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CHANGE IN MANAGEMENT OF IRRIGATION SECTOR OF PUNJAB (PAKISTAN) AND ITS IMPACT ON INCOME OF WHEAT GROWERS

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Agricultural economy of Pakistan is dependent heavily on the availability of irrigation water especially the surface irrigation water. Punjab, which is the main stake of the agriculture sector, has 80 percent of its total area wholly or partially dependent on the availability of surface irrigation water. Although Pakistan has one of the largest irrigation systems of the world, yet irrigated agriculture is facing huge problems due to increasing pressure of population on the water resources. Thus over the time, surface water supplies have become unreliable and unable to cope with increasing demand. Keeping in view the gravity of the problem, the World Bank and the Government of Pakistan agreed to initialize the institutional reforms in irrigation sector of the country. The process was given a legal shape in 1997**.** Pilot area project which was implemented in the LCC (East) canal command area in Punjab was finally given the rights of irrigation management by the end of year 2005. The present study was conducted to analyze the impact of these reforms on income of the wheat growers in the province of Punjab.
Keywords: gross value product, arithmetic, exchequer, stratified random sampling

INTRODUCTION

The agricultural growth has experienced mixed trends over the last six years. The long dry spells in the first two years of the millennium resulted in a drought like situation in the country. Hence agriculture registered negative growth in these two years because of severe droughts in the country, as well as environmental factors (increased soil salinity and deteriorating groundwater quality). In the following years (2002-03 to 2004-05), relatively better availability of irrigation water had a positive impact on overall agricultural growth and this sector exhibited modest to strong recovery. The performance of agriculture remained weak during 2005-06 because its crops sector particularly major crops could not perform up to the expectations. Growth in the agriculture sector registered a sharp recovery in 2006-07 and grew by 5.0 percent as compared with the preceding year's growth of 1.6 percent. On an average Pakistan's agricultural sector grew at a modest rate of 2.6 percent per year from 1999-2000 to 2005-06 (GOP, 2007).

Although limited water supplies had always been a serious concern among the nations of the world, yet it became a crucial issue since the last century. Increasing population pressure and resultantly rapid expansion in the area under the agriculture, to ensure food security, had put enormous pressure on the water supplies. According to a report, during the last century water availability had been threatened by an alarming increase in the demand for water which was increased six folds. It was further estimated that by the year 2025, world water demand would further increase 50 percent (World Bank, 2004a).

World Water Commission (2000) stated these realities in its report "Gloomy arithmetic of water". The report further stated that expanding population, overall economic growth in the world and increasing concerns for food security had increased the demand for water which had also resulted in increasing tension over water rights with in the society as well as across the societies.

In spite of the advancement in our agricultural sector, Pakistan's agriculture continues to suffer low productivity levels compared with world levels. Highly unpredictable growth rate, low levels of productivity especially in the case of major crop sector have resulted in unfavorable economic environment for the farming community. These conditions ultimately led to increased poverty in agricultural/rural areas as a consequence of adverse trends in rural employment and income distribution (Hussain, 2007). Several factors can be listed to these adverse trends; many of them may be associated with uncertain supply of irrigation water and management of the irrigation system.

The world's largest contiguous irrigation system was subjected to deterioration and poor operation,

management and maintenance during the last many years. Many studies have indicated the major problems and their root causes of the problems. Overall inefficiency of the system in terms of water delivery and efficiency had been increased and overall performance of the system reduced overtime (World Bank, 1994; Vermillion, 1997; World Bank, 2004b).

Since the importance of water sector specifically the irrigation sector has been well recognized to all the stake holders of the society in all corners of the world, concerns from all over the world are on increase for sustainable use of this precious resource. Perceived poor performance of public agency-managed irrigation schemes, the increasing burden of subsidies on government exchequers, poor delivery of irrigation agencies paved the way for implementation of institutional reforms aiming at devolving irrigation management functions from the agency - to the users, either local associations, NGOs, or a sort of new cooperative agencies - that would be more accountable to the needs of the users.

In Pakistan, reform process was started through a series of dialogue between the World Bank and the Government of Pakistan in which the later finally agreed to implement the reform process in the country gradually. The process was given a legal shape in 1997**.** Pilot area project which was implemented in the LCC (East) canal command area in Punjab was finally given the rights of irrigation management by the end of year 2005. The present study was conducted to analyze the impact of these reforms on income of the wheat growers in the province of Punjab.

MATERIALS AND METHODS

***Sampling framework*:** Reforms have been introduced in Punjab as a pilot project in Lower Chanab Canal (East) canal command area so the ultimate choice for the reform area selection was the LCC (East) area. "Before and After" situation approach has been employed in the present study. A multi stage sampling framework was designed to collect data from the field. At first stage, a purposive sampling was done to select 30 distributaries from the study area. Out of the 30 distributaries, 10 distributaries were selected purposively from the reform area. The selection was made by taking in to account that the distributaries had the homogenous characteristics and covered the whole system from head to tail. Out of these 10 distributaries, 60 water courses were selected by using stratified random sampling technique. Finally, 6 households were selected randomly through stratified random sampling i.e. 2 from each head, middle and tail. In all 360 households were interviewed and information were collected through well structured, comprehensive questionnaire in face to face situation.

***Analytical framework*:** A single equation model was used to estimate the impact of reforms on the income from wheat of the farmers. Cobb-Douglas production function approach as suggested by Gordon (1989), Zhang and Xue (2005) and Bhanumurthy (2007) was employed in this study. Generalized form of Cobb-Douglas production function used for wheat crop in the study area was as follow.

$$Lnwagvp = \beta_0 + \beta_1 lnwarea_{ij} + \beta_2 lnwscost_{ij} + \beta_3 lnwfcost_{ij} + \beta_4 lnwsicost_{ij} + \beta_5 lnwticost_{ij} + \beta_6 lnwmcost_{ij} + \beta_7 lnwlcost_{ij} + \beta_8 lnedu_{ij} + \beta_9 D_1 + \beta_{10} D_2 + \beta_{11} D_1 D_2 + \mu_{ij}$$

Where

β_0: Constant

lnwagvp: Natural Log of average real GVP of wheat crop of the i-th farm in the sample area expressed in Rs. per acre calculated (by using GDP deflator for the year 2001-02 as base).

$lnwarea_{ij}$: Natural Log of area under wheat crop in the sample area measured in acres.

$lnwscost_{ij}$: Natural Log of seed cost of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnwfcost_{ij}$: Natural Log of fertilizer cost of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnwsicost_{ij}$: Natural Log of surface irrigation cost of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnwticost_{ij}$: Natural Log of tube-well irrigation cost of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnwmcost_{ij}$: Natural Log of cost of mechanized operations of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnwlcost_{ij}$: Natural Log of cost of labour operations of the i-th farm for wheat crop in the sample area measured in real price (by using GDP deflator for the year 2001-02 as base) and expressed in Rs. per acre.

$lnedu_{ij}$: Natural Log of years of schooling of the i-th farmer for wheat crop in the sample area.

D_1: Dummy variable for location of outlet of specific farm. If D_1= 1, then it represents location at tail of

the distributary otherwise head or middle of the distributary.

D_2: Dummy variable for taking into account the implementation of reform process. If $D_2 = 1$ then it represents post-reform era and if value is 0 then it represents pre-reform period.

D_1D_2: Interaction variable of two dummies i.e. D_1D_2 was used to capture the impact of reform process on the farms located at the tail of the distributary.

μ_{ij}: Error Term

RESULTS AND DISCUSSION

Analysis of data was carried out to estimate the effect of irrigation reforms on farm income from wheat crop. Initially problem of multicollinearity was detected among different variables when Variance Inflation Factor VIF and tolerance of each variable was analyzed. To remove this problem and the problem of high R^2 and high adjusted R^2, analysis of only non-negative log values of different variables was carried out. Table 1 given below shows the mean and standard deviation of each variable included in the analysis for the wheat crop. Although real average cost per acre was not included in the model, it is shown in Table 1.

***Estimation of regression model for average gross value product of wheat*:** In this model average gross value product (GVP/acre) of the wheat crop (in real prices) has been taken as dependent variable to estimate the effect of reform process. Important components of variable cost i.e., seed cost, fertilizer cost, surface irrigation cost, tube well irrigation cost, mechanization and labour cost have been included in the regression model. Variables have been entered in the model as natural log form.

Table 2 summarizes the results of the regression model. The Cobb-Douglas model for wheat was estimated using lnwagvp (Natural log of per acre GVP,

Table 1. Descriptive statistics of important variables for wheat crop

Variables	Mean value	Std. Deviation
Real average gross value product/acre (Rs.)	12091.0	1727.0
Wheat area (acres)	6.97	10.7
Real seed cost (Rs.)	397.0	44.6
Real fertilizer cost (Rs.)	1493.0	377.0
Real surface irrigation cost (Rs.)	37.0	10.1
Real tube well Irrigation cost (Rs.)	862.0	434.6
Real mechanization cost (Rs.)	1254.0	348.2
Real labour cost (Rs.)	1142.0	430.9
Real average cost/acre (Rs.)	5442.0	1014.1
Average yield (maunds/acre)	33.0	4.9

Table 2. Estimated parameter of the income model for wheat crop

Variables	Parameter	T Value	Significance level
Constant	8.34	19.05	0.000*
lnwarea	-0.002	-0.195	0.84
lnwscost	0.07	1.20	0.22
lnwfcost	0.073	2.52	0.01*
lnwsicost	-0.018	-0.40	0.68
lnwticost	0.006	1.06	0.28
lnwmcost	0.017	0.68	0.49
lnwlcost	0.017	4.25	0.00*
lnedu	0.005	2.06	0.03*
D_1	-0.053	-1.76	0.08**
D_2	0.068	1.36	0.17
D_1D_2	0.026	1.01	0.31
F- Value	3.7		0.000*

*Significant at 5 percent level; **Significant at 10 percent level.

calculated by using real prices) as dependent variable. F-value depicted that the overall model was significant. The estimated coefficients (βs) of the explanatory variables showed the percentage change in dependent variable with one percent change in explanatory variable. Table 2 shows that three βs (lnwfcost, lnwlcost and lnedu) were significant at less than 5 percent level of significance and one β (D_1) was significant at about 10 percent significance level, while rest of the coefficients were non-significant at 10 percent level or below. Cost of chemical application was not included in the model as it was observed that in the study area use of chemicals application for wheat was very limited and only few farmers were applying the chemicals (herbicides spray) to the crop.

Coefficients of wheat area (lnwarea), surface irrigation (lnwsicost) and dummy variable (D_1) were negative. It was observed that each percent increase in the area under wheat crop for each farmer could reduce the respective average GVP by 0.002 percent, although the result was statistically non significant using t-statistics. Increase in the cost of surface irrigation water could also decrease the average GVP. There was an interesting finding that showed that without making any considerable improvements in the surface irrigation water supply, increase in water rates (*Aabiana*) could reduce the GVP of the farmers in the study area, although the coefficient was also statistically significant at 10 percent significance level.

The coefficients of dummy variable D_1 and D_2 which were introduced to measure the effects of location of the farm and impact of reforms on the real GVP of the farmers can be interpreted by using the Halvorsen and Palmquist device (Gujarati, 2003). This device uses the $e^{\beta i}$ value to estimate the percentage change in the mean value of intercept (i.e. base category). In case of D_1, coefficient showed that farmers at the Tail reaches of the distributary had about 5 percent less GVP as far as wheat crop was concerned. The result was significant at about 10 percent significance level. Similar conclusions had been drawn by Hussain *at al.* (2003) suggesting that Tail ends of the distributaries were characterized by majority of small, poor farmers in Pakistan.

In case of D_2, the coefficients depicted that although it was statistically non-significant yet it has a positive impact on the GVP of the farmers and has positive sign which was according to *a priori* expectations. In case of wheat crop, the real price was decreased from Rs. 373 to Rs. 352 in the year 2006 as compared to year 2004. Percentage change in D_2 was about 7 percent from that of the mean value of intercept.

Interaction term D_1D_2, was introduced in the model between two dummy variables. The coefficient was statistically non-significant but sit has a positive sign which showed that reforms have tilted the water equity towards the Tail end farmers.

CONCLUSIONS

Results of the study largely supported the notion that irrigation reforms were having positive effect on the cost recovery, O&M of the system, overall system management, head-tail equity ratio, productivity of the major crops and income of the farmers. The results indicated that the impact of the reforms on the earning of the farmers (in shape of GVP) was positive and statistically significant in case of wheat crop.

It is also concluded that the initial results of the reform process are satisfactory but sustainability of the system is still a question. It was observed that participation of farmers in irrigation management is of considerable value and needs to be pursued. The extent and arrangements for farmers participation however depends on local environment. The patterns of other countries can serve as useful models, but do not necessarily have universal application. The strategies for improving irrigation system management need to be evolved in the context of Pakistan's socio-economic and cultural setting.

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