

A Study on Growth of Irrigated Area under Groundwater in Some Districts of West Bengal in India

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Abstract Irrigation is one of the important inputs for enhancing the level of productivity of crops. West Bengal is well endowed with ground water. Historically, groundwater and surface water irrigation have played an important role in West Bengal's agriculture. The study has been conducted in respect of some districts selected on the basis of percentage increase in irrigated land in various districts of West Bengal. The study is based mainly on secondary data. Data used in the study are mostly taken from secondary sources such as Economic Review, Statistical Abstract of Bureau of Applied Economics and Statistics, Government of West Bengal. Data pertain to agricultural years during the period from 1990-91 to 2010-11. The study has been carried out with the objectives of finding growth of area under groundwater irrigation in the districts under study and comparing it with irrigated area under surface water. The results of the study indicate a positive compound growth rate of area irrigated by ground water during the period from 1990-91 to 2010-11. Negative growth rate has been observed in case of area under surface irrigation during the same period of time. These mostly attribute to increase in areas under boro paddy, vegetables and other irrigated crops.

Keywords Groundwater irrigation, Compound growth rate, Surface irrigation, Gross cropped area, Sustainable basis

Today human civilization cannot be thought without groundwater. The total fresh water used for human activity is drawn partly from surface water and partly from ground water sources. In India, the aggregate replenishable groundwater potential has been estimated to be 431 km³ per year. Out of total groundwater potential, 71 km³ of water is used for industrial and domestic purposes. (Sengupta, R. 2001). Water requirement of one third of world population is met up by rechargeable ground water sources. So, it is quite natural for human society to be much concerned with reasonable use of it. Question arises as to how reasonable use of groundwater is determined. There is inter-generational difference in the use of groundwater. Moreover, there is disparity in the use of ground water between developing and developed economies. There is also intra-economy difference in the use of it. On per capita basis use of ground water for domestic purpose is higher in urban society than in rural society. Each of the households either in urban and rural areas has no equal access to this important natural resources. Use of groundwater is increasing for domestic and production purposes. Groundwater is being widely used for crop production. Undoubtedly agricultural productivity of irrigated land is higher than that of un-irrigated land. Present study is attempted with the main objectives of finding

growth of irrigated area under groundwater in some districts of West Bengal in India.

1. Methodology

The study has been conducted in respect of some districts selected on the basis of percentage increase in irrigated land in various districts of West Bengal. The study is based mainly on secondary data. Data used in the study are mostly taken from secondary sources such as Economic Review, District Statistical Handbook, Statistical Abstract of Bureau of Applied Economics and Statistics, Government of West Bengal in India. Tabular method of analysis has been extensively used in the study. Beside this, Compound Growth rates of area under surface water irrigation and ground water irrigation has been estimated in this study. Data pertain to agricultural years during the period from 1990-91 to 2010-11.

Formula of Compound Growth Rate:

$Y = ab^x$, where, a is constant, $(b-1) \times 100$ is a compound growth rate percent per annum, x is time period. The above equation may be converted into a linear equation in logarithmic term as follows: $\log y = \log a + x \log b$, $\log y = Y$, $\log a = A$, $\log b = B$.

Then the equation is converted to, $Y = A + xB$

To obtain A and B the known normal equations can be formed. These are:

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$$\sum Y = NA + B\sum x \quad (1)$$

$$\sum xY = A \sum x + B \sum x^2 \quad (2)$$

Whereas, a = Antilog A

b = Antilog B

2. Results and Discussion

In Table 1, data on area under surface water irrigation and ground water irrigation in Burdwan, Nadia, Hoogly and Birbhum districts of West Bengal are presented. On the basis of this dataset compound growth rates of area under surface water irrigation and ground water irrigation have been estimated for individual districts under study and for combined areas under these two sources of irrigation.

Compound growth rates of area under surface water irrigation and ground water irrigation in four districts under

study are presented in Table 2. It is found that areas under surface water irrigation in Burdwan and Birbhum districts have recorded negative compound growth rate to the extent of 0.25 and 0.90 percent per annum respectively during a period from 1993-94 to 2010-11. But in the case of Nadia and Hoogly districts irrigated areas under surface water are found to record positive compound growth rates to the extent of 4.51 and 0.85 percent respectively. It is observed that areas under groundwater irrigation in all the districts have recorded positive compound growth rates. These are found to be 12.13, 0.62, 1.80, and 20.65 percent for Burdwan, Nadia, Hoogly and Birbhum districts respectively. However, for combined area compound growth rates have been estimated to be negative (0.16 percent) for the area under surface water irrigation and positive (1.66 percent) for the area under groundwater irrigation.

Table 1. Area ('000 ha) under surface water irrigation and ground water irrigation in the districts under study

Years	Districts								Total	
	Burdwan		Nadia		Hoogly		Birbhum			
	ASI	AGI	ASI	AGI	ASI	AGI	ASI	AGI	ASI	AGI
1993-94	324.00	-	5.00	156.30	123.43	59.00	300.80	1.42	753.23	216.72
1994-95	322.00	-	5.00	157.20	120.42	59.00	201.93	0	649.35	216.20
1995-96	329.00	-	5.00	160.50	136.39	59.00	239.60	0.33	709.99	219.83
1996-97	270.00	16.00	5.00	169.80	87.78	59.01	208.89	0.33	571.64	245.14
1997-98	307.00	17.00	5.00	169.80	182.93	32.26	212.40	0.35	707.33	219.41
1998-99	323.00	19.00	5.00	192.40	164.89	153.45	224.63	43.59	717.52	408.44
1999-00	329.50	19.00	16.30	192.40	163.24	154.90	223.98	43.77	733.02	410.07
2000-01	305.88	18.00	15.70	196.94	153.08	168.27	226.66	46.77	701.32	429.98
2001-02	282.50	19.52	14.73	189.73	164.91	168.59	196.63	46.78	658.77	424.62
2002-03	324.06	23.42	12.01	188.75	169.74	143.80	209.73	46.68	715.54	402.65
2003-04	317.29	23.60	20.49	188.75	183.07	159.51	218.04	53.20	738.89	425.06
2004-05	305.47	13.12	20.12	181.20	184.31	153.88	209.42	53.05	719.32	401.25
2005-06	300.56	22.43	20.58	192.22	180.12	154.99	185.17	53.00	686.43	422.64
2006-07	307.79	23.86	20.79	197.05	170.91	153.92	209.94	52.96	709.43	427.79
2007-08	320.05	21.92	20.24	190.94	191.93	153.22	230.95	46.10	763.17	412.18
2008-09	290.58	23.00	20.61	191.00	156.83	65.09	212.68	50.20	680.70	329.29
2009-10	306.23	19.04	11.71	199.45	153.76	78.04	191.38	50.00	663.08	346.53
2010-11	257.63	20.35	11.71	196.37	131.45	78.04	133.02	49.45	533.81	344.21

Source: Statistical Abstract, Economic review, District statistical Handbook (Burdwan, Hoogly, Nadia and Birbhum), Bureau of Applied Economics and Statistics, Govt. of West Bengal, (from 1995-96 to 2010-11)

N.B: i) ASI stands for area under surface water irrigation and AGI stands for area under groundwater irrigation.

Table 2. Compound growth rates (percent per annum) of area under surface water irrigation and groundwater irrigation in the districts under study during 1993-94 to 2010-11

Area under different districts under study								Combined	
Burdwan		Nadia		Hoogly		Birbhum			
ASI	AGI	ASI	AGI	ASI	AGI	ASI	AGI	ASI	AGI
-0.25	12.13	4.51	0.62	0.85	1.80	-0.90	20.65	-0.16	1.66

Crops require water for growth and production. Almost all the crops furnished in Table 3 are rainfed ones in the district under study and in West Bengal as a whole. Crops like boro paddy and potato are grown in irrigated condition. Some oilseed crops and vegetables in rabi season are also grown with irrigation. It is found that area under these crops in 2010-11 has increased as compared to the allocation of land in 1990-91. A gradual increase in the area of land under vegetable crops is found to occur during the period between

2000-01 and 2005-06. On the other hand, areas under the crops which are grown as rainfed ones have declined in 2010-11. Use of surface water as explicit in Table 2 has declined during the period from 1993-94 to 2010-11. On the other hand, area under groundwater irrigation has been extended in the same period for increased allocation of land to irrigated crops.

Water requirements of different crops in West Bengal are presented in Table 4.

Table 3. Combined area ('000 hectares) under various types of crops in the districts under study

Years	Aus paddy	Aman paddy	Boro paddy	Cereals	Pulses	Oilseeds	Potato	Fiber crops	Sugarcane	Vegetables	GCA
1990-91	128.50 (6.71)	1049.90 (54.86)	319.20 (16.68)	1562.80 (81.66)	86.00 (4.49)	208.80 (10.91)	106.30 (5.55)	163.30 (8.53)	3.80 (0.20)	NA	1913.69 (100.00)
1995-96	124.20 (5.06)	1033.80 (42.09)	448.10 (18.24)	1679.00 (68.36)	59.90 (2.44)	187.30 (7.63)	328.90 (13.39)	148.20 (6.03)	4.30 (0.18)	-	2456.17 (100.00)
2000-01	86.40 (3.65)	730.20 (30.87)	507.70 (21.46)	1425.90 (60.28)	84.10 (3.56)	236.10 (9.98)	139.00 (5.88)	172.40 (7.29)	3.00 (0.13)	208.43 (8.81)	2365.36 (100.00)
2005-06	75.30 (2.90)	1036.70 (39.89)	471.20 (18.13)	1665.50 (64.90)	68.70 (2.64)	212.70 (8.18)	154.90 (5.96)	167.20 (6.43)	3.50 (0.13)	234.75 (9.03)	2598.66 (100.00)
2010-11	64.80 (2.72)	834.70 (34.98)	440.50 (18.46)	1416.70 (59.38)	66.30 (2.78)	230.30 (9.65)	178.50 (7.48)	154.40 (6.47)	2.60 (0.11)	271.43 (11.38)	2385.96 (100.00)

Source: Statistical Abstract, Economic review, District statistical Handbook (Burdwan, Hoogly, Nadia and Birbhum), Bureau of Applied Economics and Statistics, Govt. of West Bengal, (from 1995-96 to 2010-11)

N.B: i) NA stand for not available.

ii) GCA stands for Gross Cropped Area.

iii) Figures in parenthesis indicate percentage of GCA.

iv) Areas under some other crops has not been shown in the table.

Table 4. Water requirement of different crops in West Bengal

Crops	Water requirement(ha.cm)
Autumn(Aus) paddy	88
Winter (Aman) paddy	200
Summer (Boro) paddy	175
Wheat	35
Potato	50
Mustard	32
Lentil	24
Green gram	24
Tomato	40
Brinjal	65
Okra	60
Beans	45
Beets	38
Cabbage	40
Cauliflower	46
Onion	36
Sugarcane	120

Source: i) Principles of Crop Production by Chakraborty and Mondal(4)

ii) Agriculture Research Data Book, Watershed Management of India, JVS Murthy, 1995

The Table 5 displays a comparative study of irrigated areas under surface water and ground water as percentage of gross cropped area. These are presented at an interval of 5 years from 1995-96 to 2010-11. In Burdwan and Birbhum districts irrigated areas under surface water as percentage of gross cropped area (GCA) are found to be invariably higher than those under groundwater in different years. Irrigated area under surface water as percentage of GCA has declined and irrigated area under groundwater as percentage of GCA has increased in both the districts during 1995-96 to 2010-11. A reverse picture is noted in the case of Nadia district. Irrigated area under surface water as percentage of GCA has slightly increased and irrigated area under groundwater as percentage of GCA has decreased to a large extent. In Hoogly district irrigated areas under surface water as percentage of GCA is found to be higher than those under groundwater in 1995-96, 2005-06, and 2010-11. In 2005-06 irrigated area under groundwater as percentage of GCA is observed to be higher than that under surface water. Irrigated

area under surface water is found to decrease slightly during 1995-96 to 2010-11. But irrigated area under groundwater in this district has increased slightly in this period. Combined irrigated areas under surface water are found to be higher than those under groundwater. Both the irrigated areas under surface water and groundwater as percentage of GCA are found to decline during this period with record of different directions of change in the intermediate years.

Percent irrigated areas under surface water and ground water are displayed in Table 6. In all the districts except Nadia percentage area under surface water irrigation has declined during the period from 1995-96 to 2010-11. In these districts percentage of area under groundwater has increased during this period. A reverse picture is noted in case of Nadia district. As a whole, it is observed that the percentage of area under surface water has declined and the area under groundwater has increased during the same period. It clearly indicates that dependence of the farming community on ground water is increasing for growing crops.

Table 5. A comparison of irrigated areas under surface water and ground water as percentage of gross cropped area

Year	Districts under study														
	Burdwan			Nadia			Hoogly			Birbhum			Combined		
	GCA	Percentage of irrigated area under		GCA	Percentage of irrigated area under		GCA	Percentage of irrigated area under		GCA	Percentage of irrigated area under		GCA	Percentage of irrigated area under	
		SWI	GWI		SWI	GWI		SWI	GWI		SWI	GWI		SWI	GWI
1995-96	771.83	42.63	0.00	702.25	0.71	22.86	491.76	27.74	12.00	490.33	48.87	0.07	2456.17	28.91	8.95
2000-01	788.63	38.78	2.28	721.63	2.18	27.29	396.38	38.62	42.45	458.67	49.42	10.20	2365.36	29.65	18.18
2005-06	825.03	36.43	2.27	730.46	2.82	26.31	528.67	34.07	29.32	514.50	35.99	10.31	2598.66	26.41	16.26
2010-11	749.39	34.38	2.27	670.63	1.75	3.90	544.59	24.14	14.33	421.35	31.57	11.74	2385.96	22.34	7.29

Source: Statistical Abstract, Economic review, District statistical Handbook (Burdwan, Hoogly, Nadia and Birbhum), Bureau of Applied Economics and Statistics, Govt. of West Bengal, (from 1995-96 to 2010-11)

N.B: i) SWI stand for Surface water irrigation.

ii) GWI stands for Ground water irrigation.

iii) GCA stands for Gross Cropped Area.

Table 6. Percentage of irrigated area under Surface water and ground water

Year	Districts								Combined	
	Burdwan		Nadia		Hoogly		Birbhum			
	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW
1995-96	100.00	0.00	3.11	96.89	69.81	30.19	99.86	0.14	76.36	23.64
2000-01	94.42	5.58	7.38	92.62	47.50	52.50	82.89	17.11	61.99	38.01
2005-06	93.05	6.95	9.67	90.33	51.01	48.99	77.75	22.25	61.89	38.11
2010-11	92.68	7.32	5.63	94.37	62.75	37.25	72.90	27.10	60.80	39.20

3. Conclusions

Use of surface water is declining and ground water is increasingly used in crop production. Area of agricultural land is at low ebb owing to its increased allocation for non-agricultural purposes. On the other hand, increase in population calls for expansion of agricultural output. This is not possible without use of irrigation water either from water bodies on the surface or from the stock of ground water. Considering the interest of both present and future generations attention of academicians, planners needs to be directed towards use of ground water on sustainable basis. Simultaneously this entails for promoting various sources of surface water.

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