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Impact of Water User Associations on the Income of Farmers (Case Study of Pakistan)

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ABSTRACT

The main objective of the study is to find out the impact of water user associations on the income of farmers. In the year 2004, the Government of Pakistan initiated a national program for improvement of water-courses. The water user associations were the integral part of the program. For this study cross sectional data was collected from district Vehari which is situated in South Punjab, Pakistan. The data, collected through a questionnaire, included information which was given by farmers who have water user associations and from those farmers who have either no or inactive water user associations in their villages. The regression analysis technique along with its functional forms is used to analyze data. The results obtained on the basis of Log-Lin model show that the water user associations have positive impact on the income of farmers. The Logit Model is used to explain the variables that will increase the probability of farmers to form or join water user associations. The results show that increase in family size and cultivated wheat area enhance the probability of farmers to form or join water user associations. In the light of this study certain suggestions are put forward to improve the functioning of water user associations because in future the better performance of these associations may help to improve irrigation and agricultural sectors in Pakistan.

1- Introduction

It has been estimated that 2.4 billion people throughout the world depend on irrigated agriculture for jobs, food and income. In next thirty years, an estimated 80 percent of additional food supplies will be required to feed the world population and the same will depend on irrigation (FAO, water policies and agriculture, 1993). Thus playing this fundamental role in food production, the irrigation has become the world's largest user of fresh water, accounting for more than 80 percent of water use in Africa and comparatively high percentages in other developing regions of the world (World Bank, 1994).

Keeping in view the importance of water as scarce resource, it must be used wisely and in an efficient manner. The irrigation systems should be designed in such a way that water use should be optimum with minimum wastage. Throughout the world the overall performance of many irrigation projects has not been up to-mark. The reasons are poor scheme conception, inadequate construction and implementation or ineffective management (FAO, 1993). This sub-optimal performance can be observed in all types and sizes of irrigation systems like small farmer managed systems in Nepal to giant canal systems in Pakistan and India. The irrigation efficiencies are as low as 20-25 percent in Java, The Philippines, and Thailand while in Pakistan these are about 50 percent. At the same time there are inequalities in water supplies to farmers in head reaches of irrigation system and those located downstream therefore resulting in low cropping intensities and productivities (International Irrigation Management Institute, 1998).

The incidence of rural poverty has been found to be inversely related to both the rate of growth of crop output and irrigation factor. Therefore the planners and policy makers have seen investment in irrigation as an indirect instrument for eradicating rural poverty (Narain, 2003).

- Irrigation System of Pakistan

The economic base in Pakistan depends upon agriculture and its main industrial activities also need raw material from agriculture sector. Agriculture represents 25% of Pakistan's gross domestic product, employs over 50% of rural labor force, and provides 60-70% of exports (ADB Review, 2006-2007).

Due to climatic conditions in Pakistan which are characterized by low rain fall and high rate of evaporation mainly because of high temperatures in summer, irrigation is required for most of the agricultural production. Irrigation is practiced on 75% of the cropped area which in turn contributes around 90% of the nation's total agricultural production. The river Indus and its tributaries namely rivers Ravi, Jhelum, Chenab and Sutlej serve as source of irrigation water for about 85% of the irrigated area in Pakistan (Bhatti, 1990).

The irrigation system of Pakistan (14 million hectors) is one of the largest in the world. It comprises of river Indus and its tributaries, three major dams (Warsak, Mangla and Terbella), nineteen barrages along with head works both small and big, 43 canal commands and around 80,000 water-courses. The length of canals is around 55,000 kilometers while the length of water-courses, farm channels and water ditches is about 1.55 million kilometers (Bhatti, 1990).

Out of 14 million hectors, 58% is irrigated as perennially and other 42% can be irrigated in the summer season when the water levels in the rivers are high due to monsoon rains. Canals vary from minors that carry 0.09-0.15 cubic meters of water per second and serve 2-3 water-courses to canals that transfer water between river basins and which have capacities up to 650 cubic meters of water per second (Wolf, 1986).

In India the first controlled full year irrigation began in 1859 with the completion of Upper Bari Doab canal from Madhopur head works on river Ravi. The initial foremost objective was drought protection and since then irrigation systems first in united India and then in Pakistan are designed and planned to ensure availability of water supplies in the rivers. This availability of water then leads to maturity of crops on majority of the cultivated area with minimum consumption of water (Bhatti, et al, 1990).

The basic component of irrigation system at tertiary level in Pakistan is known as a water-course. The area served by a particular water-course may range from 80 to 280 hectors but the average is around 160 hectors. Compared to other Asian countries like Thailand, Malaysia, Indonesia, Sri Lanka, Korea and Japan, it is relatively large area to be served by a single outlet (Wolf, 1986).

The flow in water-course is governed by an open outlet or a water regulator, which is locally known as '*mogha*'. It is designed to discharge water, which is self-adjusted in proportion of water flow in the parent canal. This designed discharge from 'moghas' helps the farmers in efficient utilization and handling of canal water (Bhatti, 1990).

- Introduction to National Program for Improvement of Water-courses in Pakistan (the Punjab component)

The tertiary irrigation system in Punjab comprises of about 58,000 water-courses. It has been established that a significant loss of irrigation water occurs from these more than half a century old water-courses because of poor maintenance and aging. The combined impact of leakage and seepage amounts to about 40% losses of water in the water-course system. In addition to that considerable amount of water wastage also occurs in the form of application losses due to undulations in the fields and adoption of obsolete agricultural and irrigation practices at farm level (PC-1 Form, 2004). Accordingly, improved water management offers a vast potential for growth of agricultural sector in the province. The opportunity for increasing agricultural production by reducing water wastage would have positive impact on overall economy of the country.

In the light of above said facts "National Program for Improvement of Water Courses" (NPIWC) was started in 2004. According to this program, 28,000 water-courses had to be improved in the province of Punjab. The distribution of water-courses to be improved in fresh and saline ground water areas was 33% and 67% respectively (PC-1 Form of NPIWC, 2004). The major activities carried out under the proposed program were:

(i) 'Formation of 28,000 'Water User Associations' and their registration under 'On Farm Water Management and Water Users Association Ordinance 1981'.

(ii) Remodeling / reconstruction of 28,000 canal irrigated water-courses involving complete earthen renovation, partial lining (20%) of critical reaches and installation of water control structures.

(iii) Training of 1,863 newly recruited technical staff'.

As per (PC-1 Form of NPIWC, 2004) the selection criterion for improvement of water-courses was as follows:

(i) 'The proposed water-course has not been improved previously.

(ii) Farmers are willing to form a Water User Association and should agree with the cost sharing arrangements proposed under the program.

(iii) Farmers agree to reconstruct *katcha* portion of the water-course prior to the commencement of the lining work'.

The responsibilities of Water User Associations as per (PC-1 Form of NPIWC, 2004) to:

(i) 'Arrange skilled and unskilled labour for improvement of water-courses.

(ii) Procure construction material for carrying out of civil works.

(iii) Settle disputed matters among the water users in respect of channel alignment etc.

(iv) Make alternate arrangements for provision of water during execution of work.

(v) Carry out works in accordance with standards and specifications under the supervision of (On Farm Water Management) field staff.

(vi) Regularly undertake operations and maintenance of improved water-courses'.

- Objective of the Study

The main aim of 'National Program for Improvement of Water-courses' was to improve tertiary irrigation system so as to enhance its capacity and utility. At the same time for better management and effective handling of the system certain institutional arrangements have also been introduced. One of them is strengthening and creation of new Water User Associations (WUAs), these WUAs are to be constituted under Water Users Associations Ordinance, 1981.

As these WUAs are mandatory component of 'National Program for Improvement of water-courses' therefore through this study the impact of the same will be assessed on the income of farmers in the province of Punjab. This study will be based on primary data, which has been collected from district Vehari of South Punjab. The reasons to select province of Punjab for this study are that it is the biggest province of Pakistan as far as population is concerned. It is the main hub of agricultural activity in the country with 60% of the total agricultural produce. It has the largest network of irrigation system in the country with canal network having total length of 36500 kilometers with command area of 8.32 million hectors of land (Wolf, 1986)

2- Materials and methods

The methodology adopted for the study is as follows:

- Collection of Primary Data:

In order to analyze the impact of Water User Associations along with other variables on the income of farmers of Punjab, two types of questionnaires were designed for a survey, which was carried out to collect primary data from the farmers of district Vehari.

These questionnaires were used to collect cross sectional data from the farmers of three tehsils of the district Vehari namely Mailsi, Vehari and Burewala for the period starting from June 2007 to June 2008. The reason for designing two questionnaires was to get information from two different sets of farmers; one who have active Water User Associations (WUAs) and others who either have no WUAs or inactive WUAs in their villages. 81 farmers from villages having active Water User Associations and 45 farmers from those villages that have either no Water User Associations or have inactive Water User Associations were interviewed accordingly.

Furthermore, the above said period was selected to get information from the farmers regarding cultivation of two major crops of the area namely Cotton and Wheat which have different cultivating seasons. The other reason was that as years 2007 and 2008 were the last years of NPIWC having total gestation period of five years (2004 to 2008) therefore it was expected that the by that time the program has its maximum impact.

- Economic Model:

In the context of this study, an economic model is developed and the same is written in the following form

$$totincome(y)=\beta_0+\beta_1 Dwua+\beta_2 distfso+\beta_3 cottonland+\beta_4 wtland+\beta_5 Dv+\beta_6 Db+\beta_7 family\ size+\beta_8 st\ w\ wt\ av$$

Where

i) totincome: Income for the year in thousands of rupees

ii) Dwua: Dummy variable for water user association

Dwua = 1: Farmers who have water user associations in their villages

Dwua = 0: Farmers who have either no water user associations or inactive water user associations (Base Category)

i) distfso: Distance (Km) of agriculture land from the source of canal water

ii)cottonland: Land in acres where cotton crop was cultivated

iii) wtland: Land in acres where wheat crop was cultivated
iv) Dv : Dummy variable for income of two tehsils
v) Dv = 1: For tehsil Mailsi
Dv = 0: For tehsil Vehari (Base Category)
vi) Db: Dummy variable for income of two tehsils
Db = 1: For tehsil Mailsi
Db = 0: For Burewala (Base Category)
ix) family size: Number of family members living in one household and they earn their livelihood from the land jointly owned by the family
i) St w wt av: Farmer's satisfaction with canal water availability
In the above equation β_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7 and β_8 are unknown parameters.

- Econometric Model:

The above mentioned economic model lacks error term. The inclusion of error term in the model makes it an econometric model. As it is estimable, therefore it will be estimated by using regression method. The error term is the difference between the actual observation of the dependent variable and the estimated value by the model (Greene, 2003).

$$totincome(y)=\beta_0+\beta_1 Dwua+\beta_2 distfso+\beta_3 cottoland+\beta_4 wtland+\beta_5 Dv+\beta_6 Db+\beta_7 family\ size+\beta_8 st\ w\ wt\ av+e_t$$

Where
e_t : Error Term:

- Hypothesis:

The null hypothesis is that
$B_1 > 0$
While alternative hypothesis is
$B_1 = 0$ or
$B_1 < 0$.

3- Results and discussion

A detailed descriptive study reveals various dimensions of the explanatory variables used in this study.

3-1- Descriptive Statistics

The descriptive statistics show the various characteristics of sample with respect to variables used in the statistical model.

i)- Distance from water source
It means the distance of farmer's agriculture land from the source of canal water. The maximum distance from source of water in this study is 6 kilometers and the minimum distance is 0.25 kilometer. The mean distance from water source is 1.74 kilometers.

ii)- Duration of water user associations
The maximum duration of water user association is 3 years with mean duration is 1.22 years.

iii)- Cotton Land
Minimum area under cotton cultivation is 2 acres while maximum is 69 acres. The mean area cultivated for cotton crop is 14.052 acres for the said period.

iv)- Wheat Land
Minimum cultivated wheat area is 2 acres and maximum is 50 acres with mean cultivated area of 12.04 acres.

v)- Family Size
The minimum size of family is three while the maximum number of a single family is fourteen. The mean value for the family size is 7.73.

vi)- Satisfaction from canal water availability
Ranking technique is used to find out satisfaction level for the availability of canal water. The number 3 represents satisfaction, 2 represents does not know and 1 means no satisfaction.

viii)- Total Income
The maximum total income is Rs. 1646250 while minimum income is Rs. 64250. The mean income is Rs. 427739.

ix)- Cotton Cost
The maximum cost of cotton production is Rs. 564500 while minimum cost is Rs. 11400. The mean value is Rs. 118926.

x)- Wheat Cost
The maximum cost of wheat production is Rs.447270 and minimum cost is Rs.10580. The mean value is Rs.73547.

3-2- Econometric Model

Three variants of the model are used for undertaking regression analysis. The multiple linear regression analysis is used in the first place. To preclude the possibility that the relationship between dependent and independent variables may not necessarily be linear in simple terms, the transformation of the variables is carried out to understand the real relationship. According to (Hill, 2001), the term linear in 'simple linear regression model' may not mean a linear relationship between the variables but a model in which parameters enter in a linear way. That is, the model is 'linear in parameters', but it is not, necessarily, 'linear in variables'. To overcome this possibility the variables in the model are transformed by using functional forms which are log-log and log-linear.

The equations of models are as follows:

a)- Simple regression model:

$totincome(y)=\beta_0+\beta_1 Dwua+\beta_2 distfso+\beta_3 cottonland+\beta_4 wtland+\beta_5 Dv+\beta_6 Db+\beta_7 family\ size+\beta_8 st\ w\ wt\ av+e_t$

b)- Log-Log Model:

$ln(y)=\beta_0+\beta_1 Dwua+\beta_2 lndistfso+\beta_2 lncottonland+\beta_4 lnwtland+\beta_5 Dv+\beta_6 Db+\beta_7 lnfamily\ size+\beta_8\ lnst\ w\ wt\ av+e_t$

c)- Log-Lin Model:

$ln(y)=\beta_0+\beta_1 Dwua+\beta_2 distfso+\beta_3 cottonland+\beta_4 wtland+\beta_5 Dv+\beta_6 Db+\beta_7 family\ size+\beta_8 st\ w\ wt\ av+e_t$

The results of estimation of above three models are as follows (Table 1).

3-3- Interpretation of Model parameters

- Multiple Linear Regression Model

In multiple linear regression model the positive sign of coefficient of explanatory variable 'water user association' shows that the income of farmers having water user associations in their areas is Rs.29260.5 more as compared to those farmers who have either no or inactive water user associations in their areas but at the same time it is not significant.

The dummy variables, Dv and Db, used for comparing incomes of farmers for three tehsils of Vehari, Burewala and Mailsi, show negative signs which means that the incomes of farmers in tehsil Vehari and tehsil Burewala are Rs. 165883.6 and Rs. 129850.9 respectively and these are less than those in tehsil Mailsi. Both are significant at 1% level.

The coefficient 'distance of agricultural land from canal water source' shows negative sign, which means distance from canal water source, has negative relationship with total income. The results show that an increase in 1 kilometer from canal water source has led to decrease in income of Rs. 28458.6. This variable is also significant at 1% level of confidence interval.

The coefficients 'cotton and wheat area' show positive signs which mean that that with the increase of acreage under these crops the total income increases. The increase in 1 acre of cotton and wheat has led to increase in income of Rs. 3354.2 and Rs. 29102.9 respectively. Both of them are significant at 1% level of confidence interval. The less increase in income per acre for cotton compared to wheat is due to poor cotton crop because of a viral disease known as milli bug and at the same time increase in cost of inputs in the form of more use of pesticides and insecticides for the particular period (2007-2008) under study.

The coefficient increase in 'family size' shows negative sign which is rather unexpected as with the rise in family member the income should increase but here with the increase of one family member, income has decreased by Rs. 3174. At the same time this is not significant.

The coefficient 'satisfaction with the availability of canal water' for the irrigation purposes also shows negative sign, which is unexpected. The results show that with increase of satisfaction level the income has decreased to the tune of Rs. 17492. However the coefficient is not significant.

In this model the adjusted R^2 is .88, which means that 88 percent of variation in dependent variable (total income) can be explained by the explanatory variables. As it is close to one it shows better fit of the estimated regression line. The above linear model though has high R^2 but the signs of variables like family size and satisfaction for availability of canal water for irrigation, are unexpectedly negative. The impact of three explanatory variables like water user association, family size and satisfaction for availability of canal water for irrigation on the income of farmers is not significant that leads to rejection of our null hypothesis that is $\beta_1 > 0$, hence alternate hypotheses $\beta_1 < 0$ or $\beta_1 = 0$ are accepted. This shows that it is not an adequate model to explain the impact of water user associations on the income of farmers.

- Log-Log Model

In order to investigate further, keeping in view that there are many economic scenarios for which the linear in parameters/ linear in variables, regression models may not be adequate or appropriate therefore all the variables in the model are transformed to log form.

The model is linear in logarithms of variables both for dependent and independent variables. Because of this linearity the model is called log-log or double log model. An attractive feature of double-log is that the partial slope of the coefficient β_1 measures the elasticity of y with respect to x_1 holding the influence of other independent variables x_i constant. It means that percentage change in y with respect to x_1 holding x_i constant; it is called as partial elasticity (Gujrati, 1991).

Durbin Watson test (1.41) suggests that there are chances of serial correlation in the model. The collinearity diagnostics show that there is correlation among variables but it is not significant.

The adjusted R^2 of the model is .89, which shows that 89% variation in dependent variable can be explained by explanatory variables, which is quite high.

Water user association has been used as dummy variable in the model. It shows positive sign, which means that with the presence of water user association the income of farmers has been increased by 0.18% as compared to those farmers who have either no water user association or inactive water user association. It is significant at 1% level of confidence interval.

The dummy variables used for comparing income of the three tehsils show negative signs for both Vehari and Burewala which means that the income of farmers is 0.24% and 0.18% less than the income of farmers in tehsil Mailsi. Both these variables are significant at 1% level of confidence interval.

The coefficient of 'distance of agricultural land from canal water source' has negative sign which shows that by 1% increase in distance the income has decreased by .079%. It is significant at 5% level of confidence interval.

The coefficients of 'cotton and wheat land' show positive signs meaning that an increase in 1% cultivation of land for both cotton and wheat crops has led to 0.41% and 0.57% increase of income respectively. Both of these variables are significant at 1% level of confidence interval.

The coefficient of 'family size' has negative sign which is rather unexpected because the results show that by 1% increase in family size leads to 0.088% decrease in income of farmers. The change is minimal and it is not significant as well.

The coefficient of 'satisfaction for availability of canal water' for irrigation shows negative sign, which is unexpected, as with 1% increase in satisfaction level leads to .073% decrease in income. The result is not significant.

In the log-log model though R^2 is quite good, yet Durbin Watson test suggests that there is auto correlation. In addition to that variables like family size and satisfaction for canal water availability, show negative signs, which are unexpected in the context of study. At the same time both these variables are not statistically significant. This model, however, shows that our null hypothesis, $\beta_1 > 0$ is accepted as water user associations have positive impact on the income of farmers.

- Log-Lin Model

The other functional form that has been used for the study is Log-Lin Model. The interpretation of semi-log model like Log-Log model is that the slope coefficient measures the proportional or relative change of the dependent variable for a given absolute change in explanatory variable. If the relative change is multiplied by 100, we get the percentage change (Hill, 2001).

The results of estimates show that adjusted R^2 is .78, which means that approximately 78% variation in dependent variable is explained by the explanatory variables, which is quite good.

The Durbin Watson test (2.01) suggests that there is no serial correlation in the model. The collinearity among different variables as evident from collinearity diagnostics is low thus making it insignificant.

In this model hetroscedasticity is checked by using least squares and to plot the least square residuals. Here as in the model multiple variables have been used so least square residuals have been plotted against each explanatory variable except for dummy variables. The plots of least square residuals against explanatory variables like cotton land, wheat land, distance from source of canal water, satisfaction from canal water availability and family size show no patterns of any sort. This confirms that variance in error term is constant for all values of the independent variables thus it is not hetroscedastic (Hill, 2001).

Water user association has been used as dummy variable in the model. The coefficient of this variable has positive sign and its magnitude shows that having water user association in the area increases income by 19% for farmers as compared to those farmers who have either no water user association or inactive water user association in their areas. It is significant at 1% level of confidence interval.

The two dummy variables for tehsils Vehari and Burewala show negative signs, which mean that income of farmers in both the tehsils is less than tehsil Mailsi by 28.8% and 30.3% respectively, for the year, if other variables are held constant. Both these variables are significant at 1% level of confidence interval.

The coefficient of 'distance of agricultural land from canal water' shows negative sign, which means that 1 kilometer increase in distance from water source decreases income of farmers by 7%. It is significant at 5% level of confidence interval.

The coefficients of 'cotton and wheat area' show positive signs. The increase in one acre of cotton and wheat has increased income of farmers by 1% and 5% respectively. The cotton area is significant at 1% whereas wheat area is also significant at 1% level of confidence interval.

The coefficient of 'family size' shows positive sign which means that by increase in family size by one person has led to 3.3% increase in income of farmers. It is significant at 5% level of confidence interval.

The coefficient for 'satisfaction for canal water availability' shows negative sign as it has been in the above two models. It means with increase of satisfaction the income decreases by 10%. It is significant at 1% level of confidence interval. The unexpected sign of the coefficient points to an interesting paradox inherent in the study area. There are two broad categories of the farmers in relation to the availability of irrigation water. The first category is solely dependent on canals for irrigation and has low level of satisfaction with the availability of the irrigation water due to perennial shortage of canal water. The farmers in the second category use tube wells for supplementing canal water and do not experience shortage of water and therefore have higher level of satisfaction. However it has two important implications on income. Firstly, it increases the cost of production and secondly because of poor quality of ground water it adversely affects the productivity of the land thereby decreasing per acre yields. Because of these factors though satisfaction level of the farmers is high but at the same time incomes are low.

The results of the model show that that our null hypothesis, $\beta_1 > 0$ is accepted as water user associations have positive impact on the income of farmers.

3-3- Preferred Model

Out of the above three models, Log-Lin model has been preferred on the following grounds:

a. In log-lin model, though the adjusted R^2 is 0.78, which is less than that of log-log model having adjusted R^2 of 0.89. The Durbin Watson test suggests that there is no serial correlation among variables in log-lin model (2.01 compared to that of 1.41 in log-log model) thus making it more reliable.

b. other point in favor of log-lin model is that it conforms to more expected signs of coefficients of explanatory variables as compared to log-log model.

c. All explanatory variables have shown significance at either 1% or 5% level of confidence interval in log- lin model.

d. Relatively lower adjusted R^2 is not considered as a problem for cross sectional data models, as long as the coefficients are significant and explains the ground realities. According to (Hill, 2001) the adjusted R^2 is low where cross sectional data is used as compared to that of time series data. Therefore the difference of adjusted R^2 between the last two models is not an issue.

e. In this model the errors are not hetroscedastic as there are no patterns of any sort in least square residuals when they are plotted against independent variables used in the model.

f. There is slight muticollinearity in the model but it is not close to 1 therefore making it insignificant and increasing the reliability of the log-lin model.

The overall significance of model is confirmed by looking at F-statistics. It is more than F_c that is $F > F_c$ (51.76> 2.03) as 5% critical value for the F-statistic with (8, 113) degrees of freedom is $F_c = 2.03$.

3-4- Logistic Regression

The following Logistic Regression model has been used to predict the probabilities of explanatory variables:

$$Y=\beta_0+\beta_1 distafso+\beta_2 Dv+\beta_3 Db+\beta_4 familysize+\beta_5 st\ w\ wt\ av+\beta_6 cotton\ land+\beta_7 wtland+e_t$$

Here in this case y is the dummy variable for water user associations and it takes the value of either 1 or 0. Value 1 is taken for active water user associations and 0 for either no or inactive water user associations.

The independent variables, which are taken, are distance of agricultural land from canal water source, dummy variables for tehsils Vehari and Burewala, family size, cultivated cotton and wheat land.

The results of Logit regression are shown in the table 2.

The results show that distance of agricultural land from the source of canal water, cultivated cotton land and cultivated wheat land are significant at 1% while Dv is significant at 5% level of confidence interval. The results point out that farmers with large family size and cultivated wheat land have more probability to join water user associations as Exp(B) is more than 1. Variables like Dv, distance from canal water source, cultivated cotton land and satisfaction for canal water availability may not affect the farmers choice to join water user associations as Exp(B) is less than 1.

4- Conclusion

The results of the study justify the policy of government to involve water user associations in 'National Program for Improvement of Water-courses' in Pakistan. The farmers who had active water user associations had more income for the specific years used for study when compared to that of those farmers who had either no water user associations or had inactive water user associations. In the light of results of this study the following proposals for policy makers are put forward:

The allocation of irrigation water at local water channel level in the province may be done by concerned water user associations through proper institutional structure where members of water user associations must be involved in the decision making including policy formulation and project design (FAO, 1993). It is therefore imperative that water user associations should be formed and encouraged before the start of any new program or project for improvement of irrigation system so that input of the stakeholders can be obtained during the conceptual and design phase of the program/project.

Water user associations should be made responsible for looking after the local water resources and their management issues; this will lead to more efficient use of local irrigation systems at low costs.

The levy and collection of water rate by the government functionaries may be devolved to water user associations. This will lead to more collection of water rate at local level and may reduce government's administrative costs. More over the calculation of water rate should be done on the basis of volume rather than on the basis of per acres. This will help to limit the unnecessary wastage of irrigation water by the consumers (Norton, 2004).

In order make these water user associations a success the training to the members of water user associations should be ensured especially in the field of designing, accounting, auditing and monitoring of projects and programs.

Necessary funds for future maintenance and repair of tertiary irrigation system should be allocated by the government. These increased operational and management investments will lead to improved irrigation system which may lead to higher and more reliable availability of water supplies (Chaudhry,1989) for crops thus leading to more productivity.

As proposed by majority of farmers in response to survey questionnaire, in future the lining of water-courses should be at least 50% of its total length instead of 20% which was done under 'National Program for Improvement of Water-courses'(2004-2008).

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Table 1-

Explanatory Variables	Linear Model			Log-Log Model: Log on both sides except dummy variables			Log-Lin Model: Log of only response variable		
	B	Std. Error	Sig.	B	Std. Error	Sig.	B	Std. Error	Sig.
Constant	222930.7	57531.17	.000	10.736	.165	.000	12.11	.168	.000*
Dwua	29260.5	23835.5	.222	.180	.054	.001*	.187	.069	.008*
Dv	-165883.6	27410.2	.000*	-.245	.056	.000*	-.288	.080	.000*
Db	-129850.9	25914.6	.000*	-.185	.055	.001*	-.303	.076	.000*
Distance from water source	-28458.6	10044.1	.006*	-.079	.030	.011**	-.066	.030	.028**
Cotton land	3354.25	1278.8	.010*	.415	.067	.000*	.010	.004	.007*
Wheat land	29102.997	1802.4	.000*	.569	.068	.000*	.052	.005	.000*
Family size	-3174	5119.3	.536	-.088	.081	.280	.033	.015	.032**
Satisfaction with canal water availability	-17492	13140	.186	-.073	.047	.125	-.105	.039	.008*
Adjusted R^2	.881			.894			.787		

* significant at 1% level
** significant at 5% level
*** significant at 10% level

Table 2-

Explanatory Variables	B	Std. Error	Sig.	Exp(B)
Distance of agricultural land from canal water source	-.704	.252	.005*	.495
Dv	-1.547	.692	.025**	.213
Db	-.731	.640	..253	.482
Family Size	.173	.126	.174	1.187
Satisfaction with canal water availability	-.050	.332	.881	.952
Cotton land cultivated	-.405	.086	.000*	.667
Wheat land cultivated	.482	.106	.000*	I.629
Constant	1.261	1.311	.336	3.529

* significant at 1% level
** significant at 5% level
*** significant at 10% level