Policy Brief: Reducing electricity use in irrigation - Results from a randomized control trial in Bangladesh

February 2022

Reducing electricity consumption worldwide is a critical step towards lowering greenhouse gas emissions and global warming. While most policy focus has targeted residential electricity consumption, relatively little attention has been paid to electricity use in agriculture. This paper looks at a range of approaches to applying a simple technique to reduce water usage, and so also reduce electricity for water pumping, in rice production Bangladesh.

Key messages and recommendations

The introduction of the alternate wetting and drying (AWD) irrigation technique in Bangladesh under this experiment was shown in this experiment to reduce daily electricity consumption for irrigation by up to 40%, but only in certain circumstances. Recommendations emerging from this research include:

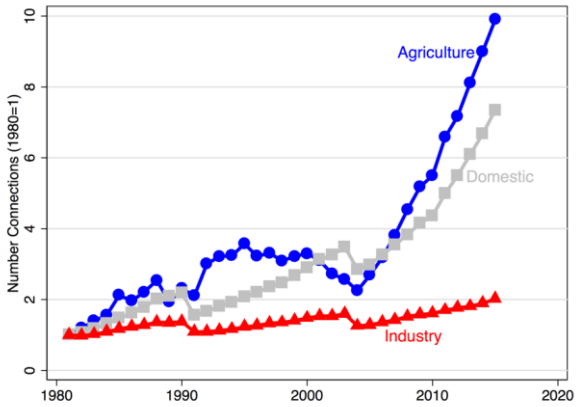
- In Bangladesh irrigation, where water for rice is sold to farmers by tube well owners, the study found the most effective way to introduce the AWD technique was to provide the subsidised PVC plastic pipes required to observe groundwater levels directly to the tube well owners. Providing pipes to individual farmers did not result in an uptake of the technique.
- Whilst providing pipes and information to tube well owners ensured the AWD technique was applied, resulting in substantial reductions in electricity usage, there was little evidence of reduced costs being passed on to farmers by tube well owners. If policy objectives were to ensure the resulting social benefits were spread more widely than tube well owners (as opposed to just ensuring more efficient use of electricity), then further research would be required to explore mechanisms to bring that about.

Introduction

Reducing electricity consumption worldwide is a critical step towards lowering greenhouse gas emissions and global warming. While most policy focus has targeted residential electricity consumption, relatively little attention has been paid to electricity use in agriculture. This sector has seen phenomenal growth in recent decades. Governments worldwide have boosted farm production by encouraging farmers to grow crops in the dry season when there is little rain and electricity is frequently used for irrigation. For example, in Bangladesh, while domestic and industrial use of electricity occupies the largest share, agricultural connections have grown the fastest in recent decades, even outpacing domestic connections in recent years, as shown in Fig.1.

Researchers from Tufts University and the International Rice Research Institute in Dhaka, Bangladesh studied the adoption of a simple water-saving technology known as AWD (Alternate Wetting and Drying).

Figure 1: The growth of electricity connections across sectors of Bangladesh



In a previous RCT, we found that AWD reduces water use by about 20%, and electricity consumption by the same margin, when it is practiced correctly. Farmers who adopt this technology increase their profits as well. However, in most rice growing regions of Bangladesh, which heavily use groundwater, farmers pay for irrigation water through seasonally fixed per acre contracts, which unfortunately gives them no incentive to save water.

Research approach

Researchers from Tufts University and the International Rice Research Institute in Dhaka, Bangladesh studied the adoption of a simple water-saving technology known as AWD (Alternate Wetting and Drying). AWD is nothing more than a plastic PVC pipe open at both ends and drilled with holes. The pipe is planted in the rice field and allows the farmer to monitor soil moisture and only irrigate the field when below-ground water levels inside the pipe fall lower than a 15 cm trigger. In a previous RCT, we found that AWD reduces water use by about 20%, and electricity consumption by the same margin, when it is practiced correctly. Farmers who adopt this technology increase their profits as well. However, in most rice growing regions of Bangladesh, which heavily use groundwater, farmers pay for irrigation water through seasonally fixed per acre contracts, which unfortunately gives them no incentive to save water.

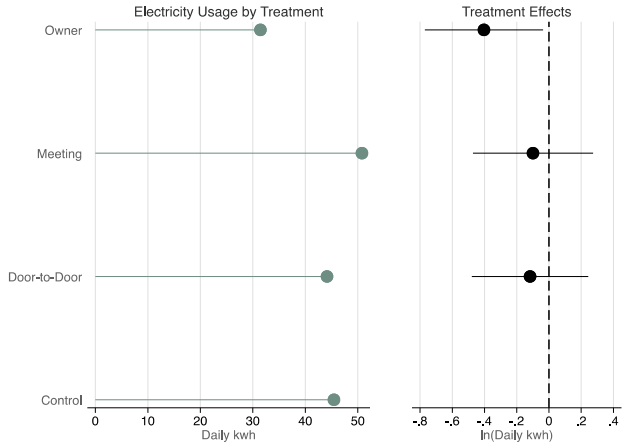
In these environments, where farmers do not pay marginal prices, promoting water-saving technologies like AWD can be a challenging task. Landholdings in rural Bangladesh are fragmented and farmers have small plots usually served by 1-2 private tube wells in the village. These tube well owners (water sellers) often pay for the electricity costs themselves and charge farmers a fixed fee by the season. These water sellers also coordinate the irrigation schedules among their buyers, to minimize losses in conveyance.

Our randomized control trial took place in the Mymensingh division of Bangladesh where per-acre water charges are quite common. A total of 360 villages were randomly divided into four groups. In the first group, farmers were offered subsidized pipes directly at their door. In another 105 villages, the subsidized pipes were offered directly to water sellers only. In a third group of 105 villages, we offered the pipe to individual farmers but during a village meeting. This third arm was designed to overcome possible coordination failures – farmers may be able to discuss and figure out how best to procure and place pipes in the command area to obtain the greatest benefit in terms of water use. Each of the first three arms received one of two randomized village level prices, both of which are lower than the market price of the pipe. Finally, the last group of 45 villages acts as a pure control. Electricity readings from the meters were then taken during unannounced visits to all villages.

Findings

After two years, statistically significant reductions in electricity usage were only detected in the arm in which the technology was targeted to the tube well owner. We found a statistically significant 40% reduction in daily electricity use in that arm, and limited impact in the other arms (see Fig.2). Mean daily electricity use in the control villages was 46 kwh/acre which decreased to 31 kwh in the villages where the owners were sold the pipes. However in these villages we did not observe any significant effects on the water price per acre, rice yields or the payment flexibility afforded to farmers by the owners.

Figure 2: Electricity use after two seasons declined sharply when the pipes were sold to tube well owners.



Our study shows that a subsidy that is targeted to the owner of the tube well results in significant social benefits. The owners lower their electricity costs. Whether some of that is ultimately shared with the farmers in the form of reduced per-acre fees or through other types of transfers is unclear and a topic for further analysis. However, the study shows that this is a likely channel through which this technology can be effectively disseminated and may result in large savings in water and energy.

About the authors:

Humnath Bhandari is the Country Representative for the International Rice Research Institute in Dhaka, Bangladesh

Ashraful Habib is a Senior Specialist at the International Rice Research Institute, Dhaka, Bangladesh

Ujjayant Chakravorty and Kyle Emerick are Professors, at the Department of Economics, Tufts University, Medford, MA, USA

Contact: kyle.emerick@tufts.edu

The views expressed in this Policy Brief do not necessarily reflect the UK government's official policies.