Research Article

Impact of Tubewell Irrigation on Agricultural Production in District Dera Ismail Khan, Khyber Pakhtunkhwa-Pakistan

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Abstract | An empirical study was conducted to investigate the role of tube well irrigation on overall agriculture production in District D.I. Khan during 2018. In this respect, only 100 sampled farmers were interviewed with the assistance of a well-designed structured questionnaire using simple random sampling procedure. Regression analysis as a statistical method was used to assess the impact of tube well irrigation on agriculture production, household annual income, poverty line, kinds of land, sources of irrigation and inputs used on land. The significant (P<0.05) impact of household annual income of farmers was observed on agriculture production. The significant (P<0.01) impact of household annual income of farmers had kept farming community above poverty line and the significant (P<0.05) relationships noticed between kinds of land and sources of irrigation, which in turn inducing farmers to become regular user of tube well irrigation. The significant (P<0.01) impact of inputs used on the adaptation of efficient networks of tube well irrigation in Dera Ismail Khan District. The results of the study concluded that those farmers who had used tube well irrigation as a source of irrigation in the area, benefited a great deal, and as a results their per household annual income were found sufficient enough to keep them above poverty line. Most of the farmers were of opinion that after the introduction of tube well irrigation, farmers found it profitable to bring uncultivated land under cultivation, enhancing the overall agricultural production in District Dera Ismail Khan.

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Introduction

Contribution of Pakistan GDP towards irrigated agriculture is about 22%, foreign exchange is 66%, food production remained over 90%, employs country's labor force about 45%. Pakistan was recognized as 8th biggest producer of food in the world. Nature has blessed Pakistan with large groundwater reservoir of more than 300 m depth and plenty of water resources. After India, USA & China, Pakistan had become 4th largest user of groundwater (Hussain and Hassan, 2017). Water is not only considered to be the significant but scarce element so necessary for the human survival, right from the dire needs of drinking water to the production of food and fiber. Since, economy of Pakistan exists in a sub-tropical semi-arid region where there is possibility of either uneven rainfall or not enough to boost agriculture sector. The Pakistan's population is increasing at the rate of 2.4% per annum in accordance to sixth Population and Housing Census of Pakistan 2017. This rapid growth of population creates growing demands

for variety of agricultural goods and services. The Pakistan's Agriculture has to depend on the availability of groundwater and surface water.

Strategy of water sector revolves around five significant factors *i.e.* water conservation, water augmentation, infrastructure protection from salinity, water logging, floods, groundwater management and institutional reforms. Pakistan economy is ranked biggest withdrawal of groundwater containing 5.2 million hectares area irrigated; Pakistan irrigates about 4.6% for world groundwater-fed cropland (Watto and Mugera, 2015). Waste water should only be utilized for the purpose of irrigation provided to avoid the risk of groundwater contamination and if it is pre-treated to reduce the level of heavy metals. Keeping in view the pertinent situation, plants of waste water treatment must be installed in industries so that if used for irrigation the treated waste water can be a source of organic matter and necessary minerals but should not be a source of health hazard and pollution. Environmental standards should be executed so as to ensure safety of the ecosystem from pollution (Parvez *et al.*, 2013).

The diffusion of tube wells among masses has the potential to bring about revolutionary change in the income distribution of rural Pakistan. To encourage tubewell irrigation, where canal water is also available, some concessions in water rates to be granted to the small owners of tubewell who supplement canal water through this source. Periodical laboratory tests for tube well water be carried out to determine the quality for irrigation purposes. Rural areas may be electrified and cheap cost of installing tube well be ensured for poor farmers having subsistence farming who could install tubewells in the area. The measures adopted such as minimum costs of pumping equipment purchase and tubewell installation often prevent poor and small farmers from owning a tube well. The study further examined the consequences of private tube wells on the income of rural peoples in terms of income level and income distribution, which may differ among farmers with different irrigation status (only canal water, canal water and purchased ground water and groundwater from his own tube well). The results shows that the work on private tube wells cause to increase the income of rural people and to decrease the income inequality in the rural areas of Pakistan. (Wang *et al.*, 2015).

The application of Tube well irrigation contains various salinities added large quantity of soluble salts into soil that adversely exaggerated the superiority of soil. As a result, the yields of various crops diminished from 3 to 15 percent. Currently the growers are utilizing salted Tube well water with Canal water but the regular use of poor quality irrigation water would have thoughtful consequences for sustainability of crop and soil in the region (Ishaq and Javed, 2015).

Water logging and soil salinity are considered greatest threats for the area. Soil does not require any remedy and water can be safely used for irrigation. Lower actual discharges may be due to wear and tear of pumps and well screens and drought condition of the past few years. Routine maintenance and repair is necessary to keep tube wells in working condition. Re-boring and replacement of pump is required at many locations where tube wells are out of order. It is appropriate to ensure remodeling of surface drains and maintenance works must be done on regular basis for drainage of excess water from waterlogged areas (Bilal and Sarwar, 2008).

Tube well irrigation, being an important input, influences various agricultural practices and cropping pattern. The general rise in the income of the farming community of all sizes of holdings and the consequent improvement in their economic position is no doubt a significant achievement of tubewell irrigation. Irrigation is one of the agricultural major inputs, which plays an important role in the development of agriculture. It provides an opportunity for the rise in the quantity of agricultural production. Therefore, irrigation is the major constant component for agricultural development (Paudyal, 2011). In Pakistan, it is painful reality that lower groundwater table condition has considerably reduced the production efficiency. The rural economy of Pakistan will be badly affected. The growers should be provided with technical and decision-making support to choose a suitable tubewell system that minimizes their production cost and expands their allocative efficiency (Asghar *et al.*, 2018). The related studies were also conducted by (Ashfaq *et al.*, 2009; Javed *et al.*, 2011; Machiwal and Jha, 2015; Solangi *et al.*, 2016; Riaz et.al., 2018).

In Pakistan, there are around 60,000 tube wells across the country. But most of them, 543, 243 tube wells are installed in the Punjab province. About 5,300 tube wells belongs to the public sector, while the others belong to the private sectors. These are widely used to

connect the underground resources due to increased lack of water. The recent survey showed that 41000 installed tube wells water is unsuitable for irrigation and human consumption. However, the farmers in areas where water scarcity is acute are forced to turn the tube wells for irrigating crops. In the long run, the fertile land are converted into the waste land as the quality of land is despoiled and its productivity is damaged.

In some areas of District D.I. Khan like Thallian village, which is about at a distance of 50 miles west of Dera Ismail Khan. In the whole area, there is no electricity and there is hardly no economic activity except agriculture and cattle grazing, depends on rain, which is very insufficient. The sub soil water is salty and in poor condition for human and agriculture purposes. The underground water at low depth is brackish. Deep drilling up to 300 ft is necessary to get regular supply of reasonably good water. The water is available at 70 to 80 ft deep that can be used for drinking and cultivation purposes. However, it is quite expensive for the farmers to install deep Tube Wells in the area (Anonymous). The main objective of the manuscript was to study the impact of tube well irrigation between the agricultural production, household annual income, poverty line and on the inputs used by the farmers in the research area.

Materials and Methods

Population

Dera Ismail Khan District was selected with population of 134 farmers used tube wells for the purpose of irrigation, because of its vast potentials for agricultural growth, with intensive and effective network of tube-well irrigation. The current study was conducted by an empirical investigation with the help of structured questionnaire. Due to close proximity of the river the water table is high and water is drawn to the surface by well and tubewells.

Data collection

The primary data were collected from only 100 sampled farmers with the assistance of a well-designed structured questionnaire using simple random sampling procedure.

Analysis method

Regression Analysis was used for the analysis of data with the help of SPSS statistical software.

Regression model

Regression Model is presented in standard format as;

$$Y = a^* + a_1 X_1 + \mu$$

Limitations

It was clearly believed that farmers do not maintain farm management records. Therefore, this analysis was based on the reported information by the respondents. The accuracy of such data is subject to the limitations of the memory of the farmers.

Justify of the models with the number of variables used

The justification of the dependant variables and independent variables have been explained in this article. In the first model, the Y as the household annual income of the farmers and X_1 is the agricultural production of the farmers. In the second model, Y is the poverty line of the farmers and X_1 is the household annual income of the farmers. In the third model, Y= Adopting tube well irrigation by farmers and X_1= Kinds of land and X_2= Sources of Irrigation and finally in the fourth model, Y= Adopting tube well irrigation by farmers and X_1= Inputs used on land.

Results and Discussion

Socioeconomic characteristics of the tube well water users in District Dera Ismail Khan

Age and gender: In the study area, the age of the tube well water users varies between 18 and 70 years, majority of the tube well water users are male family members and less female tube well water users for agriculture purpose has been found in the research area due to religious problems. Overall the mean age of the farmers in the study area was found to be 50 years, while the mean age of the sampled farmers was calculated as 47 years.

Experience and education of the respondents

On average, the respondents had an irrigation agriculture experience through tube wells of 26 years in the study area, while more than 60 percent of the farmers are illiterate, 30 percent of the farmers have primary education and other 10 percent farmers have matric and above education.

Family size and farm size of the respondents

The mean number of male farmers connected to full-time agriculture was very higher than that of females in the research area. Females of the working-age group

were commonly involved in agriculture on a part-time basis as they have to do other responsibilities in their houses. The mean number of family members in the research area was engaged in agriculture farming 4-5 members. Most of the sampled farmers (60%) owned up to 5 acres of land and overall, there were 84 percent have landholding below the subsistence level. About 12 percent had landholdings from 12.6 acres to 25 acres, while 6 percent of the total sample farmers owned 25.1 acres and finally the farmers who owned the land holdings up to 5 acres were found to be more than 40 percent.

Tenurial status of the respondents

In the research area, the majority of the farmers (53%) were the owners of the land, the number of tenants constituted about (17%) and while the number of owners-cum-tenants was observed 30%.

Regression analysis

Case 1: The Model of Household Annual Income in response to Agriculture Production.

$$Y = a^* + a_1 X_1 + \mu \ldots i$$

Where;

Y: Household Annual Income of farmers; a*: Intercept or constant; a_1: coefficient of Agricultural Production (X_1); X_1: Agriculture production in Dera Ismail Khan District; μ: Error term or Residual term.

By applying logarithm on both sides of equation i hence;

$$Log\ Y = Loga^* + a_1\ Log\ X_1 + Log\mu t \ldots . ii$$

Perusal of Table 1 showed the significant (P<0.05) and positive impact of household annual income of farmers gained due to advent of Tubewell irrigation on Agriculture Production in Dera Ismail Khan District. Figure 1 also confirmed the important association maintained between the explained and explanatory variables in histogram. The present study is on the analogy of past findings of Grogan *et al.* (2017), whom concluded that groundwater irrigation is an important element of world food and fiber production, which aimed at providing about half of all water used in irrigated agriculture. Tubewell irrigation facilitates multiple cropping which in turn, results in an intensive use of productive piece of land. Tubewell irrigation encourages more than one crop on the piece of land during cropping season, enables farm households to raise their annual income so as to enhance highest market value for their farm yields.

Table 1: *Significant impact of household annual income on agriculture production in District Dera Ismail Khan.*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Standard Error	Beta		
1	Constant	.592	.336	-	1.763	.081
	Agriculture Production	.704	.326	.213	2.160	.033

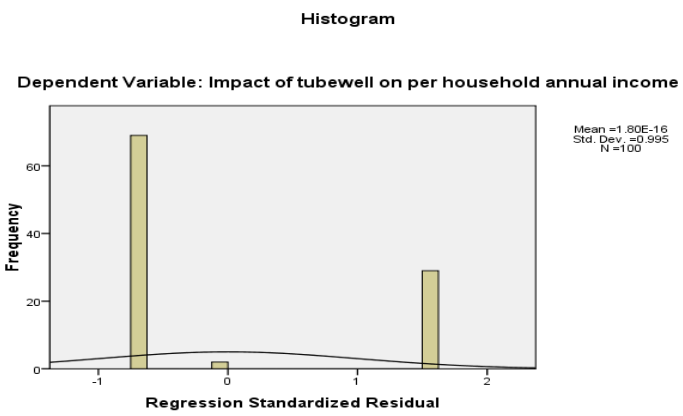

Figure 1: *Impact of household annual income on agriculture production.*

Case 2: Model for poverty line in response to household annual income.

$$Y = a^* + a_1 X_1 + \mu \ldots \text{iii}$$

Where;

Y: Keeping farmers above Poverty Line in Dera Ismail Khan District; a*: Intercept or constant; a_1: Coefficient of Agricultural production X_1; X_1: Household Annual Income of farmers; μ: Error Term.

Taking logarithm on both sides of equation iii hence;

$$Log\ Y = Loga^* + a_1\ Log\ X_1 + Log\mu t \ldots iv$$

Perusal of Table 2 revealed the significant (P<0.01) and positive impact of household annual income of farmers gained due to advent of tubewell irrigation, which kept farming community above Poverty Line in Dera Ismail Khan District. Figure 2 also confirmed the important association maintained between explained and explanatory variables in histogram. The result of the current study is in contact with the earlier studies carried out by Ashfaq and Akram (2009).

Suggesting that policy and decision makers may communicate strategies improving wheat production through well-organized and judicious use of ground water resources. It is evident from this analysis, the farmers who used tubewell irrigation, benefited a great deal and their per household annual income was sufficient to keep them above poverty line. The study is also supported by Qureshi *et al.* (2009), indicating that availability of groundwater has transformed the emerging views of uncertain and low yields of crops into more secured and assured crop production. Such attempts result in assuring food safety and better living conditions for rural life. Due to poor status, small land owners cannot afford to have a tubewell of their own should be organized to install tubewells on co-operative lines.

Table 2: *Impact of household annual income on poverty line.*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Standard Error	Beta		
1	Constant	0.645	0.081	-	7.981	0.000
	Household Annual Income	0.355	0.058	0.524	6.098	0.000

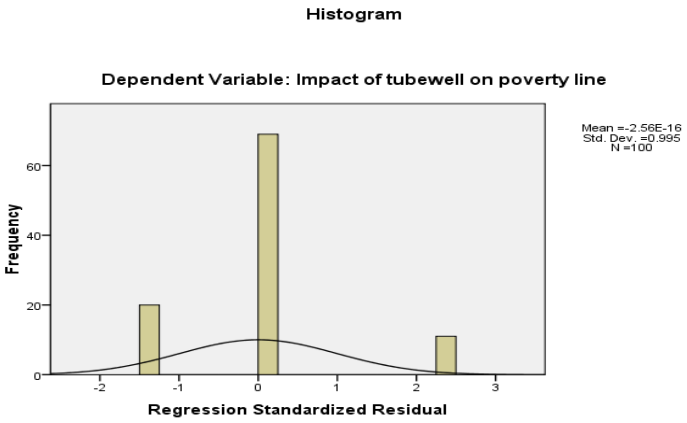

Figure 2: *Impact of household annual income on poverty line.*

Case 3: Model for showing relationship between kinds of land and sources of irrigation.

$$Y = a^* + a_1 X_1 + a_2 X_2 + \mu \ldots . \text{v}$$

Where;
Y: Adopting tubewell irrigation by farmers; a*: Intercept or constant; a_1 and a_2: coefficient of kinds of land (X_1) and sources of irrigation (X_2); X_1: Kinds of land; X_2: Sources of Irrigation; μ: Error Term.

Taking logarithm on both sides of equation (v) hence;

$$Log\ Y = Log\ a^* + a_1\ Log\ X_1 + a_2\ Log\ X_2 + Log\ \mu t \ldots \text{vi}$$

Table 3: *Significant relationships between kinds of land and sources of irrigation.*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Standard Error	Beta		
1	Constant	-0.959	1.204	-	-0.797	0.428
	Kinds of land	1.172	0.482	0.237	2.432	0.017
	Sources of Irrigation	0.594	0.340	0.170	1.746	0.084

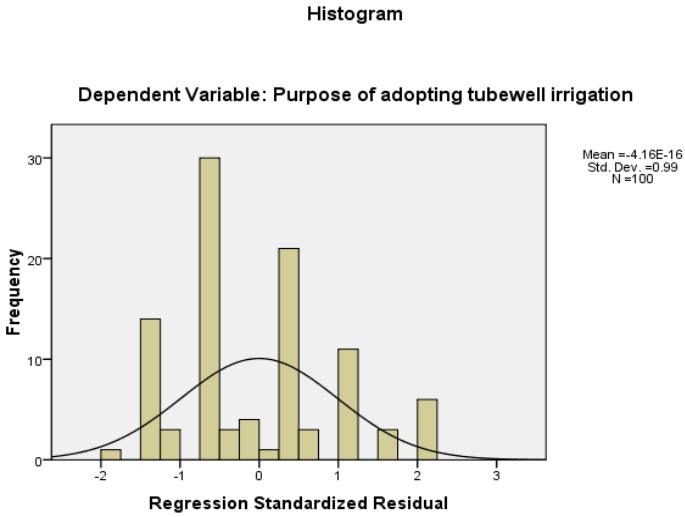

Figure 3: *Significant relationships between kinds of land and sources of irrigation.*

Perusal of Table 3 revealed the significant (P<0.05) and positive relationships between kinds of land of farmers and sources of irrigation, which in turn, resulting in adopting tube well irrigation in the area. The findings revealed that those farming community who were motivated and inspired by fellow farmers and were properly guided by agriculture extension department had obviously adopted the effective networks of tubewell irrigation for gaining potential crop yield in District D.I. Khan. Figure 3 also confirmed the important association maintained between explained and explanatory variables in histogram. The current study was related to the previous results carried out by Hussain and Hassan (2017), suggesting that 45% crop-water requirements met due to groundwater and has attained significant position in irrigated agriculture. Groundwater is not only used for irrigation, but it has been considered a major source of drinking, industrial and commercial requirements and has con-

siderably improved the cropping intensity from 60% in 1947 to 160-170% in 2015 to meet the ever increasing demand of food and fiber. Agriculture Engineering Department should encourage tubewell irrigation in the areas where vast land area is affected due to water-logging and salinity and perennial supplies of water are also found insufficient to irrigate the vast productive region of D.I. Khan District.

Case. 4:- Model for adopting tubewell irrigation in response of inputs used on land.

$$Y = a^* + a_1 X_1 + \mu \ldots\ldots \text{vii}$$

Where;
Y: Adopting tubewell irrigation by farmers; a*: Intercept or constant; a_1: Coefficient of inputs used on land (X_1); X_1: Inputs used on land; μ: Error Term.

Taking logarithm on both sides of the equation (vii) hence;

$$Log\ Y = Loga^* + a1\ Log\ X_1 + Log\ \mu t \ldots\text{viii}$$

Table 4: *Impact of inputs used on land on adopting of tube well irrigation.*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Standard Error	Beta		
1	Constant	8.644	1.581	-	5.466	0.000
	Inputs used on land	-1.240	0.323	-0.362	-3.844	0.000

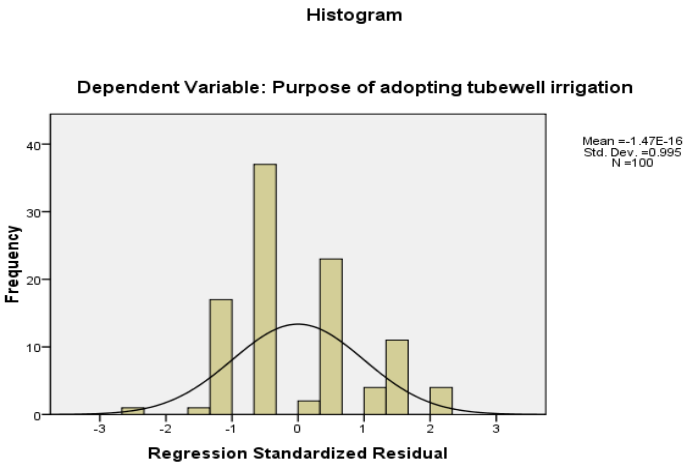

Figure 4: *Adopting tube well irrigation in response to inputs used on land.*

Perusal of Table 4 revealed the significant (P<0.01) and positive impact of inputs used on land helped in inducing the farming community for adopting regular and continuous use of effective network of tubewell in Dera Ismail Khan District. Figure 4 also confirmed the significant relationship maintained between intensive inputs use of productive piece of land and adopting tubewell as an effective and influential source of irrigation in histogram. The current study is supported with aforementioned research work carried out by Watto and Mugera (2015), examining irrigation water efficiency have become inevitable for sustainable agriculture production. The availability of tubewell components and other related inputs *i.e* seeds, fertilizers, pesticides and credits etc are indeed very crucial for the widespread installation of tubewells, therefore, easy access of farmers to complimentary inputs would induce farming community in Dera Ismail Khan District to install tubewells.

Conclusions and Recommendations

Author was arrived at conclusion that with the increased availability of water, more lands were brought under cultivation by reducing uncultivated land and the existing cultivated land were intensively cultivated by raising more than one crop during cropping season. It is evident from such study that those farmers who utilized tubewell irrigation, benefited a great deal, and that their per household income was quite sufficient enough to keep them above poverty line in District Dera Ismail Khan. The provincial Government should provide diesel oil at subsidies rates to the owners so as to regulate the supply of tube well irrigation throughout the year. Administrative and technical steps need to be taken to prevent the frequent breakdown of electric currents during the peak season. There is need to electrified rural areas of District Dera Ismail Khan after availability of cheap motor power, easily access of farmers to the complimentary inputs would induce them to adopt tube well irrigation in the region. In short, small land owners who cannot afford to have tube well irrigation of their own may be organized to install tube wells on cooperative lines.

Novelty Statement

The impact of the tube well irrigation to evaluate the Impact of Household Annual Income on Agriculture Production, Poverty Line in response to Household Annual Income, tube well irrigation in response to inputs used on land and the kinds of land and sources of irrigation was first time conducted in district Dera Ismail Khan.

Author's Contributions

This paper work was carried out in collaboration among all authors.

Muhammad Niamatullah Khan Babar: Designed the study, wrote the protocol and prepared the first draft of the manuscript.

Abdur Rehman: Did the data analysis, did model modification and rectification.

Raheel Saqib: Helped us in collecting review of literature, giving his useful suggestion about the model usage and data analysis.

Finally, all the author's reviewed and approved the draft of the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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