IMPACT OF GROUND WATER ON WHEAT PRODUCTION IN DISTRICT JHANG, PUNJAB, PAKISTAN

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ABSTRACT

Pakistan comes in a region where rainfall is untimely and not enough to support the requirements of crops. To meet ever-increasing food and fiber requirements of rapidly multiplying population, Pakistan's agriculture depends heavily on irrigation from surface and ground water resources. Canal water resources alone are not sufficient to meet crop water requirements. To overcome this deficiency, farmers exploit the ground water resources. In present study, concentration was given to quantify the impact of ground water on wheat production in District Jhang, Punjab, Pakistan. A production function was estimated by using the regression technique. Results of the study showed that tubewell irrigation accounts for about 19 percent of the total cost of production of wheat crop. The results also showed that land holding, use of fertilizer, experience of farming and sodium absorption ratio were major factors affecting gross value product (GVP) of wheat. Adjusted R^2 of the study was 0.59 which shows the goodness of fit of data. Significant F-test showed that results were overall significant. The findings of the study would help policy makers to formulate policies promoting wheat production through efficient and wise utilization of ground water resources.

Key Words: Ground water, Wheat, Productivity, Salinity

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INTRODUCTION

Water is the most important for human existence, from its drinking water requirements to the production of food and fiber. Since, Pakistan lies in a sub-tropical continental lowland semi-arid region where rainfall is untimely and not enough to support agriculture sector. To meet ever-increasing food and fiber requirement of rapidly growing population which is growing almost at 1.8 percent annually (Govt. of Pakistan, 2008), Pakistan's Agriculture has to rely on irrigation from surface and groundwater (Randhawa, 2002).

Pakistan has the largest canal irrigation system of the world. Despite this extensive canal irrigation system, the cropped area is over extended and water remains a limiting factor in the growth of agriculture. It is reported that one of the main factors of low agriculture production is the shortage of irrigation water and its poor management [Awan, 1979 and World Bank, 2004]. In recent years, water sources have emerged as one of the most critical themes of sustainable development, especially in arid countries of developing world like Pakistan. Considering that 70 percent of water usage in the world is for agriculture but in Pakistan this is as high as 95 percent (Rizvi, 2004). Thus the canal water resources are not sufficient to meet crop water requirements. To fulfill this deficiency, groundwater resources have been extensively exploited. Out of total irrigated acreage of 18.84 million hectares in Pakistan 7.79 million hectares are under canal irrigation and the rest are irrigated by underground water with major share of 7.7 million acres of canal plus tube wells (Govt. of Pakistan, 2008a). Table I shows that surface irrigation is the main source of irrigation as alone in Punjab more than 12 Mha of land are being irrigated fully or partially with surface irrigation water.

Table I. ***Irrigation sources in Pakistan***

	Total (Mha)	Canal (%)	Canal + Tubewell(%)	Tubewells (%)	Wells+Other (%)
Punjab	14.33	28.4	50.5	19.1	2
Sindh	2.34	94.8	--	5.2	--
NWFP	0.92	85.4	--	6.7	7.9
Baluchistan	1.17	41.9	38.7	28.4	11.1

Source: GoP 2007

There were about 250,000 public and 350,000 private tube wells working in various irrigated areas parts of country in the year 2000 (Alam, 2002), but the figures increased to 983312 in the year 2005-6 (Govt. of Pakistan 2008a) . The access to water in irrigation system (surface canals & tube wells) is tied to ownership of land in commanded area. The rigidity of such a system limits the productivity of surface irrigation and tube wells. The private tube wells are best solution where farmers have more control over the timing of water deliveries (Renfro and Sparling, 1986). The availability of irrigation water gives farmers greater flexibility and control in the amount and timing of water application and provide insurance against disasters with better water control with which agriculture productivity is likely to increase because of factors (1) Risk of production decline with improved water control (2) Farmers may use more inputs (3) Crop yield may increase and (4) Farmers may switch to more profitable but water sensitive crop (Meinzen-Dick, 1994).

However, the quality of ground water is poor in most areas of Pakistan. Its continuous use leads to soil degradation, which affects the crop yield, and create serious problem of salinization of productive lands. The paper aims at to study and report the effect of use of ground water on the productivity of wheat. Section II of paper discusses methodology followed by results and discussion in section III. The recommendations are given in the last part of the paper.

MATERIALS AND METHODS

The research was conducted to estimate the impact of groundwater on wheat productivity. District Jhang was selected for the study because the wheat was the major crop of that area and water quality of water is relatively better in the area than the surrounding areas. Moreover, district Jhang is a multi-crop area which depends heavily on the ground water for raring variety of crops. Data from the study area were collected during the year 2006-07. The study was based on primary data with sample size of 100 respondents from two villages (Chak No 197 J.B. and Chak No. 248 J.B.), i.e 50 respondents from each village. Different regressions techniques for production function i.e. Simple linear, Semi-log and double-log were tested but the results of best-suited technique (double-log) were best fit to the model. Log-log production models (or the Cobb-Douglas production function) have been used extensively in the literature for agriculture sector. Barker *et al.* (1985) had used the term log-log model interchangeably with Cobb-Douglas production function (CDPF). Gordon (1989), Zhang and Xue (2005) and Bhanumurthy (2007) had also employed the CDPF in their study.

The independent variables were selected as land holding, land preparation cost, cost of seed, cost of tube well irrigation, cost of canal irrigation, fertilizer cost, farming experience and value of sodium absorption ratio of ground water.

Functional Form of the Model

Double log production function is expressed in the form of equation as under:

$$\ln GVP = \beta_0 + \beta_1 \ln Hold + \beta_2 \ln L.Prep. + \beta_3 \ln S.cst. + \beta_4 \ln T.Well + \beta_5 \ln Canal + \beta_6 \ln Fert\_cst + \beta_7 \ln Exp. + \beta_8 \ln SAR + \varepsilon_t$$

Where,

lnGVP = Log of gross value of wheat (Rs./ha)
lnHold = Log of land holding of the respondent (ha)
lnL.Prep = Log of cost of land preparation (Rs./ha)
lnS.cst. =Log of seed cost (Rs/ha)
lnT.Well=Log of cost of ground water (Rs./ha)
lnCanal =Log of cost of canal irrigation (Rs./ha)
lnFert_cst = Log of cost of fertilizer (Rs./ha)
lnExp = Log of farming experience of the respondent (Years)
lnSAR = Log of sodium absorption ratio, from water test reports of laboratory
β_0 = Intercept coefficient
β_1- β_8 = Coefficients to be estimated
ε_t = Random error term

RESULTS AND DISCUSSION

Data collected by field survey was categorized and analysed in two ways. The data of variables were analyzed by specific (log- log) regression function and remaining was presented in tabular form. The facts about the socio-economic characteristics of the respondents, like age, education, and land holding revealed that about 40

percent of respondents were of age above 40 years. Literacy status of the respondents revealed that 42 percent of the respondents were illiterate in the study area. Whereas, only 20 and 13 percent respondents were having education level up to primary and middle level, respectively. There were 52 percent small, 27 and 21 percent medium and large farmers, respectively. It was revealed from survey that 3 percent farms were having clay loam soil and 21, 42 and 34 percent farms were having loamy, sandy loam and sandy soil, respectively. It was noted that there were 19 farmers out of 100 respondents, who used 5 numbers of cultivation for land preparation and 81 percent used more than 5 numbers of cultivations for land preparation. The data depicts that 2 percent farmers used irrigation less than 5 in number, 80 percent farmers used 5 numbers of irrigations and only 18 percent farmers out of total 100 respondents used more than 5 numbers of irrigations. It is also clear that 68 percent of total irrigated area was irrigated by tube well source alone, while 4 and 32 percent farms were irrigated by canal and canal plus tube well, respectively. The data shows that 15 percent farmers used 0-1 bag of fertilizer per acre, 38 percent were using 2 bags per acre and 47 percent farmers were those who used 3 and above bags of fertilizer per acre. In case of seed rate used by farmer on per acre basis, majority of farmer i.e., 62 percent used seed rate between 45-50 kg per acre. About 25 and 12 percent were using 40- 45 and above 50 kgs. per acre respectively.

Table II indicates per acre cost of production along with percent of total cost for wheat crop in the study area. The results show that 27.20 and 18.71 percent cost was incurred on fertilizer and tube well irrigation for wheat production in year 2003-04. The remaining 1.73, 15.09, 3.98, 10.44, 8.04 and 12.03 percent expenditures were spent on irrigation, land preparation, chemical applications, seed, harvesting and threshing, respectively.

Table II. ***Cost of Production for Wheat Crop in Year***

Activities	Cost /ha (Rs.)	%
Land Preparation	1944	15.09
Sowing	0	0
Seed	1351.26	10.44
Fertilizer	3521.0	27.20
Chemical Applications	515.25	3.98
Canal Irrigation	224.13	1.73
Tube well Irrigation	2419.6	18.71
Harvesting	1040.40	8.04
Threshing	1592.10	12.03
Labor cost	323.86	2.50
Total	12943.14	100

Table III shows the revenue generated by the farmers of the study area for wheat cultivation. The average revenue generated was Rs. 12597.46 per acre. The average gross margin that farmers were receiving from an acre was Rs. 7226.83 per acre.

Table III. ***Revenue of wheat production***

Yield (kgs/ ha)	Price Rs./Kg	Straw (Kgs / ha)	Price Rs/ Kg	T. Revenue (Rs / ha)
2815	9.95	2810	0.86	30426

To determine the factors affecting the production of wheat, data was analyzed by using the double log (log-log) production function. Results of analysis with gross value of wheat product as dependent variable and costs of important inputs as independent variables are presented in Table IV.

The value of coefficient of land was .045 with positive sign and was significant at 99 percent confidence level. Results show that with 1 percent increase in land holding, output increases by .045 percent. The coefficient of cost of land preparation was positive with value of .0397. However it was non-significant. With 1 percent increase of seed cost, .1031 percent of gross value of wheat product increases, it was also non-significant. The coefficient of tube well irrigation shows that with increase of 1 percent cost there was .0712 percent decrease in gross value of wheat product. It was also non-significant with "t" value -0.87. The reason for this could be due to over utilization of ground water that disturbed the soil structure and plants did not grow healthy and resulted in low yield. If 1 percent of cost spent on canal irrigation increases, .084 percent gross value of wheat product increases, because the quality of canal water is very good and fit for irrigation. One percent increase of expenditures on fertilizer use increases 0.219 percent of gross value of wheat product. Whereas with one percent increase in experience of farmer, 0.039 percents decrease of gross value of wheat product was observed although was non significant. The negative sign could be due to the reason that old farmers did not adapt new technologies easily. The farmers of sampled area were

old and illiterate that is why they were strictly fallowing the old traditions. The results show that with one percent increase in the value of sodium absorption ratio, the GVP decreases by 0.045 percents. The result was significant at 90 % confidence level. With the increase in SAR water become unfit for irrigation and if applied destroys soil structure and hence decreased the productivity.

Table IV. ***Coefficients of Variables for GVP***

Variables	Coefficient	T. Value	Significance
Constant	3.44 (0.39)	8.64	0.000
lnHold	0.045 (0.017)	2.51	0.014
lnL.Prep	0.039 (0.038)	1.03	0.305
lnS.cst.	0.103 (0.093)	1.10	0.275
lnT.Well	-0.071 (0.082)	-0.87	0.390
lnCanal	0.084 (0.060)	1.40	0.165
ln Fert_cst	0.219 (0.036)	6.06	0.000
lnExp	-0.039 (0.019)	-2.10	0.039
ln SAR	-0.045 (0.018)	-2.45	0.017

Square (R^2) = 0.683 Adjusted R Square = 0.598
DW = 1.84 F. Value = 16.06

The value of R Square (R^2) was 0.68 and Adjusted R Square (R^2) was 0.598, showing that about 60 percent variation in the yield was explained by the predictor variables included in the equation. The overall results were also significant as was shown by F-value. Durbon-Watson (DW) statistics also showed that model was free from the problem of correlation. It is clear from results that ground water was decreasing the wheat yield but this decrease was non significant. The reason behind this was that water quality of the area was found satisfactory for irrigation by the tests of laboratory. The average values of three major parameters affecting the water quality i.e. Electro conductivity (EC), Sodium Absorption ratio (SAR) and RSC were 1.26, 5.71 and 1.70 respectively. The values should be in the range of 1-1.5, less than 10 and below 2.25 respectively for water best fit for irrigation. If any one of these values is not in a particular range then water should be used carefully. The result shows that overall quality of the ground water is good in the study area. It is clear from the results that increase in the use of ground water is decreasing wheat yield but this decrease is very nominal.

CONCLUSION AND RECOMMENDATIONS

Cost of tube well irrigation was the major component of the total variable cost of production of the wheat crop after the cost of fertilizer and analysis showed that increased use of tube-well water was not affecting the crop income significantly since the average water quality in the study area was within the normal range. On the other hand SAR value (since it was marginally within the limits) was significantly affecting the crop income. It was evident from these results that use of sub-standard ground water could actually reduce the wheat crop income if used without proper precautions.

The following policy recommendations could be forward for considerations:

i. The GVP of wheat in District Jhang could be increased by using recommended practices in the area.
ii. Efforts should be made to use available amount of canal water in an efficient manner to achieve maximum productivity.
iii. Poor quality of ground water is injurious to plant health; the farmers should keep in mind this thing that water quality of all areas is not fit for irrigation therefore before applying ground water its quality should be checked from laboratory.
iv. Farmer should be motivated for the conjunctive use of both water resources (Canal and Ground water). Because this gives better results (Meinzen-Dick, 1994).
v. The farmers in Jhang were using their own seed especially small farmers. They should be motivated to use certified seed of good quality for increasing the productivity.

vi. It was observed during study, that there was need for agricultural extension services to fill the gap between modern technology at research stations and that practiced by the majority of traditional farmers.

vii. Govt. should provide facilities of water and soil-testing laboratories at tehsil level, so that farmers could make better decision about water application and maintenance of soil fertility.

REFERENCES

Awan, N. M. 1979. Development of Private Tube Wells in Pakistan Using Locally Manufactured Equipment, Centre of Excellence in Water Resource Engineering (CEWRE) Lahore, Publ. No.K1. pp. 14-15.

Alam, S.M. 2002. Ground water Syndrome, Pakistan Water gateway, articles, http://www.waterinfo.net.pk

Bhanumurthi, K.V. 2002. Arguing a Case for the Cobb-Douglas Production Function, Review of Commerce Studies, 75-94, India.

Gordon, D. V. 1989. A Revenue Function Approach to the Measurement of Output Substitution Policies in Agriculture. J. Business & Econ. Statistics. 7(4): 483-487.

Govt. of Pakistan. 2008. Economic Survey 2007-8. Econ. Aff. Div., Ministry of Finance, Islamabad.

Govt. of Pakistan. 2008a. Agricultural Statistics of Pakistan 2006-07, Ministry of Food Agric. and Livestock (Econ. Wing) Islamabad.

Govt. of Pakistan. 2007. Agricultural Statistics of Pakistan 2005-06, Ministry of Food Agric. and Livestock (Econ. Wing) Islamabad

Meinzen-Dick, R. 1994. Ground Water Markets in Pakistan, Participation and Productivity, Research Report No. 105 Int. Food Policy Res. Instt. Washington, D.C.

Randhawa, H.A. 2002. Water Development for Irrigated Agriculture in Pakistan: Past Trends, Returns and Future Requirements, Investment in Land and Water, Proc. of the Regional Consultation, Bangkok, Thailand 3-5 October 2001, FAO, United Nations.

Rizvi, H. A. 2004. A Gateway to Water Information about Pakistan, Head, Edu., Comm. and Mgmt. Group, IUCAN. The World Conserv. Union Pakistan. http//:www.waterinfo.net.pk

Renfro, R .Z. H. and E.W. Sparling. 1986. Private Tube Wells and Canal Water Trade on Pakistan Punjab Watercourses, In Irrig. Investment Tech. and Mgt. Strategies for Dev. ed. E. W. Easter. Boulder Colo U.S.A. West View Press.

World Bank. 2004. Pakistan: Water Economy Running Dry, Report No. 34081-PK, Agric. and Rural Dev. Unit, The World Bank, Washington, D.C.

Zhang, T. and B. Xue. 2005. Environmental Efficiency Analysis of China's Vegetable Production. Biomed. Envir. Sci. 18: 21-30.