Policy brief
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Missing Water

Agricultural Stress and Adaptation Strategies in Response to Groundwater Depletion among Farmers in India

In brief

- Approximately 38 percent of the world's irrigated area is irrigated with groundwater and approximately 60 percent of Indian agriculture is sustained by groundwater. However, groundwater irrigation is also leading to substantial declines in groundwater levels, imposing huge costs in terms of unmet drinking water needs and long term productivity declines.

- Groundwater irrigation may also have gender implications. Women often walk significant distances to collect groundwater for drinking water.

- This paper seeks to determine the causal impact of groundwater stress on agricultural outcomes, and to shed light on short term adaptation strategies that farmers use to cope with water stress.

- Groundwater stress has a causal impact on food production. This finding was calculated using district groundwater levels for 1999 to 2003. A 1 meter decline in groundwater level in a year reduces food-grain production by 8 percent, water intensive crop production by 9 percent, and cash crops by 5 percent

- For short run shocks to groundwater, agricultural production for food-grains and water intensive crops are unchanged, suggesting that farmers resort to intensifying the use of inputs to sustain their yields, but area under cultivation falls by 7 to 8 percent.

- In designing conservation policies, the results of this research provide a useful estimate of benefits. If the trends in groundwater depletion are not reversed, food scarcity may become a serious public policy challenge. Prices of food-grains may increase and farmer profits may decrease. Interventions to address this will need to be designed.

Policy Motivation

"Around 38 percent of the world's irrigated area is irrigated with groundwater, and groundwater reliance is much higher in India, where groundwater sustains 60 percent of agriculture"

This paper examines the impact of ground water stress on agricultural outcomes in India. Groundwater provides timely irrigation, which can increase agricultural productivity (Food and Agricultural Organization, 2003). Around 38 percent of the world's irrigated area is irrigated with groundwater, and groundwater reliance is much higher in India, where groundwater sustains 60 percent of agriculture (World Bank, 2010). On the other hand, groundwater irrigation in many countries including Mexico, United States, Yemen, Pakistan, China, and in particular in India, is leading to a substantial decline in groundwater levels. This can impose huge costs in terms unmet drinking water needs and long term declines in productivity. This can also have gender implications as women walk significant distances to collect groundwater for drinking water needs. Inspite of these costs and benefits of increasing groundwater irrigation, there is no systematic empirical evidence on the impact of groundwater stress on agricultural outcomes. The objective of this paper is to fill this gap by providing this evidence. This paper makes two contributions. First, it determines the causal impact of groundwater stress on agricultural outcomes using a detailed panel data set which provides actual measures of groundwater level. Second, it sheds light on the short term adaptation strategies that the farmers use to cope with water stress.

Policy Impact

From policy perspective, these results are important to understand the cost- benefit of increasing groundwater access for irrigation, and designing conservation strategies in the future.

Audience

Ministries of Water Resources and Agriculture, Planning Commission

Policy Implications

Groundwater stress has a causal impact on food production

"A 1 meter decline in groundwater level in a year reduces food-grain production by 8%, water intensive crop production by 9%, and cash crops by 5%"

The paper uses annual deviations of district groundwater levels for 1999 to 2003 from the medium run means, to investigate how production and area under cultivation respond to water fluctuations. Conditional on district fixed effects, year fixed effects and district specific trends, these deviations are plausibly exogenous. The paper finds that a 1 meter decline in groundwater level in a year reduces food-grain production by 8 percent, water intensive crop production by 9 percent, and cash crops by 5 percent.

For short run shocks to groundwater, agricultural production for food-grains and water intensive crops are unchanged, but area under cultivation falls by 7 to 8 percent

The research makes use of natural fluctuations in groundwater levels within Indian districts and transitions of ground water levels around the depth of 8 meters at which physical constraints limit use of cheaper technology to access groundwater, to estimate the impact of groundwater stress and coping strategies used. The results show that for short run shocks to groundwater, agricultural production for food-grains and water intensive crops are unchanged, but area under cultivation falls by 7 to 8 percent, whereas there is no change for cash crops suggesting that farmers resort to intensifying the use of inputs to maintain their yields. Using the transitions of decadal means around this cutoff, paper examines exit of farmers from agriculture and finds no evidence of exit of marginal and small farmers.

"In designing conservation policies, the results of this research provide estimates of benefits. These results are based on nationally representative data from India and apply to the country as a whole"

Implementation

The paper identifies the cost of 1 meter decline in levels of groundwater in terms of agricultural output. In designing conservation policies, the results of this research provide estimates of benefits. These results are based on nationally representative data from India and apply to the country as a whole. If the trends in groundwater depletion are not reversed, food scarcity can be a serious public policy challenge. Prices of food-grains can increase and farm profits can shrink. Interventions to reverse these trends will need to be designed. Some options like rain water harvesting are already being explored but these might have to be scaled up. It might be worthwhile to promote water saving irrigation practices and technologies (example laser levelers).

In implementing these initiatives, adoption of these practices and technologies by farmers can be a challenge. Subsidies for better farm practices and or water saving technologies might be worth exploring. From a public finance perspective, the cost benefit analysis for promoting such initiatives can be carried out using these estimates.

Dissemination

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Further Readings

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