Chapter 4: Results and Discussion

Based on the objectives of the study, empirical findings have been presented in this chapter. The first section provides the block wise share of different sources of irrigation in South 24 Parganas and also discusses the overall status and detailed characteristics (conditions, extent of irrigation, productivity) of the selected tanks in saline zone. The second section describes the factors that influencing the tank productivity in saline zone. The third and fourth sections discuss on the tank efficiency and farmer's willingness to pay for irrigation water, and the final section concludes with farmer's participation in the water body irrigation management.

4.1 Statusand Characteristics of Tanks in Saline Zone

In the agricultural sector, irrigation plays an important role in improving the production or yield, and among the irrigation sources, tank irrigation is considered as most important, particularly in the dry and saline zones (Jana et al., 2012). Total irrigated area by different sources in the district of South 24 Parganas was 122.18 thousand hectares in 2011-12, and it was decreased by 1.34% during the period of 2007-08 to 2011-12 (figure 32).

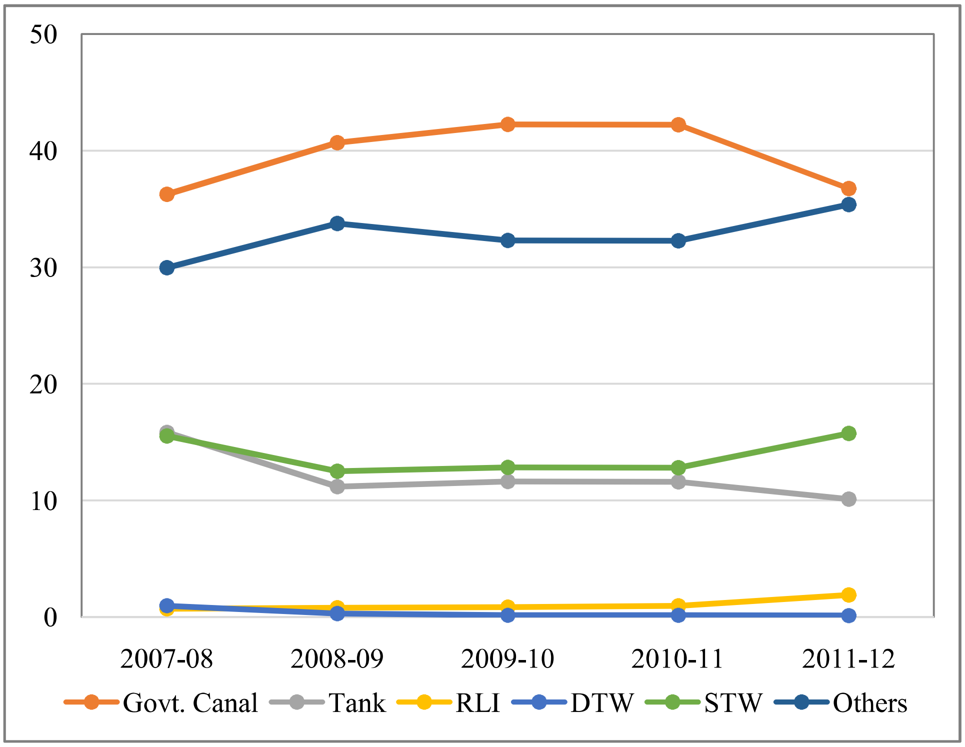

Figure 32: Different Sources of Irrigation in South 24 Parganas from 2007-08 to 2011-12

Table 22shows the block wise share of different sources of irrigation in South 24 Parganas (2011-12). It is observed that the main source of irrigation in South 24 Parganas is canal (36.8%), but in the southern parts of the district (Namkhana, Patharpratima, Sagar, Gosaba), tank water irrigation is more prominent. It is also observed that tank water irrigation is moderately prominent in Bishnupur-II (17.5%), Mathurapur-II (16.8%), Kakdwip (15.3%), and Kultali (12.3%).

Table 22: Block wise Share of Different Sources of Irrigation in South 24 Parganas (2011-12)

Blocks	**Canal**	**Tank**	**RLI**	**DTW**	**STW**	**Others**	**Total**

Blocks	**Canal**	**Tank**	**RLI**	**DTW**	**STW**	**Others**	**Total**
Baruipur	40.3	3.3	0.0	0.7	43.4	12.4	100.0
Basanti	0.0	33.0	0.0	0.0	13.6	53.4	100.0
Bhangar-I	0.0	0.0	8.0	0.3	83.4	8.4	100.0
Bhangar-II	0.0	0.1	29.7	0.3	59.3	10.5	100.0
Bishnupur-I	92.8	1.6	0.9	0.0	0.0	4.7	100.0
Bishnupur-II	12.1	17.5	0.0	0.0	0.0	70.4	100.0
Budge-Budge-I	75.4	0.8	0.0	0.0	3.0	20.8	100.0
Budge-Budge-II	16.3	0.2	0.0	0.3	0.0	83.2	100.0
Canning-I	0.0	2.3	0.0	0.0	68.9	28.8	100.0
Canning-II	0.0	2.7	0.0	0.0	94.4	2.9	100.0
Diamond Harbour-I	2.4	3.5	0.0	0.0	0.0	94.1	100.0
Diamond Harbour-II	7.8	0.6	0.0	0.0	0.0	91.6	100.0
Falta	53.4	1.3	0.4	0.3	0.0	44.6	100.0
Gosaba	0.0	53.9	0.0	0.0	31.8	14.3	100.0
Jaynagar-I	6.7	8.5	0.0	0.3	5.8	78.7	100.0
Jaynagar-II	13.4	29.6	1.0	1.9	1.4	52.7	100.0
Kakdwip	0.0	15.3	0.0	0.0	0.4	84.3	100.0
Kulpi	0.4	11.0	0.0	0.0	0.2	88.4	100.0
Kultali	0.0	12.3	0.0	0.0	51.3	36.4	100.0
Mandirbazar	0.0	6.4	0.0	0.0	0.0	93.6	100.0
Mathurapur-I	18.6	6.9	0.0	0.8	8.1	65.7	100.0

Blocks	Canal	Tank	RLI	DTW	STW	Others	Total
Mathurapur-II	0.6	16.8	0.0	0.0	37.6	45.0	100.0
Mograhat-I	19.4	1.4	0.9	0.0	0.0	78.4	100.0
Mograhat-II	81.4	0.1	0.0	0.0	1.7	16.8	100.0
Namkhana	0.0	95.4	0.0	0.0	0.0	4.6	100.0
Patharpratima	0.0	70.2	0.0	0.0	17.4	12.4	100.0
Sagar	0.0	66.6	0.0	0.0	0.0	33.4	100.0
Sonarpur	13.7	4.2	0.0	0.5	44.7	36.9	100.0
Thakurpukur- Maheshtala	94.2	0.5	0.0	0.0	0.0	5.2	100.0
South 24 Parganas	**36.8**	**10.1**	**1.9**	**0.1**	**15.7**	**35.4**	**100.0**
DTW: Deep Tubewell, STW: Shallow Tubewell, RLI: River Lift Irrigation.							
Data Source:District Statistical Handbook, South 24 Parganas (2012), Government of West Bengal							

In the present study, total 65 water bodies (Khal = 30 and Tank = 35) have been selected from four blocks of South 24 Parganas (Kakdwip, Mathurapur-II, Sagar and Patharpratima) and analysed to get the different dimensions andoverall idea on the tank irrigation system in saline zone.

Based on the collected primary data(table 23), the characteristics of water bodies have been discussed in three major parts – (a) tank conditions, (b) extent of irrigation by tanks and (c) tank productivity.

Table 23: Some Basic Characteristics of the Selected 65 Water bodies

Characteristics	Tank (*N* = 35)	Khal (*N* = 30)	All Water bodies (*N* =

			65)
Area (acre)	0.04	10.27	4.76
Depth of water body (ft.)	11.20	9.50	10.40
Capacity (‘000 m^3)	0.62	123.21	57.20
Number of beneficiaries (families)	2.14	223.40	104.26
Water availability (months)	12	8.80	10.50
Command area (acre)	0.92	95.37	44.51
Soil quality (1 = Bad – 5 = Good)	3.70	3.60	3.65
Irrigation water quality (1 = Bad – 5 = Good)	4.26	3.43	3.88
Management	Personal = 35	Government = 29, Community = 1	Government = 29, Community = 1, Personal = 35
Data Source: Primary Survey			

4.1.1 Tank Conditions

Area and Depth: The average area of all water bodies is 4.76 acres, whereas it is 0.04 acre for tanks and 10.27 acres for khals. It is observed that average depth of tanks (11.20 ft.) is more than khal (9.50 ft.). The average depth of all water bodies is 10.40 ft.

The depth of water body is not uniform in all seasons. During rainy season the average depth of all water bodies is 10.04 ft. It is only 4.51 ft. during the time of summer (Figure 33). It is also observed that the average depth is 7.96 ft. during winter season.

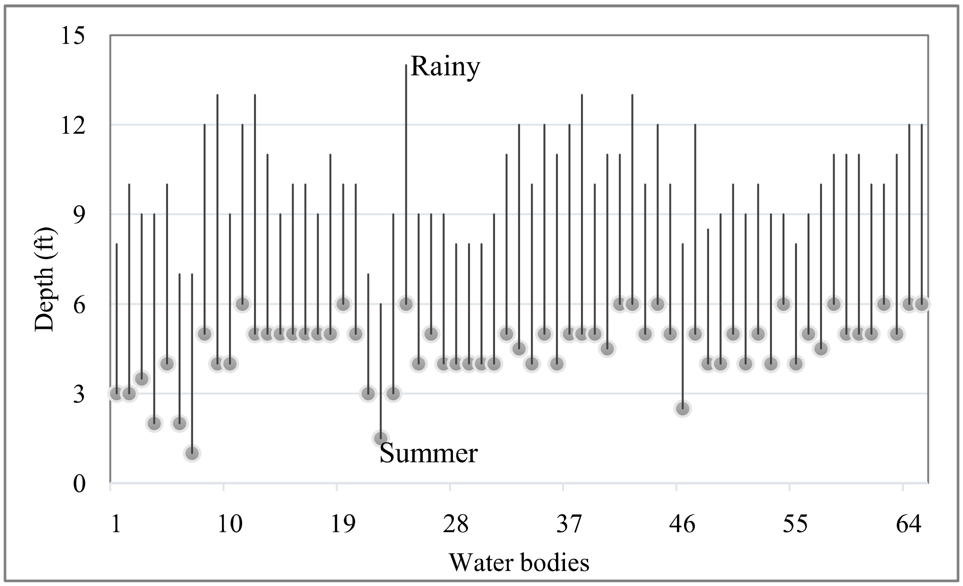

Figure 33: Depth of All Water bodies during summer and Rainy Seasons

Age: The age of all water bodies varies from 16 years to 120 years. Large water bodies are more than 100 years old. It can be said that large water bodies were constructed during the British period to manage or overcome from the drought situations.

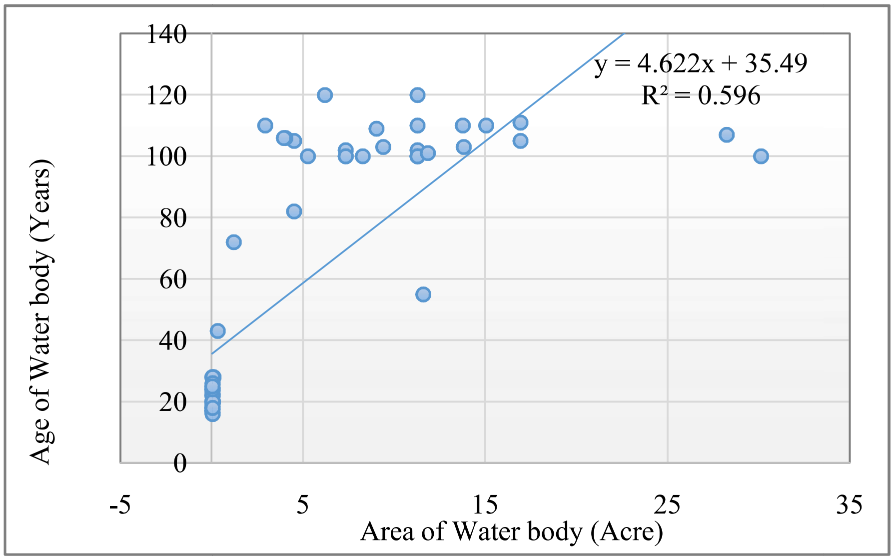

Figure 34: Age and Size of All Water-bodies

Figure 34 shows the relationship between age and size (area) of all water bodies. It indicates the positive relationship i.e. larger water body, more old and small water body, less old (or new).

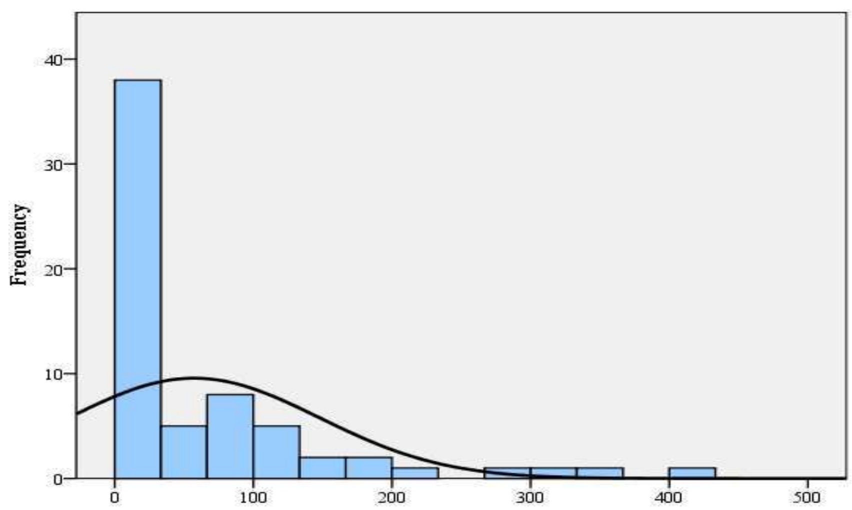

Figure 35: Capacity of All Water-bodies

Capacity: The capacity or volume of water body has been calculated from area and depth, and it is more than 57000 m^3 (average). This capacity is 123210 m^3 for khals and 620 m^3 for tanks (figure 35).

Water availability and Spread area: The average water availability of all water bodies is 10.50 months. Rain is the main source of water for all water bodies. During rainy season, 96 percent of total water spread areas are filled with rain water, and it is very low during summer (50%) (figure 36).

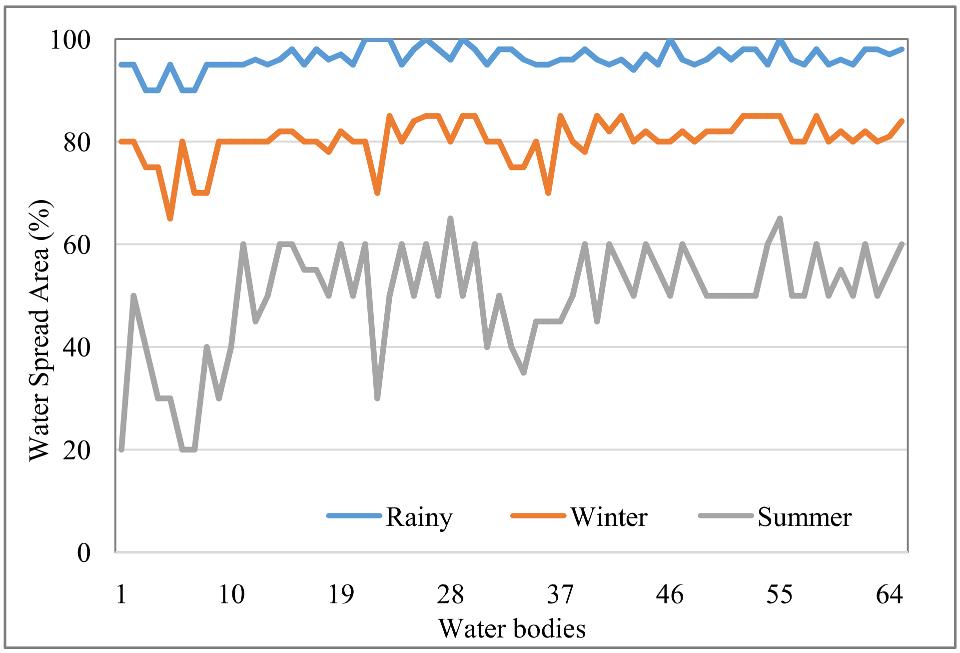

Figure 36: Water Spread area (%) during Different Seasons

Source of Water: Rain is the main source of water for all water bodies. Only 12 tanks (18%) are connected rivers like Muriganga, Saptamukhi. Irrigation water quality is moderate to good (ranges 3 – 4 in 5 point scale).

Tank filling in the last 10 years: In the last 10 years, on an average, 90-100% of the tank was filled for 2.1 years, 70-90% was filled for 6.2 years and below 70% was filled for 1.7 years.

4.1.2 Extent of Irrigation by Tanks

Command area: The average command area of all water bodies is calculated as 44.51 acre. 5 No. *Gheri Khal* has the highest command area (363.64 acre), whereas *Chapla Khal* shows the lowest command area which is less than 1 acre. Figure 37 shows the frequency distribution of command area of all selected water bodies.

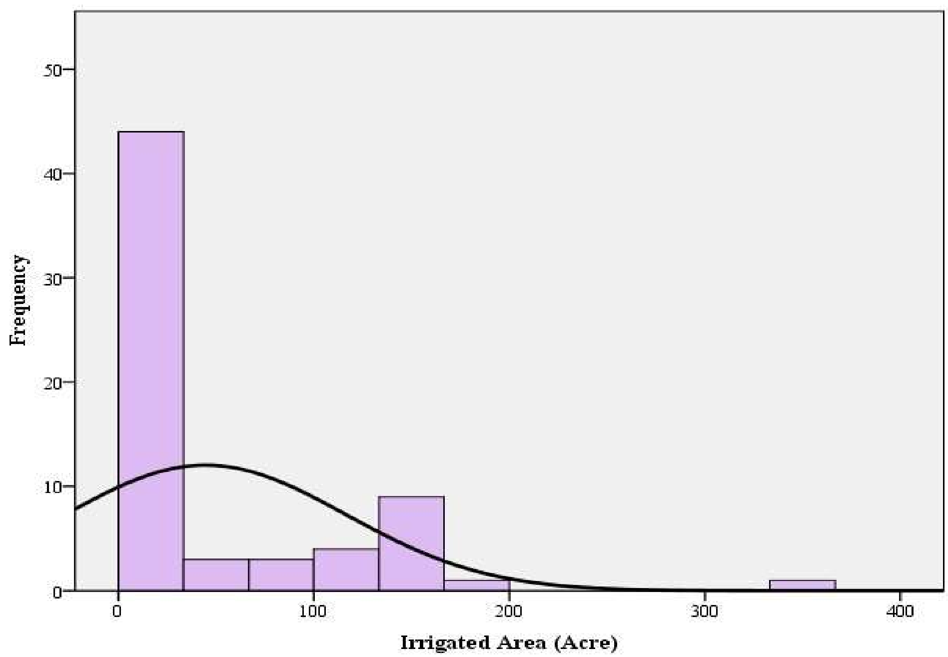

Figure 37: Command Area of All Selected Water bodies

Beneficiaries: Average number of beneficiary farmer families per water body is 104.26.In other words, on an average, 100 farmer families are benefited from one water body. Khals like 5 No. Gheri, Tetulia, Gajir, Sodial, Jogendrapur and Raidighi give benefit to more than 300 families. Only 2 families are benefitted from one small tank.

Management: Out of 65 water bodies surveyed, 29 water bodies are managed by the government organisations or departments and 1 water body managed by the community. 30 small water-bodies are owned and managed by famer families. More than 90 percent of all the water bodies are lift irrigation types.

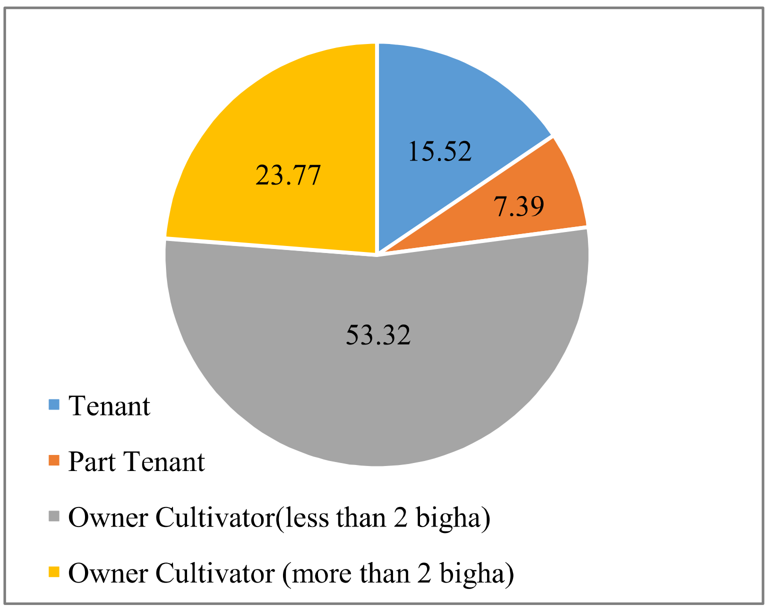

Figure 38: Type of Farmers in the Tank Command Area

Types of Farmers: All farmers, including small and marginal are dependent on tank water irrigation system for cultivation. Owner cultivators (less than 2 bigha) constitute 53.32% of the total farmers in the command area (figure 38).

Use of Tanks: Tanks are used for many purposes. Other than irrigation, villagers use tank/khal water for different purposes like domestic uses, fisheries and Plantation. Many families dependent on livestock keep cows, ducks, goat, and sheep in their homestead which supplements their income. They are rarely used for the family's own consumption. It can be said that all the water bodies in the identified location provides economic benefits to the rural people.

4.1.3 Tank Productivity

The efficiency of all water bodies has been measured by the value of production per acre of irrigated area, known as tank productivity. The average irrigated area and production value are 44.51 acres and INR 44, 934 respectively. It is understood that this productivity is related to many aspects of cultivation. Figure 39 shows the frequency distribution of tank productivity of all selected water bodies.

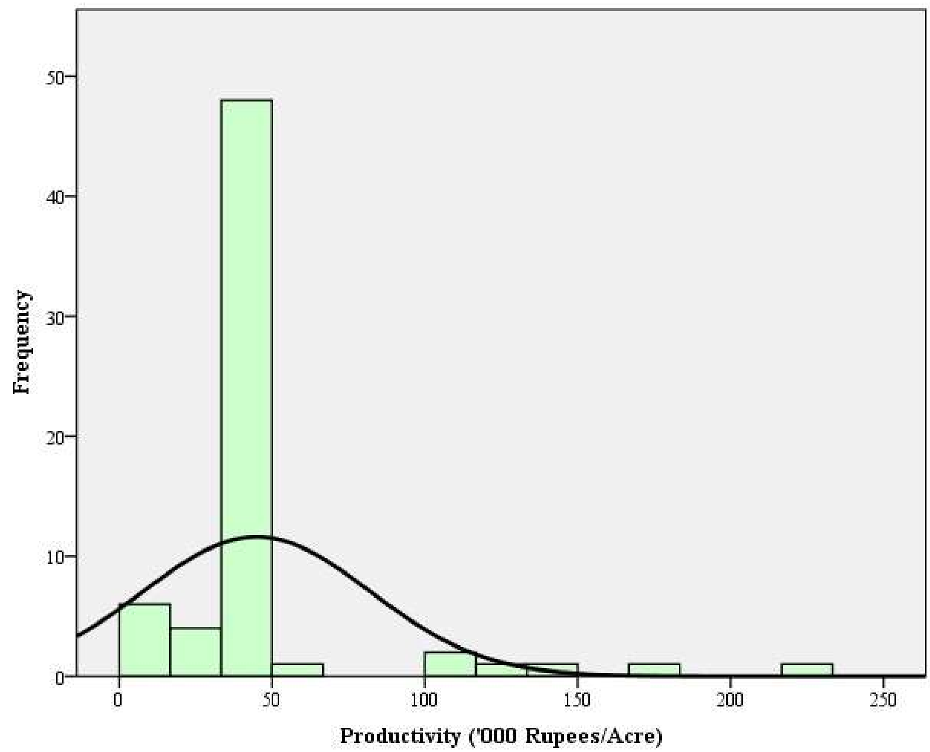

Figure 39: Tank Productivity ('000 rupees/ acre)

Tank increases the land value and reduce the risk of yield. The average land value for irrigated land is Rs. 1.53 lakhs per acre and Rs. 1.07 lakhs per acre for non-irrigated land in the study area. The crops grown in tank command area gets the benefit of life- saving irrigation as a result of which the yield loss is reduced. The yield of Kharif paddy is always higher than the crops outside the tank command areas. It is understood that the crop loss due to inadequate rainfall or dry spell is reduced in tank command areas. The primary survey data clearly reveals that tanks are still a crucial component of the rural livelihood of the South 24 Parganas, particularly in the saline zones.

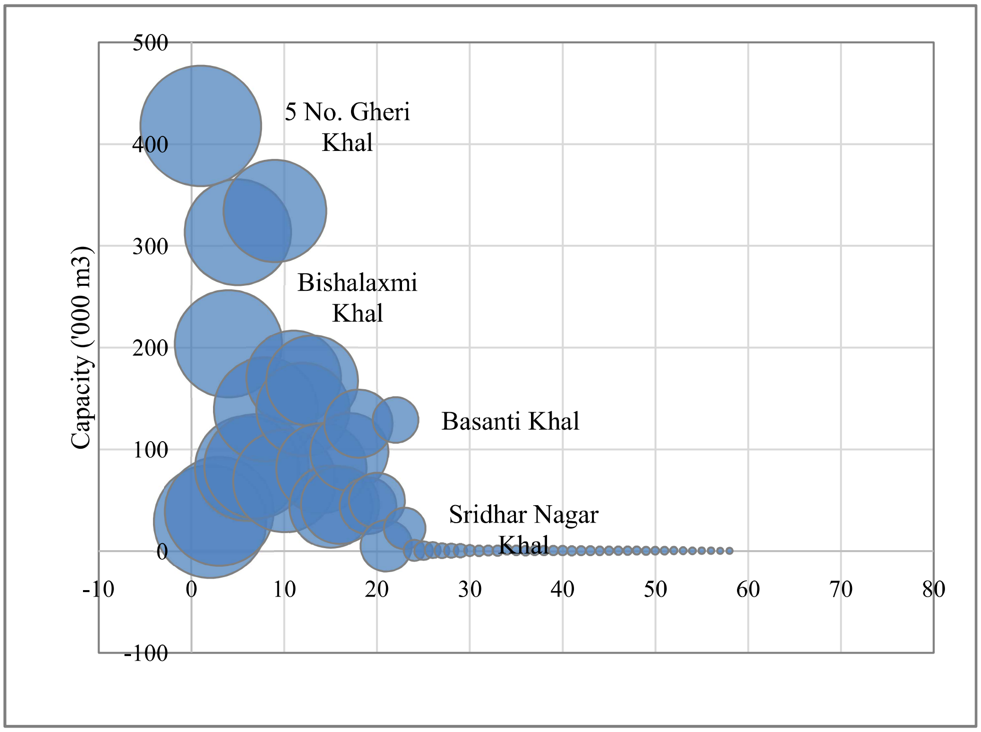

Figure 40: Bubble Diagram showing Total Productivity (size) and Capacity of All water bodies

4.2 Factors Influencing Tank Productivity in Saline Zone

To understand the influence of different variables/aspects on the tank productivity multiple linear regression model has been used (table 24). Six variables –capacity or volume of water body (‘000 cubic metre), management, water availability (months), command area (acre), soil type, beneficiaries (families) have been considered for this study. The correlation matrix of all selected variables is presented in table 24It is found that the selected variables are not highly correlated with each other, which suggests that there is no multi co linearity issue (Table 25).

Table 24: Correlation Matrix of All Selected Variables

Correlation Matrix						
	Capacity	Beneficiaries	Management	Water availability	Soil type	Command area
Capacity	1.000	.784	-.526	-.642	.513	.729
Beneficiaries	.784	1.000	-.724	-.718	.621	.916
Management	-.526	-.724	1.000	.791	-.400	-.591
Water availability	-.642	-.718	.791	1.000	-.489	-.699
Soil type	.513	.621	-.400	-.489	1.000	.687
Command area	.729	.916	-.591	-.699	.687	1.000
a. Determinant = .004						

Table 25: Collinearity statistics for Regression analysis

Model		Collinearity Statistics	
		Tolerance	VIF
	Capacity	.345	2.901
	Beneficiaries	.206	4.848
	Management	.247	4.045
	Water availability	.257	3.884
	Soil type	.527	1.897
	Command area	.258	3.869
Dependent Variable: Productivity (Rs. /acre)			

The regression results are reported in table 26.The results show that the model is fit and almost 20 percent of variation in the tank productivity is explained by the variables included in the model.

Table 26: Estimated Regression Coefficients of the Tank Productivity Analysis

Tank Productivity	*Coefficient*	*Std. Err.*	*t*	*Sig.*	*[95% Conf. Interval]*	
Capacity	-0.041046	0.0227124	-1.81	0.076*	-0.0865099	0.0044179
Management	17.88614	5.94628	3.01	0.004***	5.983368	29.78891
Water availability	1.413835	1.236072	1.14	0.257	-1.060432	3.888102
Command area	0.3177473	0.0516272	6.15	0.000****	0.2144042	0.4210904
Soil type	0.3614115	5.093652	0.07	0.944	-9.834641	10.55746
Beneficiaries	-0.1383478	0.0261886	-5.28	0.000****	-0.1907699	-0.0859257
Constant	21.92468	10.66526	2.06	0.044**	0.5758365	43.27352

Observations = 65; $F(6, 58) = 9.35$; Prob > F = 0.0000; R-squared = 0.1941

**** $p < 0.001$, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Data Source: Estimated from Primary Survey, 2018

The results show that the significant variables are beneficiaries with negative coefficient value, and command area, management with positive signs. It can be interpreted that large command area, proper management and less number of benefited families are responsible for higher tank productivity. In the case of other variables, they have expected signs, but are not significant.

It is clear from the regression analysis that management aspect is very important in increasing the tank water productivity. Government, community and personal level initiatives and tank management activities can influence the productivity and change the socio-economic scenario of the study area. The command area is also expected to positively influence the tank water productivity. If the command area is large then production will be more and if the area is small then production will be less. Families who are dependent on tank water for irrigation and other domestic purposes use water as much as they can do. They are using tank water as public good, and overuse tank water sometimes which reduces the tank water productivity. This observation is reflected in the results presented in figure 41.

In the present analysis, water availability is not significant but it improves the tank productivity. It is quite possible to increase the water availability by improving the catchments and field channels. It is also observed during the survey that few tanks with good structures have the higher water availability. It can be suggested that according to the tank productivity, the tank rehabilitation options are important in improving the tank performance in the district as well as state.

It is true that proper maintenance of water body can increase or improve the productivity. Figure 41 shows the reasons for lack of maintenance of water bodies in the selected locations of South 24 Parganas. Most of the respondents reported that poverty/financial constraints, encroachment, political issue are the main reasons behind the lack of maintenance of water bodies.

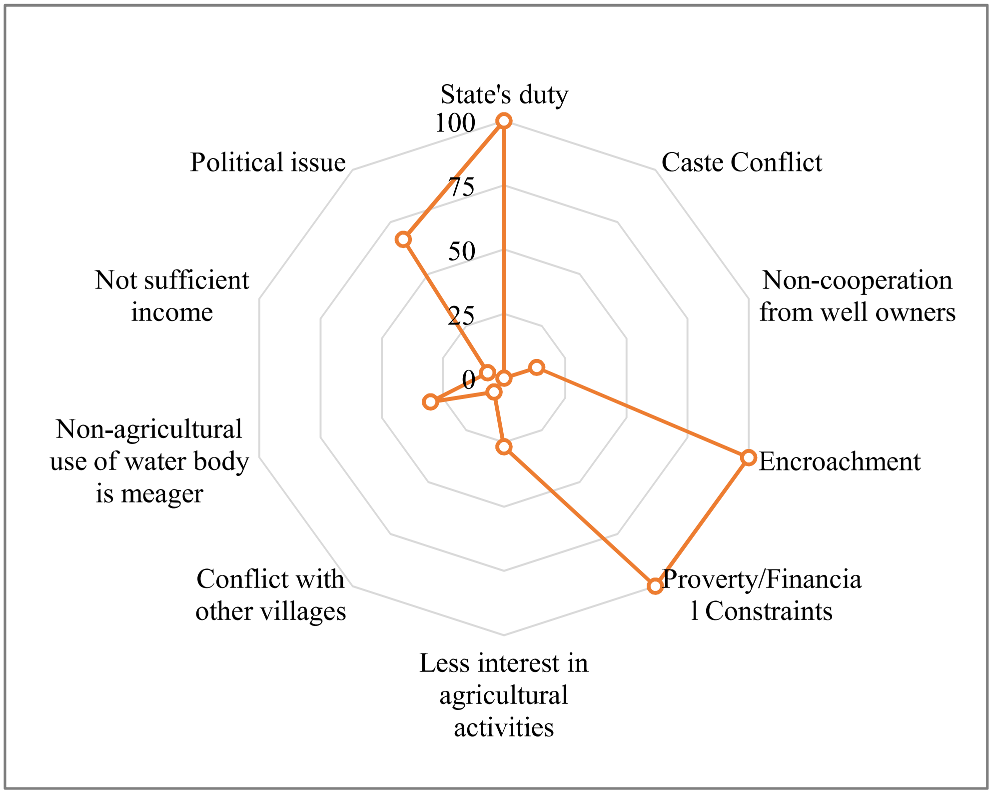

Figure 41: Reasons for Lack of Maintenance of Water bodies

The survey reveals that after the renovation of water bodies, the area of cultivation in the command area and value of production will be significantly changed in the study area. The growth rate of production, before and after the renovation of water bodies will be more than 100%. In figure 42, the improvement in average value of production of different crops and items has been presented.

It is clear that the renovation of water body is very much needed to increase the productivity, and for that willingness to pay (WTP) for irrigation water can be expected in the study area.

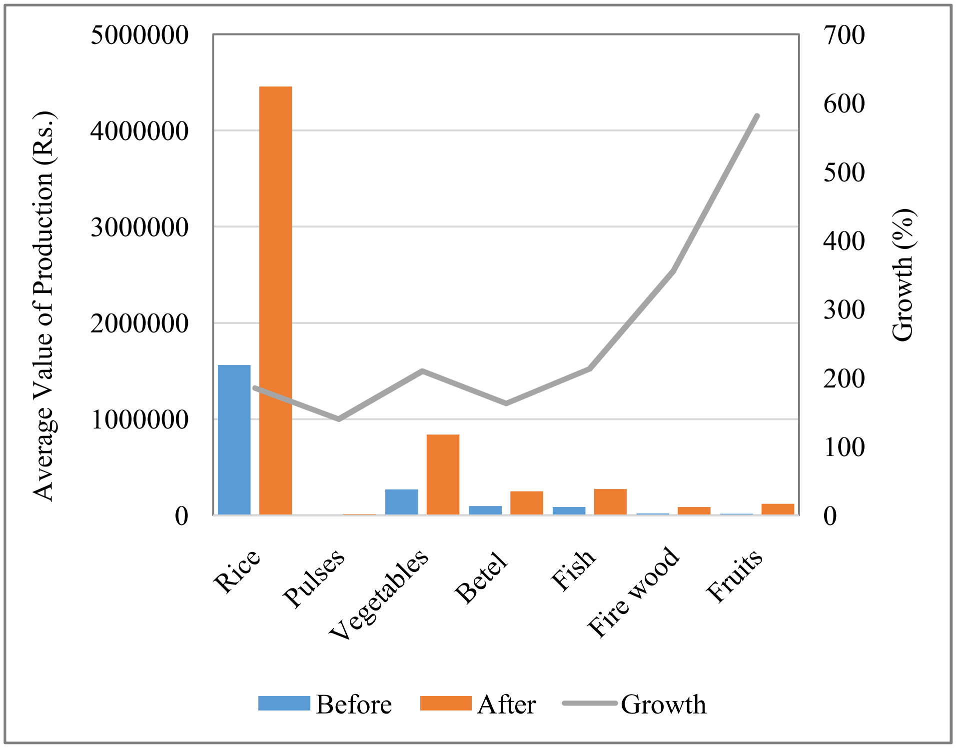

Figure 42: Productivity Improvement after Water body Renovation

4.3 Efficiency Analysis of Water Bodies

Efficiency analysis of water bodies has been done using Data Envelopment Analysis (DEA) method to know the more about the efficient and inefficient tanks in saline zone of South 24 Parganas. For DEA analysis, seven variables of tank productivity analysis have been used as input and output variables and presented in table 27.

Table 27: Statistical Summary of Input and Output Variables of Water bodies

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Capacity ('000 m^3)	65	0.34	418.06	57.20	90.35
Beneficiaries (families)	65	1.00	800.00	104.26	144.75
Management	65	0.00	1.00	0.60	0.49
Water availability (months)	65	6.00	12.00	10.51	1.89
Soil type	65	0.00	1.00	0.14	0.35
Command area (acre)	65	0.00	363.64	44.51	71.83
Productivity (rs./acre)	65	0.00	224.35	44.93	37.24

The correlation matrix of all the inputs and outputs is presented in table 28.It is found that the correlation coefficients among the variables are not so high which indicates that variables are not highly correlated with each other.

Table 28: CorrelationMatrix of Input and Output Variables of Water bodies

Correlation Matrix[a]								
		Capacity	*Beneficiaries*	*Management*	*Water availability*	*Soil type*	*Command area*	*Productivity*
Correlation	*Capacity*	1.000	.784	-.526	-.642	.513	.729	-.244
	Beneficiaries	.784	1.000	-.724	-.718	.621	.916	-.275
	Management	-.526	-.724	1.000	.791	-.400	-.591	.372
	Water availability	-.642	-.718	.791	1.000	-.489	-.699	.279
	Soil type	.513	.621	-.400	-.489	1.000	.687	-.091
	Command area	.729	.916	-.591	-.699	.687	1.000	-.140
	Productivity	-.244	-.275	.372	.279	-.091	-.140	1.000
a. Determinant = .003								

Table 29: Results of Data Envelopment Analysis (DEA)

No. of DMUs	65
Average	0.52973834
Maximum	1
Minimum	0.138427
Standard Deviation	0.32591788
No. of Efficient DMUs	7
No. of Inefficient DMUs	58

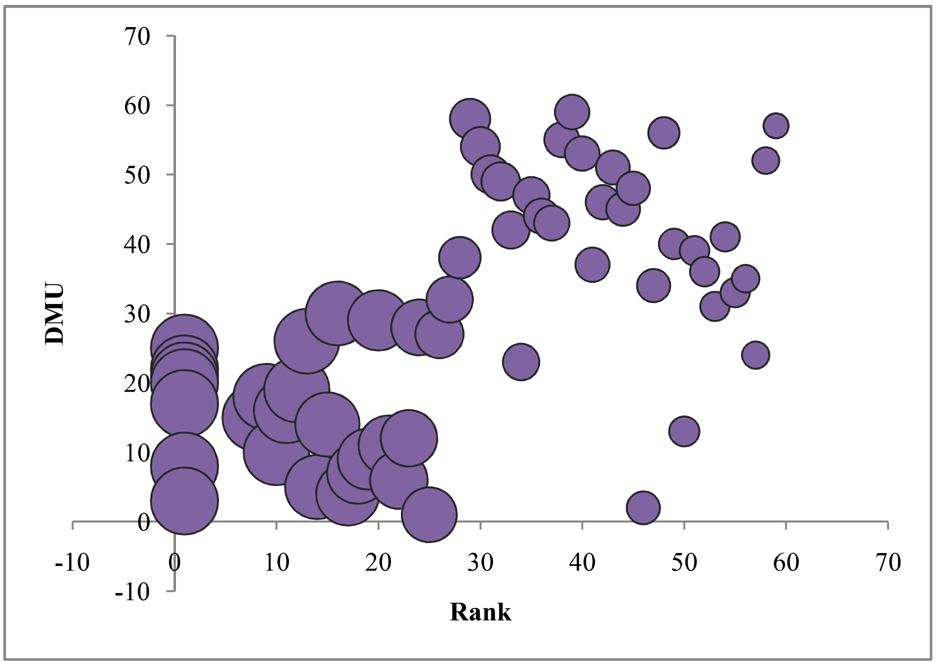

Figure 43: Efficiency scores, DMUs and Ranks of all water bodies

Table 29shows the results of DEA analysis and mentions the numbers of efficient and inefficient tanks in the study area. The efficiency scores and ranks have been presented in Figure 43. Out of 65water bodies, 7 water bodies have the efficiency score1 and ranked 1. Almost 13 water bodies are close to the efficiency score 1. The average efficiency score of the water bodies has been calculated as 0.53. The minimum efficiency and standard deviation are 0.14 and 0.33 respectively. Sevenwater bodies which have achieved 100% efficiency are: Gajir Khal, Sodial Khal, Panchamer Khal, Prasadpur Khal, Gamatala Khal, Netaji Tank and Pathik Bhunia's Tank.

4.4 Famers' willingness to pay for irrigation water

To analyse famers' willingness to pay for irrigation water, total 300 farmer households have been surveyed in the selected sites of South 24 Parganas. Table 31 provides some information about the respondents and cultivated area. The average age of respondents is 49 years. Respondents are mainly household heads and farmers. Average Family size is 4.17, and working member per household is 2.46. Annual income is INR 80,000 per household. Most of the respondents reported that they can pay INR 225 per acre per year for irrigation water.

Table 30: Descriptive Statistics of the Surveyed Households

Descriptive Statistics	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age (years)	300	62	25	87	49.15	12.819
Schooling (years)	300	17	0	17	5.76	3.439
Family size (numbers)	300	7	1	8	4.17	1.399
Working members (numbers)	300	5	0	5	2.46	.919
Command area (bigha)	300	15.0	0.0	15.0	1.540	1.7835

Family annual income (lakh)	300	3.3	.3	3.5	.827	.3247
Willing to pay (Rs./acre/year)	300	600	0	600	225.00	176.006
Distance (meter)	300	2200	0	2200	300.08	310.666

To understand the factors/variables influencing farmers' WTP for irrigation water both multiple regressions model and binary logistic model have been used. For the multiple regression model, the dependent variable is the WTP amount per acre per year, and the 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 (table 30), expect water requirement.

The regression results are presented in table 31. The results show that model is fit for analysis and explains 41 percent of the variation in the data.

Table 31: Estimated Regression Coefficients for the Willing to Pay Model

Willing to Pay	*Coefficient*	*Std. Err.*	*t*	*Sig.*	*[95% Conf. Interval]*	
Age	1.336485	0.7076782	1.89	0.060*	-0.0563515	2.729322
Education	4.457555	2.560646	1.74	0.083*	-0.5822511	9.497361
Family size	-3.325169	6.724703	-0.49	0.621	-16.56058	9.910243
Working members	-3.376191	10.32425	-0.33	0.744	-23.69615	16.94377

Command area	16.21417	5.002567	3.24	0.001****	6.368226	26.06011
Family income	69.9932	28.35543	2.47	0.014**	14.18467	125.8017
Distance	0.0988866	0.0274135	3.61	0.000****	0.0449319	0.1528413
Water requirement	239.585	23.3171	10.28	0.000****	193.6928	285.4772
Constant	-159.9202	52.33577	-3.06	0.002***	-262.9263	-56.91411

Observations = 300; $F(8, 290) = 25.18$; Prob.> F = 0.0000; R-squared = 0.4099

**** $p < 0.001$, *** $p < 0.01$, **$p < 0.05$, * $p < 0.1$

Data Source: Estimated from Primary Survey, 2018

The results indicate that the command area, distance, water requirement, family income are significant variables and have higher positive coefficient values. It can be said that respondents with higher income, large command area, water requirement will pay more for irrigation water.

Binary logistic model has also been used to describe the farmer's decision on whether or not they agreed to pay for irrigation water. In this analysis, the dependent variable is the farmer's decision on WTP for the irrigation water, and it is 1 if the farmers are willing to pay and 0 for otherwise. The independent variables are same as multiple regression model (table 32).

The regression results are presented in table 32. The results show that model is fit for analysis and explains 22 percent of the variation in the data.

Table 32: Binary Logistic Regression for the Willing to Pay Analysis

Willing to Pay	*Coefficient*	*Std. Err.*	*z*	*Sig.*	*[95% Conf. Interval]*	
Age	0.027328	0.0171021	1.6	0.11	-0.0061914	0.0608474
Schooling	-0.0114882	0.059535	-0.19	0.08*	-0.1281746	0.1051983
Family size	-0.2235926	0.1628553	-1.37	0.17	-0.5427831	0.095598
Working members	-0.2099624	0.2739164	-0.77	0.44	-0.7468287	0.3269038
Command area	-0.1402252	0.1097935	-1.28	0.02**	-0.3554165	0.0749661
Family income	2.18679	1.116499	1.96	0.05**	-0.0015079	4.375087
Distance	0.0097984	0.0020508	4.78	0.00***	0.005779	0.0138179
Constant	-1.307585	1.25051	-1.05	0.30	-3.758539	1.143369

Observations = 300; LR chi2(7) = 56.19; Prob > chi2 = 0.0000; Pseudo R2 = 0.2218

** *p < 0.01, **p < 0.05, * p < 0.1

Data Source: Estimated from Primary Survey, 2018

The results from binary logistic regression are similar as multiple regression analysis, which is good for the study. The results show that command area, distance and family income are significant variables. It can be said that farmers' willingness to pay for tank water is expected to influence by farmers annual income, command area and distance from the field. In the case of other variables, they have expected signs, but are not significant.

It is understood that socio-economic aspects play crucial role in farmer's WTP for tank water. Education has two different types of effects on WTP for tank water. One is education sometimes offers exit options which is likely to reduce WTP. Another one is farmers with education can influence in the household and participate in the tank management related activities. This means farmers' WTP will be positively influenced by education. The age of the respondents is another important and critical for taking decisions on family and farm operations. Age normally reflects the experience of the respondents. The different sources of income positively influence the farmers participation in household and tank management activities and hence the WTP. If farmers have more income from different sources, then farmers likely to pay more for the tank water. The command area is expected to influence the WTP for tank water. Normally, the small and marginal farmers (working less than 6 months) who are totally dependent on tank water for irrigation may have higher WTP.

The study also reveals that the average value of WTP for the tank irrigation water is found to be considerably less than the opportunity cost of the irrigation water which is indicating the unsustainable use of irrigation water from the tank system at present. Therefore it can besaid that for both farmers' and government perspectives, sustainability of irrigation systems is very important in the present days.

4.5 Farmers'Participation in the Water Body Irrigation Management

Farmers' participation in irrigation management in saline zone is important in tank irrigation study. PCA or factor analysis method has been employed to reduce the set of 13 decision variables to the key decision making variables.

This new set of variables, or factors, can be interpreted as farmer's decisions for managing irrigationsystem. The description of the variables used in the present study is provided intable 33.

Table 33: Descriptive Statistics of Selected 13 Variables of Farmers' Participation

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Catchment	300	2.0	5.0	3.318	.7102
Water Supply	300	1.0	5.0	2.957	.6813
Control	300	1.0	5.0	2.613	.7591
Effort	300	1.0	4.0	2.389	.6788
Water Sharing	300	1.0	4.0	2.168	.7162
Channel	300	1.0	4.0	1.725	.7130
Maintenance	300	1.0	4.0	1.668	.6616
Sluice	300	1.0	3.0	1.564	.7003
Water Spread	300	1.0	4.0	1.543	.7369
Cooperation	300	1.0	3.0	1.282	.5034
Panchayat	300	1.0	4.0	1.279	.6172
Public Fund	300	1.0	3.0	1.039	.2285
Decision Making	300	1.0	3.0	1.061	.2538

Source : Estimated from Primary Survey Data

Table 34: Correlation Matrix of Selected Variables of Farmer's Participation for PCA

Correlation Matrix[a]

	Catchment	Water Supply	Control	Effort	Water Sharing	Channel	Maintenance	Sluice	Water Spread	Cooperation	Panchayat	Public Fund	Decision Making
Catchment	1.000	.662	.408	.463	.296	.374	.367	.305	.276	.217	.122	.188	.070
Water Supply	.662	1.000	.507	.547	.399	.469	.451	.417	.237	.201	.138	.264	.201
Control	.408	.507	1.000	.406	.415	.406	.397	.217	.224	.363	.231	.399	.272
Effort	.463	.547	.406	1.000	.476	.481	.560	.463	.385	.369	.210	.201	.153
Water Sharing	.296	.399	.415	.476	1.000	.528	.509	.337	.347	.304	.176	.288	.140
Channel	.374	.469	.406	.481	.528	1.000	.676	.543	.306	.242	.015	.068	.095
Maintenance	.367	.451	.397	.560	.509	.676	1.000	.590	.502	.486	.235	.086	.120
Sluice	.305	.417	.217	.463	.337	.543	.590	1.000	.417	.298	.148	.085	.108
Water Spread	.276	.237	.224	.385	.347	.306	.502	.417	1.000	.609	.517	.064	.053
Cooperation	.217	.201	.363	.369	.304	.242	.486	.298	.609	1.000	.646	.339	.174
Panchayat	.122	.138	.231	.210	.176	.015	.235	.148	.517	.646	1.000	.252	.189
Public Fund	.188	.264	.399	.201	.288	.068	.086	.085	.064	.339	.252	1.000	.329
Decision Making	.070	.201	.272	.153	.140	.095	.120	.108	.053	.174	.189	.329	1.000

a. Determinant = .003, Source: Own Estimation Based on Primary Survey data

Table 34 shows the descriptive statistics of selected 13 variables of farmer's participation in irrigation management. The range of each variable varies from 1 to 5. Most of the respondents agreed that catchment condition is good and water supply is adequate. Mean value of four variables – co-operation, Panchayat, public fund and decision making is close to 1 which indicates that respondents are not agreed with the statements asked during the primary survey or in other words, respondents are dissatisfied. The correlation matrix of selected variables is presented in table 34. It is found that the variables are not highly correlated with each other.

Table 35: KMO and Bartlett's Test for PCA

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.846
Bartlett's Test of Sphericity	Approx. Chi-Square	1560.124
	df	78
	Sig.	.000

The Kaiser-Meyer-Olkin (KMO) test suggests that there is no multi-collinearity issue in the data and the sampling adequacy is perfect for the study. The determinant of the correlation matrix (0.003) and Bartlett's (1954) Test of Sphericity (0.000) indicate that PCA or factor analysis is appropriate for the data (table 35).

In this analysis, threecomponents or factors with an eigenvalue more than 1.0 have been retained (table 36). The varimax (orthogonal) rotation has been opted to improve the interpretability of factors and presented in table 36.

Table 36: Total Variance Explained in PCA

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.049	38.835	38.835	5.049	38.835	38.835	3.993	30.712	30.712
2	1.682	12.941	51.776	1.682	12.941	51.776	2.321	17.852	48.564
3	1.442	11.090	62.866	1.442	11.090	62.866	1.859	14.302	62.866
4	.918	7.063	69.929						
5	.768	5.905	75.834						
6	.589	4.533	80.367						
7	.541	4.159	84.526						
8	.465	3.576	88.102						
9	.391	3.008	91.110						
10	.369	2.841	93.951						
11	.280	2.152	96.103						
12	.277	2.130	98.233						
13	.230	1.767	100.000						
Extraction Method: Principal Component Analysis.									

Source: Own Estimation Based on Primary Survey Data

Table 37: Rotated Component Matrix in PCA

Rotated Component Matrix[a]			
	Component		
	1	2	3
Catchment	**.641**	-.023	.281
WaterSupply	**.730**	-.056	.385
Control	.486	.116	**.591**
Effort	**.710**	.218	.179
WaterSharing	**.614**	.194	.226
Channel	**.826**	.059	-.039
Maintenance	**.766**	.384	-.051
Sluice	**.687**	.264	-.128
WaterSpread	.373	**.769**	-.095
Cooperation	.218	**.830**	.243
Panchayat	-.030	**.828**	.269
PublicFund	.058	.157	**.792**
DecisionMaking	.041	.087	**.641**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 6 iterations.			

Source: Own Estimation Based on Primary Survey Data

The results of rotated component matrix is presented in Table 37. Three factors account for 62.87 percent of the total variation in the data. For the first factor (38.84%), channel, maintenance, water supply, effort have shown markedly higher positive loadings, while variables like Panchayat, public fund, decision making have shown negative and low positive factor loadings. It can be said that well-maintained channels, proper maintenance, adequate water supply, sufficient effort are very much needed in irrigation management. This factor can be interpreted as the most important consideration of farmers in water body irrigation management. This factor can be labelled as *proper maintenance of tanks*. The second factor explains 12.94 percent of the total variation in the data. The second factor is far less important than the first factor. Variables like cooperation, water spread and Panchayat have shown positive loadings for second factor. It means that good co-operation and good water spread area and the local Panchayat have active role in water body maintenance. This factor can be labelled as*good co-operation.* The second factor explains 11.09 percent of the total variation in the data.Variables like public fund, control, and decision making have shown positive loadings. This factor can be treated as*strength ofdecision making*.