 Allocative Inefficiency and Tenure Arrangements in Irrigated Agriculture in Pakistan

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Introduction

Pakistan is home to one of the largest and most complex irrigation infrastructure systems in the world, consisting of 25 million hectares of irrigated agriculture, 56,000 kilometers of main canals, and tubewells in excess of 600,000. Nearly 100 million people depend on 107,000 water courses that are fed by 44 canal systems. Ineffective water management policies in the past have affected water availability and soil quality.

Pakistani agriculture is characterized by a diversity of tenure arrangements that reflect the risks and constraints that farmers face. Agricultural tenure falls under three basic categories: owner-cultivators, fixed-rent tenants, and sharecroppers. Tenure arrangements involving irrigated agriculture in Pakistan could lead farmers to misallocate inputs. In addition, differences in incentives across tenure systems may explain an important part of Pakistan’s water management issues.

Pakistan’s economic growth strategy, as laid out in the report Pakistan: Framework for Economic Growth 2011, emphasizes irrigation water reform as one of its goals to enhance agricultural productivity. Past studies have identified over-watering as a major problem in Pakistan’s agricultural sector. These studies show that agricultural crop yields in Pakistan decline with surface water use and that low surface water charges increase the incentive for farmers to over-utilize surface water.

However, a comparison of agricultural crop yields with surface water availability alone may be misleading, because yields also depend on a host of other farm-specific factors, such as utilization of groundwater, other agricultural inputs, soil quality, weather conditions, and technical knowledge of farmers. Quantification of the effect of irrigation water on agricultural yields in Pakistan requires a more systematic approach with simultaneous considerations of surface and groundwater sources.

Most farmers in Pakistan supplement surface water with groundwater, and the share of groundwater in irrigation has increased significantly in the last two decades. However, the degree of utilization of both sources of irrigation water depends on many factors. Since most tubewell pumps utilized to extract groundwater in Pakistan are diesel-operated, the price of groundwater in Pakistan varies with the price of diesel and is relatively high. The degree of utilization of groundwater and surface water also depends on access to capital and interest rates, which are influenced by tenure and the overall institutional environment of farms. To help achieve the goals of Pakistan’s economic growth strategy, a comprehensive analysis is needed to identify the factors that influence the efficiency of utilization of irrigation water in Pakistan and to formulate policies that could lead to a more optimal allocation of irrigation water.
This paper provides an empirical analysis of groundwater, using a rural household panel dataset from Pakistan that spans the period 2000-2001 to 2003-2004. The paper examines the utilization and allocative efficiency of groundwater, and compares it across a number of important farm characteristics.

**Technical vs. allocative efficiency**

Given the differences in incentives across tenure systems, one way of examining Pakistan’s water-management problem in relation to institutional constraints is through estimating the allocative efficiency of irrigation water within each tenure system. Allocative efficiency reveals the degree of over- or under-utilization of inputs, given their prices. It measures the ability of a firm to use inputs in optimal proportions, given their prices and the existing production technology. Technical efficiency, in contrast, reflects the ability of a firm to produce the maximum output from a given level of inputs.

Studies on Pakistani agriculture have generally focused on overall technical and allocative efficiency of farms and have not compared input-specific allocative inefficiencies across tenure systems. Failure to account for input-specific allocative inefficiency might lead to biased estimates if the inputs are correlated with the error term. Estimation of input-specific allocative inefficiency explains the degree of utilization of each input. Quantifying the differences in input-use across tenure systems could help policymakers target input-conservation policies towards farmers under specific tenure arrangements.

The analysis in this paper shows that improvement in the technical efficiency of farms is likely to have a complicated relationship with the allocative efficiency of groundwater. At low levels of technical efficiency – at which many farms operate – there appears to be opportunity for improving technical and allocative efficiency simultaneously. But at higher levels of technical efficiency, there is a trade-off. Thus, the constraints that affect the technical efficiency of farms could also indirectly affect farms’ allocative efficiency, but the direction of the impact would depend on the level of technical efficiency.

Results of water productivity vary by the context of the analysis. The paper finds that groundwater per hectare had the largest marginal effect on output per hectare across most farm groups, when the analysis used all pooled data. Surface water per hectare, in contrast, does not have a significant effect on land productivity across any of a number of farm groups. When the model was estimated for each season separately, the impact of groundwater on land productivity was not statistically significantly different across seasons. However, groundwater per hectare showed the largest marginal impact on land productivity in the rabi (spring harvest) sample. The effect of surface water became pronounced in the rabi sample, but was zero in the kharif (autumn harvest) sample.

Low surface water charges have been suggested as a cause for over-use of surface water, poor maintenance of irrigation infrastructure (through lack of resource generation), and failure to move scarce water to higher value uses. These factors likely contribute to the elasticity estimates for surface water.

**Conclusion**

This paper found evidence that suggests drawbacks and limitations of the current institutional environment of irrigation water management in Pakistan. Results show that sharecroppers operate closer to the production frontier than owner-cultivators, although there was a high degree of inefficiency for both groups. The results for the allocative efficiency of groundwater showed significant differences in the utilization of groundwater across tenure and farm size. Differences in allocative efficiency across tenure and farm size might be explained by distortions in output and input prices, and by differential constraints.

This policy note is based on a paper of the same title.

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