Year 2 Pre-Analysis Plan: Impact of Alternate Wetting and Drying on Farm Incomes and Water Savings in Bangladesh

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January 15, 2018

1 Overview

This document describes the analysis to be carried out for the second year of data collected on the project "Impact of Alternate Wetting and Drying on Farm Incomes and Water Savings in Bangladesh". We first describe our interventions. Each regression and outcome variable is then specified and the blank regression tables are included at the end of the document.

The first year of the study quantified the impact of Alternate Wetting and Drying (AWD). AWD is a water management technique for irrigated rice that involves inserting a perforated PVC pipe into the soil to allow the farmer to observe soil moisture below the surface. The AWD guidelines suggest that the farmer let the field dry until the water level reaches 15 cm below the surface — which has a visible marking within the pipe. Once this water level is reached, the farmer should re-irrigate the field up to a level that depends on the current status of the crop. The process of alternatively wetting and drying the field should be practiced up to the time that the crop starts to flower or reproduce. The farmer should keep sufficient water in the field during flowering because the crop water requirements are much higher during flowering relative to the previous vegetative stage of growth. The farmer also drains the field approximately one to two weeks before harvest, regardless of their chosen method of irrigation. AWD is meant to reduced total irrigation withdraw relative to a system where the field is never allowed to dry, i.e. "continuous flooding". In addition, agronomic trials on experiment stations have found that AWD reduces the methane emissions from rice relative to continuous flooding.

This phase of the study turns to understanding the barriers to AWD adoption. In particular, does the absence of volumetric water pricing limit the uptake of AWD? We have two sources of random variation.

1. Demand curves for AWD will be estimated in 312 villages (56 in Mymensingh, 56 in Rangpur, and 200 in Rajshahi). All villages in Mymensingh and Rangpur, along with 56 of the villages in Rajshahi, were part of the first year of the study. The sample for the demand curve estimation amongst these villages contains 25 farmers per village - 10 farmers from the previous phase of the study and 15 new farmers. A complete roster of 25 new farmers was identified in the 144 new villages of Rajshahi. The random prices for AWD are set at the village level and will range from 20 taka (around $0.24) to 90 taka (around $1.10).

2. Focusing on the 144 new villages in Rajshahi, we designed a simple treatment to increase the penetration of prepaid irrigation cards. These cards allow the farmer to pay for water by the hour, rather than on a seasonal basis. In effect, this treatment is intended to convert farmers from seasonal contracts for water to volumetric pricing. In

a random 96 of the 144 villages we organized meetings with the 25 farmers, explained to them the application process for prepaid cards, helped them fill out the necessary paperwork (including a picture of their ID and a passport-size photo) and agreed to pay the 152 taka signup fee on their behalf. This campaign was meant to increase the penetration of volumetric pricing within villages, allowing us to test whether pricing policy is a barrier limiting uptake of AWD.

2 Specifications

2.1 Effect of random prices and volumetric pricing on AWD purchase, use, and water management

The basic estimate of the demand curve will be

$$purchase_{iv} = \beta_0 + \beta_1 price_v + \varepsilon_{iv}, \tag{1}$$

where $purchase_{iv}$ is an indicator variable for choosing to purchase an AWD pipe and $price_v$ is the random village offer price. The standard errors will be clustered at the village level and the model will be estimated with a linear probability model. We will also include additional specifications to account for different functional forms:

- Price is measured in logarithmic form
- A fully non-parametric specification using dummy variables for each of the prices (results to be shown graphically in the main text)
- A non-parametric Fan Regression

We will focus on the 144 new villages in Rajshahi to estimate the impact of volumetric pricing. Defining $treat_v$ as in indicator for the villages with prepaid irrigation card distribution, we will estimate

$$purchase_{iv} = \beta_0 + \beta_1 price_v + \beta_2 treat_v + \beta_3 treat_v * price_v + \varepsilon_{iv}, \tag{2}$$

The standard errors will continue to be clustered at the village level. In this model we will make the trivial modification of subtracting 90 from the price. This allows us to interpret β_2 as the effect of introducing volumetric pricing at the relatively higher price of 90 taka. Similarly to Equation (1), we will also estimate this regression using the log of price (with-out any normalization of course). We will also estimate a simpler version of 2 where the interaction term is dropped.

Survey teams will visit the farmer's fields during the year to observe whether the AWD pipe has been installed and to measure the amount of irrigation water. This provides additional outcome variables to use in specifications equivalent to equations 1 and 2. The additional variables are whether AWD has been installed in the field, the amount of water in the field, and an indicator variable for whether the field is dry.

2.2 Correlates of willingness to pay

We will also estimate the correlates of demand. The baseline covariates to be considered are:

1. Farm size
2. Age
3. Education
4. Asset Ownership
5. Livestock Ownership

2.3 Usage of prepaid cards

We will attempt to obtain data from the government authority that manages the irrigation tube wells. Such data will allow us to track how the prepaid irrigation cards are being used in the prepaid treatment villages. We will also try to obtain data on the usage of prepaid cards in the control villages. Using these data, our basic specification will be

$$y_v = \beta_0 + \beta_1 treat_v + \varepsilon_v, \tag{3}$$

where the outcome y is now at the village level, $treat_v$ is an indicator for villages where volumetric pricing was introduced with prepaid irrigation cards, and the regression is estimated with heteroskedasticity robust standard errors. The outcomes y_v will be as follows:

1. Number of cards loaded with credit by farmers
2. Number of unique cards used to buy water
3. Average number of times each card loaded by farmers
4. Average load amount

5. Average amount spent on irrigation throughout the season

6. Quantile regressions for average spending (each decile from 10 to 90%)

Tables

Table 1: Effects of prices on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				

Table 2: Effects of prices on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Log Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				

Table 3: Effects of volumetric pricing treatment on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Volumetric Treatment				
Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				

Table 4: Effects of volumetric pricing treatment on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Volumetric Treatment				
Log Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				

Table 5: Effects of volumetric pricing treatment on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Volumetric Treatment				
Price				
Volumetric Treatment * Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				

Table 6: Effects of volumetric pricing treatment on demand, usage, and irrigation management

	(1) Purchase AWD	(2) AWD in field	(3) Water Level	(4) Dry Field (0/1)
Volumetric Treatment				
Log Price				
Volumetric Treatment * Log Price				
Mean of Dep Variable				
Elasticity at Mean				
Number of Observations				
R squared				