, the landless agricultural labourers have leased-in 0.72 ha. for cultivation. Similarly the marginal farmers operated 0.94 ha. of fish farms of which 0.43 ha. (45.74 %) as own land and 0.57 ha. (60.64%) as leased-in land and a very insignificant portion 0.06 ha. (6.38%) as leased-out land. Small farmers operated 1.22 ha. of which 1.62 ha.(132.79%) is own land and 0.40 ha. (32.79%) as leased-out land. For all farms operated 0.90 ha. of which 0.40 ha. (44.44%) as own land and 0.57 ha. (63.33%) as leased in land and a very small portion i.e., 0.07 ha. (7.77%) as leased out land. Details have been given in Table 6.

Table 6: Operational holding in paddy-cum-fish farms

(ha./household)

Sl. No.	Type of farms	Type of land			
		Own	Leased-in	Leased out	Operational holding
1.	Landless agril. labour	-	(0.72)	-	(0.72)
2.	Marginal farmers	0.43 (45.74)	0.57 (60.64)	0.06 (6.38)	0.72 (100.00)
3.	Small farmers	2.00 (100.00)	-	-	2.00 (100.00)
4.	Medium farmers	1.62 (132.79)	-	0.40 (32.79)	1.22 (100.00)

Table 6: Operational holding in paddy-cum-fish farms (Contd.) (ha./household)

Sl. No.	Type of farms	Type of land			
		Own	Leased-in	Leased out	Operational holding
5.	Large farmers	-	-	-	-
	Total	0.40 (44.44)	0.57 (63.33)	0.07 (7.77)	0.90 (100.00)

(Figures in parentheses indicates percentage to total)

Cropping Pattern:

The entire cultivated area under paddy in Kharif season had not been leased-out. So the cropping intensity for marginal farms had been 130 per cent. Of the total 0.64 ha. gross cropped area, 76.92 per cent had been under Kharif paddy and 15.70, 6.28 and 1.10 per cent had been under summer paddy, mustard and vegetables respectively. For small farms the cropping intensity had been only 100 per cent indicating that they had not grown any crops in the Rabi season. For all farms, the cropping intensity had been 125.40 per cent. 80.06 per cent of the gross cropped area had been put to Kharif paddy. In Rabi season 14.13, 4.71 and 1.10 per cent respectively had been put to Rabi/Summer paddy, mustard and vegetables. Details have been given in Table 7.

Table 7: Cropping pattern of paddy-cum-fish farms

(ha./household)

Sl. no.	Type of farms	Season				Net sown area	Gross cropped area	Cropping pattern
		Kharif	Rabi/Summer					
		Paddy	Paddy	Mustard	Vegetables			
1.	Landless agricultural labour	-	-	-	-	-	-	-
2.	Marginal farmers	0.49 (76.92)	0.10 (15.70)	0.04 (6.28)	0.007 (1.10)	0.49	0.64 (100.00)	130.00
3.	Small farmers	2.00 (100.00)	-	-	-	2.00 (100.00)	2.00	100.00
4.	Medium farmers	-	-	-	-	-	-	-

Table 7: Cropping pattern of paddy-cum-fish farms (Contd.)

(ha./household)

Sl. no.	Type of farms	Season				Net sown area	Gross cropped area	Cropping pattern
		Kharif	Rabi/Summer					
		Paddy	Paddy	Mustard	Vegetables			
5.	Large farm-ers	-	-	-	-	-	-	-
	All farms	0.51 (80.06)	0.09 (14.13)	0.03 (4.71)	0.007 (1.10)	0.51	0.64 (100.00)	125.40

(Figures in parentheses indicates percentage to gross cropped area)

Yield and income from paddy and fish

In comparison to yield of paddy fish yield and income from it has been quite sustentative. Paddy only gives 12.58 per cent of the total income. Whereas, rest about 88 per cent from fish only. Among fish, prawn has provided maximum income to the extent o 67.21 per cent. Details of which has been given in Table 8.

Table 8: Income and cost of paddy-cum-fish farming

Sl. no	Particulars	Yield (qtls/ha.)	Income (Rs./ha.)
1.	Paddy @ Rs 500.00 per qtls	39.06	19530.37 (12.58).
2.	Fish		
2.1.	Indian Major Carps @ 4000.00 per qtils	3.36	13458.41 (8.67)
2.2.	Mallets @ 7000.00 per qtls	1.68	11766.41 (7.58)
2.3	Talapiya and Nylotica @ Rs 2200.00 per qtls	2.79	6147.09 (3.96)
2.4	Prawn @ Rs 30,000.00 per qtls	3.48	104327.39 (67.21)
			137649.67 (100.00)

(Figures in parentheses indicates percentage to tota)l

Profitability of paddy-cum-fish farms

The Table 8 compares the profitability of crops and paddy-cum-fish farms. The comparison shows that net income from crops and fish has been Rs. 8,850.63 and Rs. 88,503.96 per ha respectively for paddy-cum-fish farms. It indicates that always paddy-cum-fish farming more profitable than crop farming. Net income from prawn farming did not show any particular trend with the increase in size of farms for land less agricultural labour, marginal, and small farms it had been Rs. 20154.16, Rs. 77800.99, Rs. 36227.28 per ha respectively.

Table 8: Profitability of crops and paddy-cum-fish farms

(Rs./ha.)

Sl. no.	Type of farmers	Paddy-cum-fish						Total (5+8=9)
		Cost	Gross income	Net income	Cost	Gross income	Net income	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Landless agricultural labourer	-	-	-	66416.41	86570.57	20154.16	20154.16
2.	Marginal farmers	10598.56	19955.45	9356.89	65653.31	134097.41	68444.10	77800.99
3.	Small farmers	10999.12	17858.10	6858.98	40594.45	69962.75	29368.30	36227.28
4.	Medium farmers	-	-	-	-	-	-	-
5.	Large farmers	-	-	-	-	-	-	-
	All farms	10679.74	19530.37	8850.63	63789.71	152293.67	88503.96	97354.59

Note: Cost of crops, extensive and semi-intensive farms includes out of pocket expenditure such as, human labour, bullock labour, seeds, manures, fertilizers, plant protection, rent (tax) and depreciation. Whereas, gross income has been calculated on the basis of total output (main and by product wherever applicable) multiplied by farm harvest price.

Benefit –Cost ratio, Net Present Value and Internal rate of return:

In paddy-cum-fish farms, the commercial banks advance loans for a period of 5 years. So for calculating benefit-cost ratio the project period has also been taken here as 5 years. But as the activity continues beyond 5 years and seldom given up by the farmers, the calculations for benefit-cost ratio, net present value and internal rate of return has been extended to 10 and 15 years also. The purpose of doing such exercise is also to compare the three results such as benefit-cost ratio, net present value and internal rate of return. There has been an increase in benefit-cost ratio for landless agricultural labourer from 0.22 to 0.27 and 0.31 for 5, 10 and 15 years project period respectively. While for marginal, small and all farms the benefit-cost ratio did not change with the increase in project period.

The internal rate of return in case of landless agricultural labourers has in-creased from 0.03 to 0.30 and to 0.30 for 5, 10 and 15 years period respectively. The internal rate of return for marginal small and all farms remained same at 1.02, 0.70 and 0.91 respectively for all the three project periods.

The net present value for landless agricultural labourer did follow the same trend as in benefit-cost ratio and internal rate of return. The NPV in Rs. '000/ha in-creased from 187.86 to 718.43 and 1366.40 respectively for 5, 10 and 15 years. While for marginal farmers the NPV for 5 years period has been 1002.06 and it has increased to 3048.84 in 10^{th} year and further decreased to 554.85 at the end of 15^{th} year. For small farms NPV has increased with the increase in life of project period at 467.45, 1422.26 and 2588.31 respectively for 5, 10 and 15 years. For all farms NPV has also increased with the increase in life of project period 847.98 to 2580.04 and to 4695.32 for 5, 10 and 15 years period. Details of benefit-cost ratio, internal rate of return and net present value has been given in Table 9.

Table 9: B/C ratio, NPV and IRR for paddy-cum-fish farms

Sl. No.	Type of farmers	B/C ratio, NPV and IRR after 5th, 10th and 15th year								
		5th year			10th year			15th year		
		B/C ratio	NPV (Rs '000 ha.)	IRR	B/C ratio	NPV (Rs '000 ha.)	IRR	B/C ratio	NPV (Rs '000 ha.)	IRR
1.	Landless agricultural labourers	0.22	187.86	0.03	0.27	718.43	0.30	0.31	1366.40	0.30
2.	Marginal farmers	1.02	1002.06	1.02	1.02	3048.84	1.02	1.02	554.85	1.02
3.	Small farmers	0.70	467.45	0.70	0.70	1422.26	0.70	0.70	2588.31	0.70
4.	Medium farmers	-	-	-	-	-	-	-	-	-
5.	Large farmers	-	-	-	-	-	-	-	-	-
	All farms	0.91	847.98	0.91	0.91	2580.04	0.91	0.91	4695.32	0.91

(NPV and IRR calculated at 6% discount rate)

Conclusions:

The untreated sewage discharged from the Kolkata metropolitan system has been discharge into Bidyadhari river and has turned it to an open sewer. But the paddy-cum fish farming practiced by leasing in land from farmers after cultivation of the main crop paddy has been responsible for removing a major part of the pollutant load which had been otherwise been falling into sea (Bay of Bengal). This activity has been has improved the economic status of not only farmers but also to landless agricultural labours as they have been engaged in fish cultivation after harvesting of paddy by leasing in land. The farmers who did not cultivated any crop after paddy can has been earning a hefty amount (Rs 4000.00 per ha per year) by leasing out land. Apart from this, the un-employed youths of the locality has been generating employment by guarding the fish farms and in various activities like catching of fish etc.

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