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Procedia Economics and Finance 2 (2012) 292 – 298

Procedia Economics and Finance

www.elsevier.com/locate/procedia

2nd Annual International Conference on Qualitative and Quantitative Economics Research (QQE 2012)

Irrigation, Farm Productivity and Poverty Reduction in KPK: Understanding Direct and Indirect Impacts and Linkages

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Abstract

The present study was conducted in Stage II of the Chashma Rgith Bank Canal area in D.I. Khan District. The study was based on 139 farm households randomly selected in the study area. The aim of the study was on some of the fundamental questions in relation to irrigation, farm productivity and poverty linkages: (1) Has irrigation played an important role in improving productivity and aggregate food production. (2) Has it also reduced poverty and improved rural incomes? The paper identifies conditions under which irrigation has greater anti-poverty impacts. The analysis of data suggests that there are strong linkages between irrigation, crop productivity and poverty alleviation. The linkages between irrigation and poverty alleviation are both direct and indirect. Irrigation has benefited the poor through higher agricultural productivity; higher yields increased cropping intensity, increased income, consumption and savings as well as higher farm and off-farm employment. The indirect linkages operate via regional, national and economy–wise effect.

Keywrods: irrigation; performance; crop productivity; poverty alleviation; diversification; land holdings; Pakistan.

1. Introduction

The province of Khyber Pakhtunkhwa is less developed in terms of agricultural productivity as compared to other provinces like Punjab and Sind. Sugarcane, wheat, maize, and chickpea are the main crops of this area. The southern districts are more backward where the yields of different crops are much lower than

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 doi:10.1016/S2212-5671(12)00090-1

that of the Peshawar Valley. D.I. Khan, the area of this study, is poverty stricken. Illiteracy and unemployment are widespread. Yields of crops are low. However, there has been phenomenal change in the agricultural economy of this district because of the construction of Chashma Right Bank Canal (CRBC). It has led to increase in cultivated area as well as crop yields. Sugarcane was not grown before the construction of CRBC but it has become one of the major crops in the study area. The major crops grown are wheat in the *rabbi* season and rice in the *kharif*, sugarcane as a yearlong crop covers both seasons. Other crops in rabbi and *kharif* season are less than 10 %. (Sheladia Associates, Inc., 2001). The paper seeks to answer questions with respect to the role of irrigation in enhancing farm productivity and poverty reduction. The study aims at improving the understanding of how and to what extent irrigation has played a positive role in poverty alleviation. The study investigates that under what conditions the irrigation has significant impacts on poverty reduction. Research methodology is described in section II. The study findings and results are discussed in Section III. Conclusions and recommendations of the study have been given in section IV.

Literature regarding the impact of irrigation on farm yields and poverty reduction is well documented. The detail literature can be seen in Hussain et. al (2006). We, however, understand that no such study has been undertaken in the study area. The present study would constitute as a pioneering work in this area.

2. Research Methodology

2.1 Universe and Sample of the Study

D.I. Khan District constituted the area of this study. Five villages were purposively selected from the study area. The selected villages truly represent the study area. A random sample of 139 households in these villages was used for this study. A pre-tested interview schedule was used for data collection. The data were collected in June-August 2004. The statistical package for social sciences (SPSS) was used for data analysis.

2.2 The Econometric Model

We specified the following logit model which has the capability of dealing with a binary dependant variable and it has a well-established theoretical background.

The logit model based on the logistic probability is specified as

$$P_i = E(Y = 1 | X_i) = F(Z_i) = F(\alpha + \beta_i \sum_{i=1}^{n} X_i) = \frac{1}{1 + e^{-Z}} \qquad (1)$$

Where $Z_i = \alpha + \beta_i \sum_{i=1}^{n} X_i + \varepsilon_i$ (the cumulative logistic density function) (2)

$$P_i = \frac{e^{Z_{ii}}}{1 + e^{Z_{ii}}} \text{ and } (1 - P_i) = \frac{1}{1 + e^{Z_i}} \qquad (3)$$

Odd ratio is given by $\frac{P_i}{1 - P_i} = e^{Z_i}$ (4)

Taking a natural logarithm of eq. (4) we obtain

$$Z_i = \ell n\left(\frac{P_i}{1 - P_i}\right) = \alpha + \beta \sum_{i=1}^{n} X_i + \varepsilon_i = L_i \qquad (5)$$

Where Pi is the probability that Yi = 1, that a randomly chosen household is efficient in crop productivity, 1-Pi is the probability that Yi = 0, that a randomly chosen household is not efficient in crop productivity, β_i are coefficients of explanatory variables to be estimated. The unknown parameters βi are usually estimated by maximum likelihood. Xi are explanatory variables which include area under jth crops, labor used in man-days during the entire crop season, number of irrigations, use of chemical fertilizers and farm yard manure and highest level of farmer education, etc. e = base of natural logarithm, ε_i = the stochastic error term, $\ln\left(\frac{P_i}{1-P_i}\right)$ = Li (also called logit) is the log odds ratio of the probability that a household is efficient in crop productivity to the probability that it is not. It is linear in both independent variables and parameters. This was estimated using maximum likelihood estimator (MLE). In addition, the multiple regression model of the following form was also estimated.

$$\ln Y_j = \beta_0 + \beta_i \sum_{i=1}^{k} \ln X_i + \varepsilon_i \qquad (6)$$

Where Yj = Natural logarithm of net revenue from the jth crop, X1 = crop area in acres, X2 = use of labor in man days, X3 = Irrigation, X4 = Fertilizer in kilograms, X5= Level of education of farmer, ln = natural log, and βi are regression coefficients and εi= Stochastic error term.

3. Results and Discussion

3.1 Irrigation - Agricultural productivity-Poverty alleviation linkages

Figure 1 shows the linkages that exist among irrigation, farm productivity and poverty alleviation. It shows how access to irrigation facilities benefits farm households directly through increased crop yields, crop area, cropping intensity and crop diversification as well as increased income, consumption and savings, increase in food security and farm and off-farm employment. It also shows it indirectly effects farming community.

Development of irrigated agriculture benefits land-owning households in the first instance by increasing their incomes from gains in productivity. One challenge in promoting irrigation for poverty reduction is to specifically target the land-poor. The land-poor include those who neither own nor operate land, or whose major source of income is derived from agricultural wage employment, even if they own or rent small amounts of land. These programmes include: (i) employment-intensive construction, operation and maintenance practices, (ii) approaches that allow the land-poor to own irrigation systems and sell water for profit, (iii) settlement practices that allocate irrigable land to the land-poor when irriga¬tion is introduced, or the water supply is extended, (iv) rights of water use and appropriate technology for unregistered water users (such as squatters in urban and rural areas), (v) compensation and justice for dispossessed cultivators, (vi) institutional reforms to give security of water supply to the poor in times of scarcity, (vii) mobilizing small or marginal quality supplies to help disadvantaged rain-fed farmers (FAO, 1999).

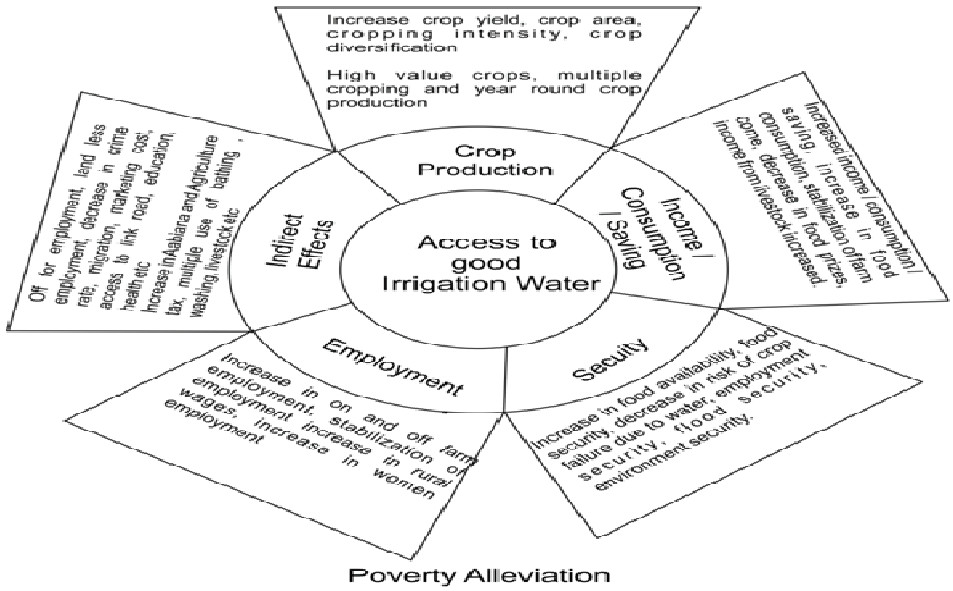

Figure 1: Linkages among Irrigation, Farm Productivity and Poverty Reduction

3.2 Estimation of Multiple Regression Models

Results of the estimated regression models are available in Table 1. The dependent variables in the estimated equations are net revenues from the selected crop yields. The analysis confirms the significant role of irrigation in crop yield. The coefficient of irrigation is highly statistically significance which means that irrigation has positively changed crop yield. Therefore, we can infer that the CRBC has played a role of pivotal importance in increasing yields of various crops.

Table 1 Estimated Multiple Regression Equations

Variables	Wheat	Gram	Sugarcane	Rice
Intercept	38.6	33.6	1834.5	1728.4
Crop area	0.65*	0.31	1.11**	0.20*
	(2.13)	(1.52)	(3.41)	(2.11)
Chemical fertilizer	1.63**	0.62	0.82**	0.8**
	(2.59)	(1.51)	(3.21)	(2.63)
No. of irrigation	0.92**	0.63*	0.81**	0.93**
	(4.13)	(2.15)	(3.11)	(3.61)

Level of education	0.41*	0.21*	0.42*	0.43
	(2.10)	(2.19)	(2.32)	(1.42)
Labour	0.40	0.31*	0.32*	0.29*
	(1.59)	(2.40)	(2.21)	(2.10)
R^2	0.43	0.38	0.45	0.37
Sample Size	139	139	139	139
F. Stat	22.4	19.7	26.4	23.5

Note: Numbers in parentheses are t-stats. * and ** shows significance at 5% and 1%, respectively.

3.3 Results from Logistic Regression

The results of the logit analysis are given in Table 2.

Table 2. Effects of Socio-economic Characteristics on the Probability of Farm Household being Efficient in Profit Maximization (Results of Logit Regression)

Independent Variable	Coefficient
Constant	3.75 (0.25)
Area under crops	0.16 (4.1)***
Irrigation (No.)	0.14 (3.5)***
Labour (man-days)	0.01 (2.1)
Chemical Fertilizers	0.35 (2.16)**
Education of household members (No. of school years)	0.02 (2.10)**
Household Size (Nos.)	0.08 (2.3)***
Log (L)	231
Sample Size	139
Per cent correct predicted	0.76 %

Note: The numbers in parentheses are the ratio of the coefficients to the estimates of their asymptotic standard errors. *, **, and *** show significance level of 10, 5 and 1 percent, respectively.

4 CRBC and Poverty Alleviation

As can be seen in the previous sections, the CRBC has led to reduce poverty in the area. It has led to increase in crop production and yields as well as improvement in farm and family incomes. The findings of the study imply that improved irrigation access has contributed much to the poverty alleviation in the form of improved employment and livelihoods in the command area. Intensities of cropping have gone up. Crop productivity have been improved. Household incomes, level of consumption as well as saving have been increased. Socio-economic conditions of the people of the area have been uplifted. There has been an increase in the number of *pucca* houses in the study villages after the CRBC. The findings of the study confirm very strong linkages between irrigation and farm productivity and between increased agricultural productivity and poverty alleviation. That data also shows a strong linkage between irrigation and poverty. There are direct and indirect linkages where the former linkages shows local and household level effects while the latter shows aggregate sub-national and national impacts. Irrigation has benefited people through higher yields, increased area under crops. Direct effects also shows more diversified cropping pattern and from low valued subsistence production to high valued market oriented production. This increased production made food available and affordable for all and especially for poor.

The indirect linkages work through regional, national, and economy wide effects. Irrigation investment acts as production and supply shifters and has a strong positive effect on growth. The indirect effects shows increased markets in the command area, better health and sanitation conditions, demand for education and better education , availability of drinking water, increased in non-farm employment, decrease in crime rate, rural to urban migration has reduced as people are getting employment at their door step in the agriculture sector. Irrigation benefits the poor and landless in the long run through farm and off farm employment and through low food prices.

5 Conclusions and Recommendations

The paper concludes that the livelihood of farming community can further be improved if the following recommendations could be adopted in the study area in particular and in the country in general.

Continued investment in irrigation will be central to future food production. Rain-fed agriculture will not be able to keep up with the growing demands to feed increasing populations. In this case, investment in irrigation would be a key element of the strategy to increase food production and maintain stable prices for food crops.

By extending irrigation, increased production and employment can be created. Participatory design, sensitive to environmental and societal conditions, will be essential to prevent repetition of past weaknesses in irrigation development. Improved access to water by small farmers at a scale of development suited to the local conditions will be essential.

The involvement of farmers in the identification and design process and their investment in the scheme in terms of money and labor are essential to achieve sustainable development. In all cases support is needed to improve management and institutional structures so that poor smallholders benefit from reliable water supplies. An improved awareness of the interventions and initiatives that can sustain irrigation, both physically and institutionally, will be important to prevent impoverishment of small irrigators.

Initiatives that involve the landless gaining access to the benefits of irrigation require greater exposure. New concentrations of the poor in peri-urban areas and regions where water resources are scarce and risk-prone need to be targeted. These areas may still be vital to providing a livelihood to families with few other opportunities. The poor also need to be able to defend their water rights in the face of competition from both larger farmers and from other sectors of water use. Support should be given to irrigation management organizations that promote equitable and efficient use of natural resources, both land and water.

Acknowledgements

The authors are highly obliged to Higher Education Commission, Islamabad Pakistan for providing travel grant for presenting this paper in the Second International Conference on Qualitative and Quantitative Economics Research held on May 21-22, 2012 in Singapore. The authors would also like to thank the Global Science and Technology Forum, Singapore for providing their encouragement and publication of this study in their proceedings.

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