Original Research Article

Socio Economic Factors Responsible for Groundwater Consumption in Purba Bardhaman District of West Bengal

Abstract

Groundwater is the biggest freshwater reservoir in the world. More than 95% of the unfrozen water comes from groundwater. Factors responsible for groundwater consumption by rice and vegetable growers, Groundwater market, have been included in the study. For the study, Purba Barddhaman district was selected purposively considering the pattern of agriculture and extent groundwater use in the state. One community development block from the district has selected based on crop diversity, type of irrigation, amount of water extraction for irrigation purposes. From the selected block a big parcel of cultivating land (*Math*) were again selected randomly keeping the consideration of homogeneity in lad type, soil type, type of crops, variety and seasons. Farmers' knowledge level, Farmers' attitude towards irrigation, economic motivation, improved water extraction mechanism and method of irrigation are the major contributing factors in predicting the amount of groundwater consumption when crop and land situation are constant.

Keywords

Groundwater, socioeconomic, Irrigation

Introduction

Groundwater is the biggest freshwater reservoir in the world. More than 95% of the unfrozen water comes from groundwater. Groundwater is an essential part of the hydrological cycle and is a valuable natural resource providing a primary source of water for agriculture, domestic, and industrial uses throughout the world. Nearly half of all drinking water in the world and about 43% of all water effectively consumed in irrigation is sourced from groundwater. Groundwater is vital for sustaining many streams, lakes, wetlands, and other dependent ecosystems (UNESCO, 2015). [1]

On an average, Globally71% of the total extracted groundwater is used in Agriculture and it is 89% for India. The water use efficiency in India is low as compared to other sectors. It is estimated that irrigated agriculture contributes to 70% of India's food grain production in which groundwater plays a major role. At an aggregate level, India exploits about 58 per cent of annual utilizable potential. However, groundwater over-exploitation is a major concern in certain states of the country like Punjab (145 per cent), Rajasthan (125 per cent) and Haryana (109 per cent) (CGWB, 2004) [2] . Most of the blocks in these states have been classified as over exploited or critical blocks implying that water is being extracted at an unsustainable level. Further, the numbers of block in which, officially, the creation of wells must completely stop are scaling new heights every year. How India manages its groundwater resources in the future will clearly have very serious implications on the growth and development of the agricultural sector in general and on food security in particular.

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Ground water is the largest source of fresh water in West Bengal that is occurs in saturated zone of variable thickness and depth, below the earth surface. In West Bengal most of the local or urban area, people, centre and headquarter depends on the ground water. Agriculture in West Bengal is dependent on irrigation during the dry eight months from mid-October to mid-June when rainfall is minimum. Groundwater supplies about 75% of dry season irrigation and almost all municipal water supplies. The State of West Bengal, lying in the lower Indo-Gangetic Basin is the single largest contributor of rice (15-16%) production in India. Of the three rice growing seasons in West Bengal, summer rice is exclusively irrigated and it alone accounts for 60% of total rice from 25 % of net rice area of West Bengal. Again, out of 50% net irrigated area, 70-80% area is irrigated by taping underground water through D.T.W., S.T.W., and Dug well etc. During late 70's to mid 90's there was a noticeable increase in irrigated area and it was mostly due to rise in summer rice area. At present, India is the second highest rice producer in the world (103.5 MT). West Bengal is predominantly an agricultural state and its economy depends on agriculture. In West Bengal, geoclimatic variations and agriculture's dependence on rainfall have resulted in three distinct rice growing seasons: kharif rice (June/July to November/December); autumn rice (November/December to Feb/March); and summer or summer rice (Feb/March to May/June). The natural catastrophe like floods, droughts etc. hinder the agricultural development. Flood and drainage congestion generally destroy the Kharif crop in many parts of West Bengal. Therefore, farmers especially the small farmers have to obtain summer rice as a second crop, and for this they have to depend upon groundwater. Water wells have helped small farmers to obtain a second (and even third) crop per year, and made irrigation possible beyond the anal command of government irrigation projects. As a result of technological advances, groundwater use has spread rapidly in recent decades, increasing reliability of irrigation supplies, encouraging crop diversification and expanding the cropping season. Even in cases where groundwater development is costly the poor can benefit from buying water in informal groundwater markets (Saleth, 1998) [3]. Groundwater pumping has also brought immense benefits for safe drinking water supplies, particularly in rural areas. More than 1.5 billion people in the world rely on groundwater for their primary source of drinking water (Pimentel *et al*., 2004) [4].

Often neglected, but nonetheless very important, are the social and economic impacts of intensive groundwater use. Such impacts may be either positive or negative depending on the factors, such as nature of the aquifer, pressure on the aquifer, recharge rates, types of use, climate and so on. However, most frequently, it is seen that at least in the short and medium term, impact of groundwater use is positive and includes such benefits as increased productivity, food security, job creation, livelihood diversification and general economic and social involvement. In the long run, depending on the factors as mentioned above, the impact might be negative, such as permanent lowering of the water table, deterioration of water quality, saline intrusion in coastal areas, emergence of arsenic problem, rise in lifting cost of irrigation water, squeezing of command area and area under crops, reduced crop output, crop diversification towards superior and cash earning crops, and thereby affecting rural employment, sustainability of agriculture system and food security of the country. The key challenge then becomes to manage risk in such a way as to minimize chances of long term negative impacts without seriously damaging short- term and medium-term benefit flow. In order to understand and manage risk, it is important to understand the social and economic dimensions of groundwater use, and its benefits and dis-benefits.

In this broader context, this paper tries to give an insight into several facts associated with groundwater consumption in West Bengal. It explores different factors responsible for groundwater consumption, changes happened due to groundwater irrigation characteristics of groundwater buyers and sellers.

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2. Research Methodology

Locale of Research

The study was conducted in the district named Purba Bardhaman in West Bengal. It focuses Bhatar Block of Purba Barddhaman district. The farmers who are using groundwater for the irrigation purpose was considered as the respondents of the present research work.

Pilot Study

Before taking up actual study, a pilot study was conducted to understand the areas, it people, institutions, communication and extension system and the knowledge, perception level and attitude towards groundwater consumption.

Sampling Design

The state, district, sub divisions were selected using non-probability sampling technique called purposive sampling and the respondents were selected using simple random sampling method. The block was selected purposively. Total 80 respondents were selected randomly for final data collection.

Preparation of Interview schedule

On the basis of findings of pilot study a preliminary interview schedule was formed with the help of literature, and by the assistance of Chairman of Advisory Committee and subsequent discussion with the members of the advisory Committee.

Finalizing of schedule after Pre-Testing

The draft schedule for collection of data, incorporating the tools and techniques of different variables were presented twice each time on respondents. The quantification was done for each and every variable after operationalized them. Before starting final data collection, entire schedule was pretested for elimination, addition and alternation with respondents of the study area.

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Techniques of Field Data Collection

This was personally interviewed during the growing season of Boro paddy. The items were asked in Bengali as well as English version in a simple term so that the members could understand easily. The entries were done in the schedule by student investigator himself at the time of interview.

Variables and their measurements

After reviewing various literature related to the field of study and consultation with the respected chairman of Advisory Committee and other experts, a list of variables was prepared. On the basis of selected variables, a schedule was formed. Analyses were done by SPSS V20.0 software.

Table- 1 Measurement of Dependent and Independent Variables

Dependent variable	Test used in the study

Amount of groundwater extracted by a farmer in a particular season for irrigation	***Amount of water (m^3 / per hour) = Running hour x 11.36*** (Groundwater users used groundwater lifted by pump of 5 hp with 3" diameter of delivery, and the average flow rate of the WEMs is 0.19 m^3/min i.e. 11.36 m^3 per hour.)
Independent variables	
Age(X_1)	Chronological Age
Education (X_2)	Socio-Economic Status Scale (Pareek & Trivedi,1964)
Topography(X_3)	Test developed in this Study
Irrigation Water Management(X_4)	Test developed in this Study
Method of Irrigation(X_5)	Test developed in this Study
Improved water extraction mechanism(X_6)	Test developed in this Study
Economic Motivation(X_7)	Economic motivation scale(Moulik,1965)
Production orientation(X_8)	Management Orientation Scale (Samanta,1977)
Participation in water market(X_9)	Test developed in this Study
Other source of surface water for irrigation(X_{10})	Test developed in this Study
Knowledge level(X_{11})	Test developed in this Study
Attitude towards Groundwater consumption(X_{12})	scale developed in this Study

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3. Results and Discussion

3.1 Mean Standard Deviation and Variance of 12 Independent Variables.

Table- 2 presents the distribution of 12 independent variables in terms of their Mean**, Standard Deviation** and **variance.** The mean age of the respondents was about 49 years exhibiting a

standard deviation of 8.933 and variance was 79.804. The variable Education was recorded with a mean of 4.15 with a standard deviation of 1.51 thus the variance was 2.285 , the variables topography and irrigation water management were measured with mean values 2.275 & 2.55 exhibiting standard deviations 0.452 & 0.986 and variance 0.204 & 0.972 respectively. The mean value of method of irrigation was recorded as 3.395 exhibiting a standard deviation of 0.221 and variance 0.049. The improved water extraction mechanisms showed the mean value of 2.475 with the standard deviation of 0.506 and variance representing 0.256. The psychological variables i.e. economic motivation, production orientation, knowledge level regarding irrigation, attitude towards irrigation, recorded the mean values of 6.25, 18.025, 82.875, 55.825 exhibiting the standard deviations of 0.707, 1.151, 3.763, 1.866 with the variance 0.50, 2.281, 14.163, 3.481 respectively. Finally the variables participation in water market and other source of irrigation showed the mean values of 0.450, 0.050 with exhibiting the standard deviations of 0.504 and 0.221 and the variance of 0.254, 0.049.

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Table 2 Mean Standard Deviation and Variance of 12 Independent Variables

Variable	**Mean**	**Std. Deviation**	**Variance**
Age(x_1)	49.125	8.933	79.804
Education(x_2)	4.150	1.511	2.285
Topography(x_3)	2.275	0.452	0.204
Irrigation water management(x_4)	2.550	0.986	0.972
Method of Irrigation (x_5)	3.950	0.221	0.049
Improved Water Extraction Mechanism(x_6)	2.475	0.506	0.256
Economic motivation (x_7)	6.250	0.707	0.500
Production orientation(x_8)	18.025	1.510	2.281
Participation in water market(x_9)	0.450	0.504	0.254

Other sources of irrigation(x_{10})	0.050	0.221	0.049
Farmer's knowledge level regarding irrigation (x_{11})	82.875	3.763	14.163
Attitude towards irrigation(x_{12})	55.825	1.866	3.481

3.2 Coefficient of Correlation (r): Total amount of groundwater extracted (y) vs. 12 Independent variables.

According to the simple correlation i.e. Pearson correlation it was found that the variables except Age(X_1), Topography(X_3) Irrigation water management (X_4), Method of Irrigation(x_5), Production orientation(x_8), Other source of irrigation (X_{10}), other 6 independent variables had been found significant relationship with the dependent variable i.e. Amount of groundwater extracted by a farmer in a particular season for irrigation. These 6 independent variables had not any significant correlation with the dependent variable. Education (x2) was negatively significant at 0.05 level of probability it can be inferred that respondents having higher degree of Education the amount of water extracted was less for irrigation. Economic motivation (x_7) was positively significant at 0.05 level of probability with the dependent variable. Thus it can be said that respondents with higher economic motivation extract more groundwater for irrigation.

The independent variables Improved Water Extraction Mechanism (X_6) and Participation in water market(x_9) were positively significant at 0.01 level of probability with the Amount of Groundwater extraction. It indicates that more use of improved water extraction mechanism i.e. technologically advanced and buried deep underground the amount of groundwater extraction is more and the respondents who had participated in groundwater marketing extracted more groundwater.

The independent variable Attitude towards irrigation (X_{12}) was positively significant at 0.01 level of probability. That means farmers having higher degree of attitude towards irrigation extracted more groundwater for irrigation.

Independent variable Farmer's knowledge level regarding irrigation (x_{11}) was negatively significant at 0.05 level of probability it can be inferred that respondents having higher degree of knowledge of irrigation the amount of water extracted was less for irrigation.

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The findings of the study are on the line of the study made by **Srivastava *et al* (2009) [5]** while working on Uttar Pradesh.

Table-3 Coefficient of Correlation (r): Total amount of groundwater extracted (y) vs. 12 Independent variables.

Sl. No.	Independent Variables	'r' Value	Remarks
1	Age(x_1)	-.222	
2	Education(x_2)	-385	*
3	Topography(x_3)	.194	
4	Irrigation water management(x_4)	-.124	
5	Method of Irrigation (x_5)	.180	
6	Improved Water Extraction Mechanism(x_6)	.702	**
7	Economic motivation (x_7)	.316	*
8	Production orientation(x_8)	.287	
9	Participation in water market(x_9)	.679	**
10	Other sources of irrigation(x_{10})	.028	
11	Farmer's knowledge level regarding irrigation (x_{11})	-.317	*
12	Attitude towards irrigation(x_{12})	.465	**

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3.3 Stepwise Regression Analysis: Total amount of groundwater extracted (y) vs. 12 Independent variables.

It was also found that the independent variables Education(X_2) Improved Water Extraction Mechanism (X_6), and Attitude towards irrigation (X_{12}) had been retained after eliminating the other trivial variables in the preceding steps.

Improved Water Extraction Mechanism (X_5) recorded highest regression effect on the amount of groundwater extracted having the β value of 0.594. Thus representing a positive effect on the amount of groundwater extraction and with the unit change in this variable had contributed 4133.192 unit changes, which is also the highest contribution of all.

The variable Education (X_2) had a negative effect on amount of groundwater extraction exhibiting the β value of -0.252. A unit change in this variable had contributed 585.555 unit changes (Negatively) in the amount of groundwater extraction.

The variable Attitude towards irrigation (x_{12}) had a positive effect on amount of groundwater extraction exhibiting the β value of 0.286. A unit change in this variable had contributed 201.463 unit changes in the amount of groundwater extraction.

Here the R^2 value being 0.670, it is to infer that the 3 variables together explain 67.00% variation embedded with the predicted variable of amount of groundwater extraction.

Table 4 Stepwise Regression Analysis: Total amount of groundwater extracted (y) vs. 12 Independent variables.

Sl. No	Variables	Reg. coef. B	S.E. B	β	t value	R^2	The standard error of the estimate
1	Improved Water Extraction Mechanism(X_6)	4133.192	733.831	.594	5.632	**0.670**	**2134.18194**
2	Education(X_2)	-585.555	229.945	-.252	-2.547		
3	Attitude towards irrigation (X_{12})	539.464	201.463	.286	2.678		

r square: 67.00 per cent

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Conclusion-

In this research we found that the majority of the farmers are marginal and small farmer therefore they have to cultivate two or three crops in a year. Availability of groundwater throughout the year is enabling them to do so. Farmers cultivate boro paddy to a large area in Bhatar block of Purba Barddhaman district .This crop cannot be removed from the cropping

sequence as there is a strong marketing channel as well as the demand. Actually, farmers do not choose crops on the basis of water requirements, rather they choose crops based on water availability and estimated net returns. It was previously commented by **Sarkar and Das (2014) [6].** The farmers were not following efficient and judicious use of groundwater. Selling of water or becoming a water entrepreneur is an opportunity to earn and it helps in compensating the loss in farming (if any). However, for ensuring sustainable use of groundwater, knowledge and management aspects have to be given due attention.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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References

1. UNESCO, E. (2015). Global action programme on education for sustainable development information folder.

2. Dynamic ground water resources of India (CGWB report- published on March 2004)

3. Saleth, R. M. (1998). Water markets in India: Economic and institutional aspects.

4. Pimentel, D., Berger, B., Filiberto, D., Newton, M., Wolfe, B., Karabinakis, E. and Nandagopal, S. (2004). Water resources: agricultural and environmental issues. *Bioscience*, **54**(10): 909-918.

5. Srivastava, S.K., Kumar, R. and Singh, R.P. (2009). Extent of groundwater extraction and irrigation efficiency on farms under different water-market regimes in Central Uttar Pradesh. *Agricultural Economics Research Review*, **22**(347):87-98.

6. Sarkar, A. and Das, A. (2014). Groundwater IrrigationElectricity-Crop Diversification Nexus in Punjab Trends, Turning Points, and Policy Initiatives. *Review of Rural Affairs*, **22**: 64-73.