Chapter 3: Study Area and Methodology

3.1 Introduction

South 24 Parganas district has been selected for the purpose of collecting and evaluating data regarding tank irrigation since it is located in the saline zone of West Bengal. Since the study is focused to find out the status and impact of tank irrigation in the saline zones, 5 blocks of south 24 Parganas district namely Patharpratima, Matharapur-II, Kakdwip, Sagar and Namkhana which are closer to Bay of Bengal had been selected for the study(Figure 28). These five blocks are chosen because due to the vicinity of Bay of Bengal, there is high degree of salinity problem in the ground water and surface water (river water). Owing to this hazards of salinity both the ground water and surface water (river) is not suitable for agricultural irrigation. Agricultural activities of these five blocks basically depend on the rain fed surface water irrigation through tanks like ponds, khal, beals etc.

3.2 Location

South 24 Parganas is situated in the extreme southern part of West Bengal. The district lies between 22º 33' 45" N and 21º 29' 00" North Latitudes and between 89^0 4' 50" and 88^0 3' 45" East Longitudes. The total geographical area of the district is 9960 sq.km. Out of this total area 9783.24 sq.km is rural area and 176.76 sq.km. is urban area. The district is bounded by Kolkata and North 24 Parganas on the North, Sundarban and Bay of Bengal on the South, Bangladesh on the East and Hooghly River on the West.

Patharpratima bock is located at 21º 47' 32"and 88º 21' 20" E. Total geographical area is 484.48 sq.km. This block is bounded by Mathurapur I and II in the North, Sundarbans forest in the east, Bay of Bengal in the South, Namkhana, Kakdwip and Kulpi in the West.

Mathurapur-II is located at 22º 07' 13" N and 88º 23' 39" E. Total geographical area is 227.45 sq.km. This block is bounded by Mathurapur I block in the North and a part of the West, Joynagar –II and Kultali blocks in the east, Sundarbans forest in the South and Patharpratima in a part of West.

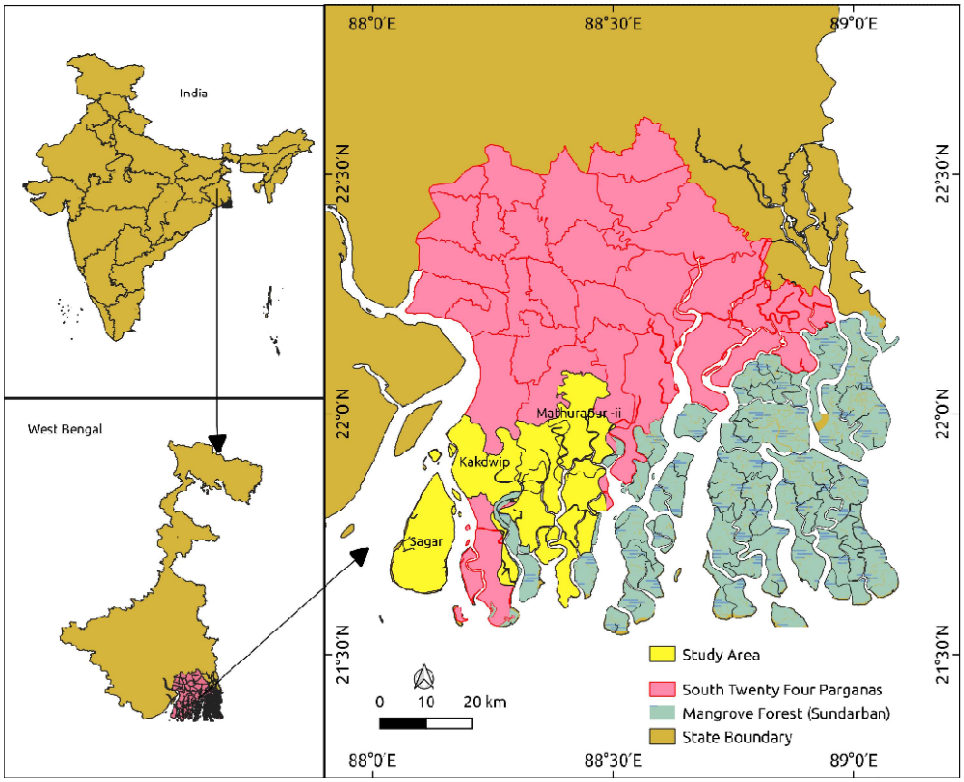

Figure 28: Location map of the study area

Kakdwip block is bounded by the latitudes 21º 52' 34" N and longitudes

88º11' 07" E. The total geographical area is 252.74 sq.km. This block is surrounded by Kulpi block in the north, Patharpratima in the east, Namkhana and Sagar blocks in the south and Nandigram block in Purba Mednipur district across the river Hooghly in the West.

Sagar block is situated by the latitudes 21º 38' 45" N and longitudes 88º 03' 30" E. Geographical area of the block is 282.11 sq.km. Sagar block is surrounded by Muriganga in the north, Namkhanna block across the Muri Ganga in the east, Khejuri-II in Purba Medinipur district on the West across the Hooghly River.

Namkhanna block is situated at 21º 46' 12" N and 88º 13' 53" E. Total geographical area of the block is 370.62 sq.km. Namkhanna block is surrounded by Kakdweep block in the north, Patharpratima block and Sundarban forests in the east, Bay of Bengal in the south and sager block in the west across the Muriganga.

3.3 Rainfall and Climate

The usual rainfall in the district varies in between 1750 mm to 1770 mm. Climate of south 24 Parganas district is quite hot and humid in nature. Relative annual humidity varies from 71% to 85%. Plenty of rainfall received by the district North-East and South-West monsoon which starts in the latter half of June and withdraw by middle of October. In the month of March-April pre monsoon rains occurs to a great extent in the district. Hottest month of the year is May when the temperature rises to a high 40^0C and falls to a minimum of 10^0C in the month of January which is the coldest month of the year.

3.4 Geomorphology

The district is divided into four different zones.

i) Deltaic plains

ii) Levees

iii) Marshes

iv) Islands of Sundarban

3.5 Topography

Topographically the district is divided into two broad zones: northern marine river line and southern marine delta zones. Over the recent past it had been observed that the see is moving away towards the south and as a result a vast low lying area is emerging. Sedimentation is growing rapidly due to tidal inflow and river deposition in this plain. Due to the inflow of brackish water into wetlands which ultimately trickle down into the agricultural field from the interconnected tidal channels causes heavy losses in irrigation in this district. Due to this salinity problem there is high level of scarcity of non-saline water for irrigation in this district.

3.6 Nature of Soils

Entisols, alfisols and aridisols are three types of soilformed the basic structure of the soil of the district. In the Western part of the district Entisols are seen. Delta region contains alluvium soils. Aridisols is seen in the southern part of the district which is saline and alkaline in nature. A soil salinity map of the study area is given in Figure 29.

Figure 29: Soil salinity map of South 24 Parganas
Sources: NBSS & LUP, Kolkata

3.7 Condition of Ground Water

In the south 24 Parganas district ground water is available at Quaternary and Tertiary sediments within the depth of 75 meters to 360 meters range below ground level (bgl) under the clayey and sandy thick layer. This aquifers is divided into two groups moving from north to south of the district. The aquifers which exists within the depth of 20 to 160 m meters is brackish to saline in nature with high concentration of chloride ranging from 1750 to 6300 ppm and hence are not suitable for use in domestic and agricultural activities.

The aquifers which prevail within the depth of 160 meter to 360 meter bgl are free of salinity problem. Aquifers of this range are fresh in nature and are

utilized rigorously for agricultural and domestic uses.

3.8 Problems of Ground Water

Arsenic contamination and salinity are the two major problems in the ground water of the district for which this is very difficult to use ground water to meet the need of drinking water, domestic uses and for agricultural irrigation Aquifers available within the range of 10-150 m bgl which are generally used to construct shallow tube wells, are not useable in coastal area i.e. blocks closer to costal area. Moreover these aquifers contain high chloride concentration ranges from 1854 to 13581 mg/lit.

But the aquifers which are available within the range of 160-360 m bgl are free from arsenic, salinity and chloride concentration and hence are used for drinking, domestic and agricultural irrigation purposes. But to use this aquifers over the range of 160-360 m bgl, deep tube well should be constructed which are beyond the capacity of small and marginal farmers of the district. Moreover long term data showed that average ground water level of the district is declining over time rapidly all most in all the blocks of the district.

3.9 Land Utilization and Area of Major Crops

Area available in the district is 948710 hectare among which net area shown is 361876 hectares. Area under more than one crop is 217305 hectares. Major crops of the district are food grains (Rice, Wheat, Pulses etc.), oil seeds (Rape seed, Mustard etc.) fibers (Jute etc.) and miscellaneous crops (Potato, sugarcane etc.). Area used for the rice production is 990.4 thousand hectares, for wheat production 9.9 thousand hectares and 0.6 thousand

hectares for the production of other cereals. Total area used to produce cereals in this district is 1000.8 thousand hectares. Pulses are another important agricultural produce of the district. 19.8 thousand hectares of land is used for the production of pulses. Almost 1020.6 thousand hectares of cultivable land is used to produce foodgrains. Potato is the second important agricultural output in the district. 85.5 thousand hectares of land is utilized for the production of potatoes. 11.9 thousand hectares of land had been utilized for the production of chilies. Cropping intensity of the district is 161.20%. It should be mentioned here that 59.37% of the gross cropped area is used to produce Aman paddy, 0.006% for Aus paddy, 0.084% for wheat production, 0.062% for Kharif vegetables production, 0.045% for winter vegetable, 0.004% for betel production, 0.025% for oil seeds production, 0.100% for the production of pulses, 0.008% for cotton production, 0.001% for jute production and 0.07% for other cash-crop production. So the main crop produce in the district is paddy (rice). Majority of cultivators are engaged in the production of paddy to earn their livelihood. Figure 30portrays the land use or land cover map of the study area.

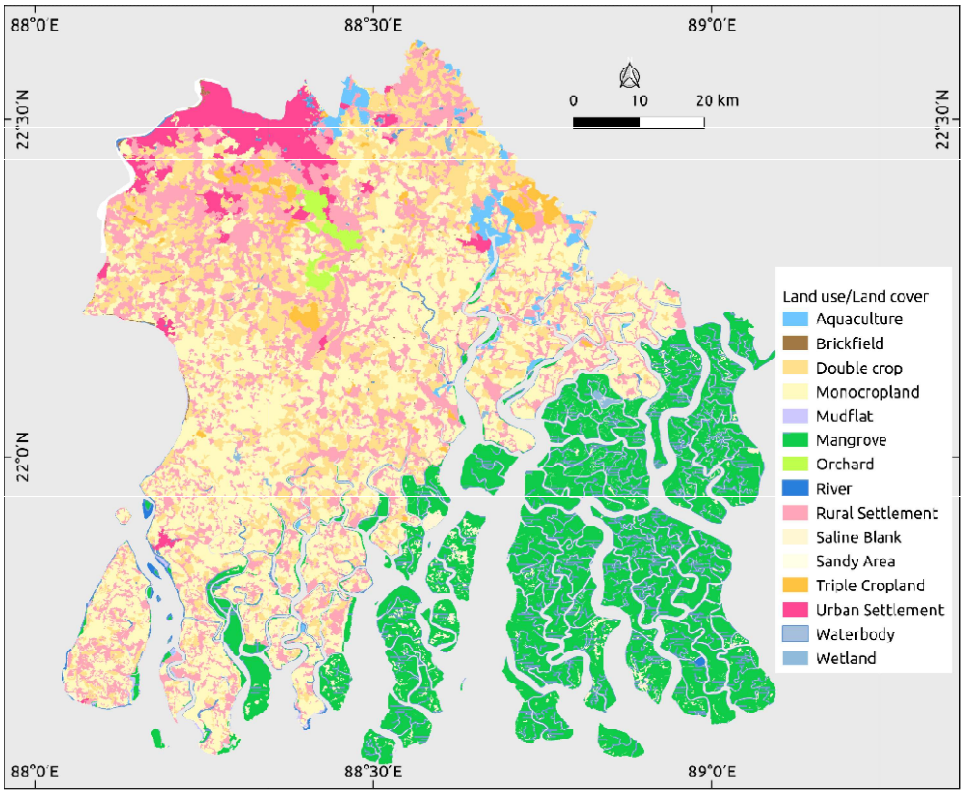

Figure 30: Land use / land cover map of the study area

3.10 Demographic profile

3.10.1 Profile of the District

- South 24 Parganas District comprises of 29 C. D. Blocks and 7 Statutory Towns.
- There are total 2,042 villages and 111 census Towns in the District.
- South 24 Parganas District 2nd most populated District and has the highest Child (0-6 year's) Population in the State.
- South 24 Parganas District has highest Scheduled Caste Population in

the State.

- The percentage of urban share of Population of South 24 Parganas District has expanded from 15.7% (2001 Census) to 25.6% (2011 Census) of total Population of respective Census.
- South 24 Parganas District ranks 4thin decadal Population growth rate among the Districts with 18.2%.
- The density of Population (Population per square km) of the District is 819 per square km which makes its rank 12th in the State.
- The Sex Ratio of the District is 956 (No. of females per 1000 males) which is higher than the State's Sex Ratio (950) and it ranks 6th in the State along with the District Birbhum and Dakshin Dinajpur. The District slips to the 8th rank along with Bardhman District when only Rural Sex Ratio (954) & 13th (971) respectively.
- In case of proportion of Child Population (0-6 years), South 24 Parganas District ranks 6th in the State (12.6%).
- South 24 Parganas District has experienced slight decline in Child Sex Ratio (CSR) from 964 in 2001 Census to 963 in 2011 Census via-a-vis for the decline from 960 in 2001 Census to 956 in 2011 Census has been noticed.
- Literacy Rate of the District is 77.5% (higher than the State average of 76.3%) thereby making its rank 8th in the State.
- The Work Participation Rate has risen from 32.5 (in 2001 Census) to 36.3 (in 2011 Census) and in this case it ranks 15th in the State.

3.10.2 Profile of the Surveyed Blocks

3.10.2.1 Mathurapur – II Block

- Total population of Mathurapur – II block is 220839 as per 2011 census.
- No. of males is 113831 which is 52% of total population and no. of female is 107008 which is 48% of total population.
- Population below 6 years is 26447.
- Decadal growth of population of south 24-parganas district of 20.89%.
- One third of the total population i.e. 60519 is schedule case and no. of schedule tribes is 5676.
- Literacy rate of Mathurapur-II is 77.77% of which mail literacy rate is 56% and female literacy rate is 44%.

3.10.2.2 Patharpratima Block

- Total population of Patharpratima block is 331823 as per 2011 census.
- No. of males is 169422 which is 51% of total population and no. of female is 162401 which is 49% of total population.
- Population below 6 years is 42021.
- Decadal growth of population of South 24-Parganas district of 17.37%.
- No. of schedule caste 76163 and no. of schedule tribes is 2640.
- Literacy rate of Patharpratima is 72.77% of which male literacy rate is 84.30% and female literacy rate is 60.64%.

3.10.2.3 Sagar Block

- Total population of Sagar block is 212037 as per 2011 census.
- No. of males is 109468 which is 52% of total population and no. of female is 102569 which is 48% of total population.
- Population below 6 years is 26212.
- Decadal growth of population of south 24-parganas district of 20.38%.
- No. of schedule caste 56261 and no. of schedule tribes is 854.
- Literacy rate of Sagar is 84.21% of which mail literacy rate is 87.96% and female literacy rate is 67.12%.

3.10.2.4 Kakdwip Block

- Total population of Kakdwip block is 281963 as per 2011 census.
- No. of males is 144120 which is 51% of total population and no. of female is 137843 which is 49% of total population.
- Population below 6 years is 34715.
- Decadal growth of population of south 24-parganas district of 25.93%.
- No. of schedule caste 87638 and no. of schedule tribes is 3398.
- Literacy rate of Kakdwip is 77.93% of which mail literacy rate is 55% and female literacy rate is 45%.

3.10.3 Agriculture-Dependent Population

Population of the district is 816196 (Census of India, 2011). Total work force

of the district is 36.32% of the total population. Out of this, 11.99% is cultivators, 27.21% works as agricultural labourers, 8.13% are engaged as household workers and 52.57% are other workers. 24.55% of total population are main workers, 11.77% of total population work as marginal worker and 63.68% of total population are non-worker.

In Mathurapur-II block, 36.63% of total population of the block is total workers. Out of this 21.97% are cultivated, 42.65% are agricultural workers, 4.06% are household workers and 29.20% are other workers.

In Patharpratima block 42.49% of total population of the block is total workers. Out of these total workers 24.07% are cultivators, 49.09% are agricultural workers, 3.12% are household workers and 23.72% are other workers. 35.70% of the total population of Kakdwip block is workers. Out of which 14.12% are cultivators, 38.25% are agricultural workers.

40.03% are total population of Sagar block are workers. Among this 24.46% are engaged as cultivators, 43.72% are agricultural labours.

36.04% of total population of Namkhana block is workers. Out of these total workers, 23.26% are engaged as cultivators, 34.08% are agricultural labours.

Total population of the 5 surveyed block is 12, 29,492 (census report 2011). Out of which 31.12% of total populations of five blocks are workers. Total cultivators of these five blocks is 3, 82,739 which is 8.29% of the total population of the blocks. 16.41% of total population of five blocks i.e. 2, 01,795 agricultural labourers is there in surveyed area. 20.80% of total population i.e. 2, 55,810 main workers are there. Numbers of marginal workers in the five blocks is 2, 11,529 which is almost 17.20% of total population of the five blocks.

3.11 System of Tank Irrigation in the Study Area

Total Irrigated area in south 24 Parganas district is 47.287 thousand hectare where 12.342 thousand hectare is irrigated by 59634 tanks. 23 MDTW and 9555 SWT are in operation. River lifting is another source of irrigation 58 RLI is in operation. Contribution of tank irrigation in five selected blocks is summarized in the following Table 19.

Table 19: Sources of Irrigation in the study area

Blocks	Canal	Tank	RLI	DTW	STW	Others	Total
Patharpratima	0.0	70.2	00	00	17.4	12.4	100.0
Mathurpur-II	0.6	16.8	00	00	37.6	45.0	100.0
Kakdwip	0.0	15.3	00	00	0.4	84.3	100.0
Namkhana	0.0	70.2	00	00	0.0	4.6	100.0
Sagar	0.0	66.6	00	00	0.0	11.4	100.0

Source: District statistical Handbook (2012), Govt. of West Bengal

RLI = River Lift Irrigation, DTW = Deep tube well, STW = Shallow Tube well

It is seen from the table that as a source of irrigation canal and River Lifting irrigation (RLI) has very insignificant role in irrigation in the selected blocks of south 24 Parganas because of high degree of salinity in the river and can water due to intrusion of saline water from Bay of Bengal into such water bodies. Consequently People of these five blocks heavily relied on the tank water for the purpose of irrigated agriculture. It is reflected in Table 19 that tank as source of irrigated agriculture plays an important role in Mathurapur –II (16.8%), Patharpratima (70.2%), Namkhana (95.4%), Kakdwip (15.3%),

Sagar (68.6%). So, in the southern part of this district due to the salinity hazards in river and canal water, cultivators have no options but to use tank irrigation for the purpose of agricultural production and allied activities.

3.12 Data and Methodology

3.12.1 Data

3.12.1.1 Secondary Data

Secondary data have been collected from Statistical Abstract, District Census Handbook, District Statistical Handbook, District Human Development Report, State Statistical Handbook of Govt. West Bengal and from the office of Department of Irrigation, Govt. of West Bengal at district and block levels. Moreover, Census report of 2011, 5thMinor irrigation report, Economic report of Govt. of India of 2018, different issues of RBI bulletin of 2018, IPCC reports had been utilized as a source of Secondary data.

3.12.1.2 Primary Data

Primary data have been collected at the tank, village and household level during 2016-18, with structured questionnaire and through random sampling from four blocks of South 24 Parganas district namely Mathurapur-II, Patharpratima, Sagar, and Kakdwip which are very close to the Bay of Bengal and have high salinity problem in ground water and river water.

Total 80 water-bodies – 40 large (*Khal*) and 40 small (Tank) have been identified in 26 villages (Table 20).The total population of the selected villages is 1, 77,323.

Table 20: Number of Selected Villages and Water bodies in the Surveyed Blocks of South 24 Parganas

Block	No. of Selected Villages	Gram Panchayat	Population of Selected Villages	No. of Selected Water bodies
Kakdwip	8 (Budhakhali, Fatikpur, 3 No. Madhusudanpur, Kashiabad, Harendra Nagar, Uttar Kashiabad, Akshay Nagar, Gangadharpur)	4	48,425	20 (Khal = 10, Tank = 10)
Mathurapur-II	5 (Sodial, Kumrapara, Raidigh Abad, Baribhanga, Dighirpara Bakultala)	4	63,902	20 (Khal = 10, Tank = 10)
Patharpratima	8 (Chintamanipur, Durga Gobindapur, Chhoto Banashyam, Indranarayanpur, Bardapur, Ramnagar Abad, Shridhar Nagar, Debichak)	7	32,723	20 (Khal = 10, Tank = 10)
Sagar	5 (Mandirtala, Debi Mathurapur, Manasadwip, Rudranagar, Gangasagar)	3	32,273	20 (Khal = 10, Tank = 10)
Total Sample	**26**	**18**	**1,77,323**	**80**

Data Source: Primary Survey, 2018

Total 15 water bodies have been excluded from this analysis, as few variables of these water bodies are substantially higher and lower compared to the other water bodies in South 24 Parganas. Therefore, their inclusion in this study may potentially have a negative effect on the derived results, as they

act as outliers (figure 31). In this study, the sample size (cases) is 65 (Khal = 30 and Tank = 35).

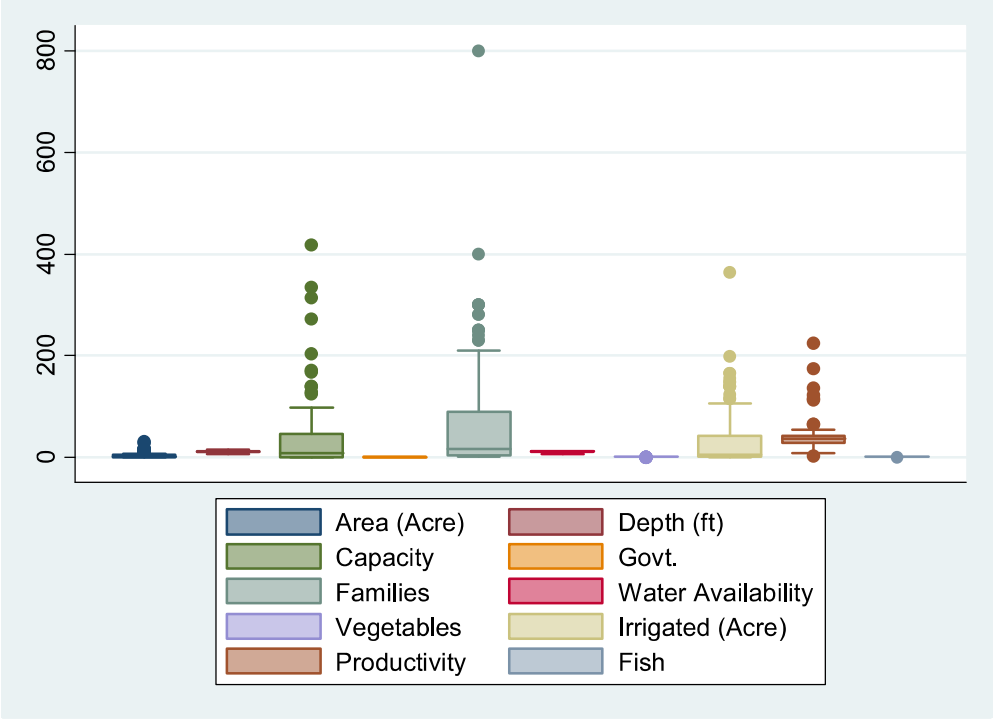

Figure 31: Box plots for outliers

Total 300 farmer households have been surveyed in the selected sites of South 24 Parganas to know their willingness to pay (WTP) for irrigation water and participation in irrigation management.

3.12.2 Methodology

Many different methods and approaches have been used toanalyse the characteristics and overall status of tanks and also to understandthe tank productivity in saline zones. To achieve the above mentioned objectives, multiple linear regression, binary logistic regression, data envelopment

analysis and principal component analysis methods had been applied for the present study in STATA and SPSS platforms.

3.12.2.1 Multiple Linear Regression (MLR) for Determinants of Total Productivity

Tank productivity is the value of production per acre of irrigated area, which depends on many factors. To understand the influence of different variables/factors on the tank productivity multiple linear regression model has been used in the present study. This model is to find out whether the independent variables have any significant impact on the dependent variable. Based on literature surveys and collected primary data sets, six independent variables – capacity or volume of water body, management, water availability, command area, soil type, beneficiaries have been considered for this study. Due to less variation in the data and sample size, two or three relevant variables (fishery, tank conditions) haven't been used.

In this study, the sample size (cases) is 65 (30 large water-bodies and 35 small water-bodies). The subjects-to-variables (STV) ratio is 10:1 (10 cases per variable), which is fair enough for the study.

The regression model is represented as follows:

$$TOTPODY = b_0 + b_1CAPCT + b_2MANGE + b_3WTAVL + b_4COMDA + b_5SOLTY + b_6BNFCS + U_i$$

Where, TOTPODY = Total productivity at tank level (rupees/acre)

CAPCT = Capacity or volume of water body ('000 m^3)

MANGE = Whether management is present for tank (=1 if present, = 0 otherwise)

WTAVL = Water availability for irrigation (months)

COMDA = Command area of tank (acre)

SOLTY = Soil character in the tank command area (=1 if loamy,

0=otherwise)

BNFCS = Number of beneficiaries in tank command area

U_i= Random error term

3.12.2.2 Willingness to Pay

A separate study on farmer's willingness to pay (WTP) for irrigation water has also been done using the multiple regression model where the dependent variable is the WTP (amount per acre per year). The selected independent variables are age of respondents, education of respondents, family size, working members, command area, family income, distance from field, water requirement. All the variables are continuous, expect water requirement. The sample size (cases) is 300.

A. OLS Regression

In this study, farmers' WTP for irrigation water is demonstrated as a model of various individual, household level and farm level factors. The OLS regression model is represented as follows:

$WTP = b_0 + b_1AGE + b_2EDN + b_3FSIZE + b_4WORKM + b_5AREA + b_6WTREQ + u$

Where, WTP = Farmers' WTP for irrigation water (amount per acre per year)

AGE = Age of the respondent/ household head (years)

EDN = Education level of the head of the household

FSIZE = Family size (numbers)

WORKM = Working members (number)

COMDA = Command area (hectares) and

FINC = Family income (rupees)

DISTF = Distance from the field

WTREQ = Water requirement (=1 if yes, =0 otherwise)

To explain the relationship between the independent variables and dependent variable, the regression co-efficient with p-valuefor each independent variable has been examined.

B. Binary Logistic Regression

We have used the following logit model to find the determinants of whether the households are willing to pay or not.

$$Y_i = \frac{1}{1+ e^{-[\alpha+\sum_{j=1}^{7}\beta_j x_i+u_i]}}$$ For all j = 1, 2… 8 and i = 1… 300

Where,

Y_i= 1, if the household is willing to pay for the tank construction or renovation

=0, otherwise

α = coefficient of the constant term

β_j = coefficient of the independent variables

x_i = independent variables

u_i = Error term

In this model, we have used the following variables

Where, WTP = Farmers' WTP for irrigation water (=1 if yes, =0 otherwise)

AGE = Age of the respondent/ household head (years)

EDN = Education level of the head of the household

FSIZE = Family size (numbers)

WORKM = Working members (number)

COMDA = Command area (hectares)

FINC = Family income (rupees)

DISTF = Distance from the field

WTREQ = Water requirement (=1 if yes, =0 otherwise)

3.12.2.3 Data Envelopment Analysis (DEA)

Data envelopment analysis (DEA) is a non-parametric approach that involves the use of linearprogramming methods to construct a non-parametric frontier and to evaluate the relative Input-Output efficiency of a Decision Making Unit (DMU). Efficiency estimates how effectively a firm is transforming its inputs into output. Technical Efficiency (TE) of a firm is measured either by (i) output-oriented measure or by (ii) input oriented measure. In case of output oriented measure the TE of a firm can be computed by comparing its actual output with the maximum producible output from its observed inputs i.e. by how much can output quantities be proportionally expanded without altering the inputs quantities used. In input oriented measure, the TE of a firm can be measured by comparing its actual input in use with the minimum input that would produce the targeted output level i.e. by how much can input quantities be proportionally reduced without changing the actual output bundle. On the other hand, under variable VRS the envelopment surface presents convexity as a consequence of the constraint in the model. The convexity condition essentially ensures that an inefficient DMU is only benchmarked against DMUs of similar size.

DEA methodology is as follows. In the output maximization approach, the farm seeks to maximize output given the input bundle. As per the Banker, Charnes, and Cooper (1984) orientation (under the assumption of the variable returns to scale) the problem is,

Max ϕ

s. t. $\phi Y^0 \leq \lambda Y$

$X^0 \geq \lambda X$

$\sum \lambda_j = 1 \qquad \lambda_j \geq 0$

In case we assume the operation of constant returns to scale then the condition $\sum \lambda_j = 1$ is dropped. The calculation of Technical Efficiency is contingent on the assumption about returns to scale. If one assumes constant returns to scale then the productive units are penalized more as compared to the case where the units are assumed to exhibit variable returns to scale. The ratio of VRS and CRS technical efficiency scores gives us the scale efficiency for the respective units.

Based on literature surveys and collected primary data sets, six input variables – capacity or volume of water body, management, water availability, command area, soil type, beneficiaries and one output variable namely total productivity have been considered for this study.

Output variable:

TOTPODY = Total productivity at tank level (rupees/acre)

Input variables:

CAPCT = Capacity or volume of water body ('000 m^3)

MANGE = Whether management is present for tank (=1 if present, = 0 otherwise)

WTAVL = Water availability for irrigation (months)

COMDA = Command area of tank (acre)

SOLTY = Soil character in the tank command area (=1 if loamy,

0=otherwise)

BNFCS = Number of beneficiaries in tank command area

The efficiency score (θ) is a scalar that measures the technical efficiency and ranges between 0 and 1. The efficiency score means thedistance between the DMU and the efficiency frontier, which is defined as a linear combination of the "best practice" units. If $\theta < 1$, the DMU is inside the frontier and it will relatively inefficient, whereas $\theta = 1$, the DMU will be on the efficiency frontier and it will be considered technically efficient.

3.12.2.4 Principal Component Analysis (PCA)

Principal component analysis (PCA) is an approach to factor analysis that considers the total variance in the data, which transforms the original variables into a smaller set of linear combinations. In other words, it is used to determine the minimum number of factors that will account for the maximum variance in the data. This method has been employed in the present study to reduce the set of 13 decision variables to the key decision making variables. By using the collected 13 variables and principal component analysis methodology, this study has been carried out for the identified blocks of South 24 Parganas (Table 21).

Table 21: Description of the Selected Variables of Farmer's Participation

No.	Variables	Description	Scale
1	Catchment	The catchment condition is good	(1 – 5) 5-Agree strongly, 4-Agree a little, 3-Neither agree nor disagree, 2-Disagree a little, 1-Disagree strongly
2	Water supply	The water supply is adequate	
3	Control	Control over water use	
4	Effort	There are sufficient efforts to bring water to water body	
5	Water sharing	There are fair water sharing arrangement	
6	Channel	Maintenance of channel is good	
7	Maintenance	Maintenance of water bodies is good	
8	Sluice	Sluice condition is good	
9	Water spread area	Condition of the water spread area is good	
10	Co-operation	There is good co-operation in water body maintenance	
11	Panchayat	Panchayat has an active and positive role in water body maintenance	
12	Public fund	Public funds are sufficiently available for water body maintenance	
13	Decision making	There is a high degree of member involvement in decision making	

The Kaiser-Meyer-Olkin (KMO) test has been done to detect multi-collinearity issue in the data and also to measure the sampling adequacy. Multi-collinearity can also be detected by looking at the determinant of the correlation matrix which should be greater than 0.00001. The Bartlett's (1954) Test of Sphericity tells whether correlation matrix is significantly different from an identity matrix.All of the tests indicate that PCA or factor analysis is appropriate for the data.

In PCA, factors or components account for much of the variance among the set of original variables, and first factor explains most of the variance, then second factor, and so on. In this analysis, only those components or factors with an eigenvalue (the variances extracted by the factors) more than 1.0 have been retained using the "eigenvalue-greater-than-one" rule proposed by Kaiser (1960). The varimax (orthogonal) rotation has been opted to improve the interpretability of factors.