Evaluating the impact of reliable water supply in the adoption of alternate wetting and drying irrigation practice for rice in China

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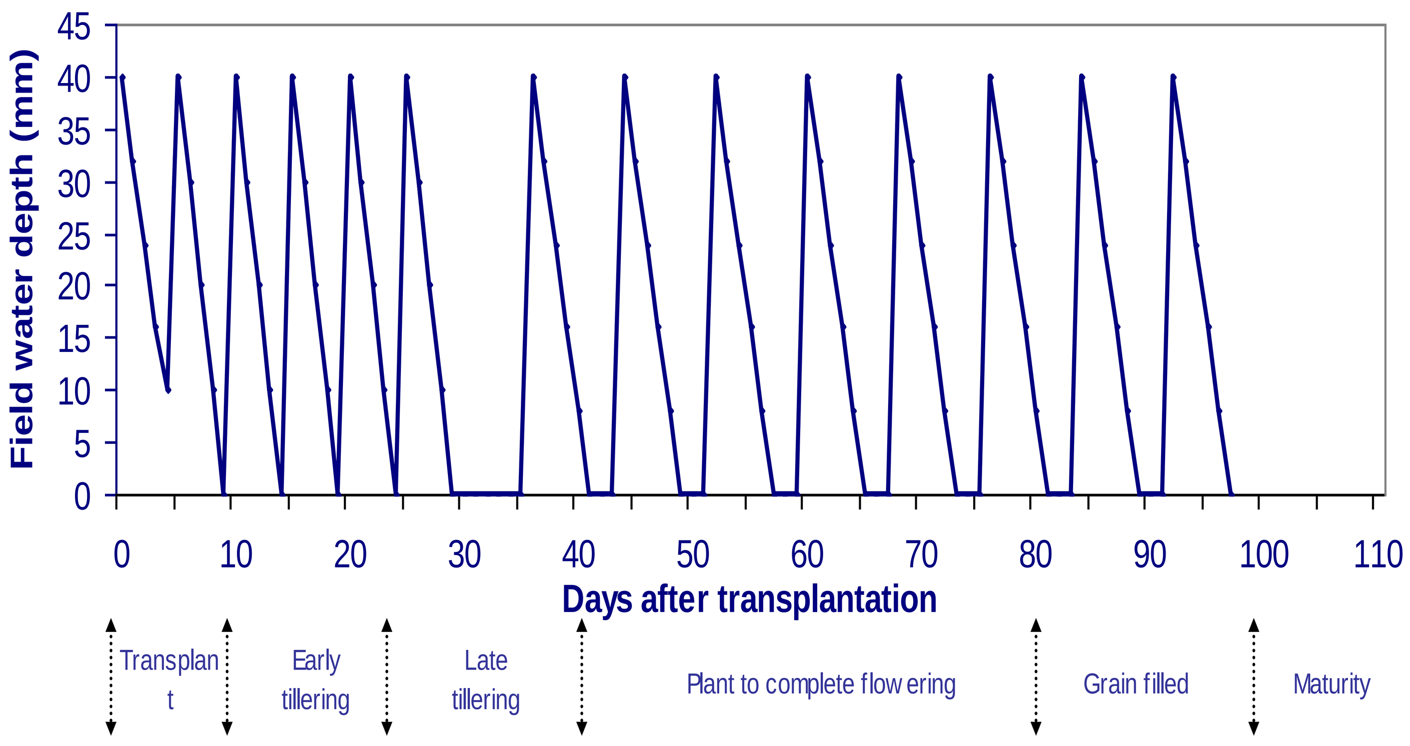
1 Background and Objective

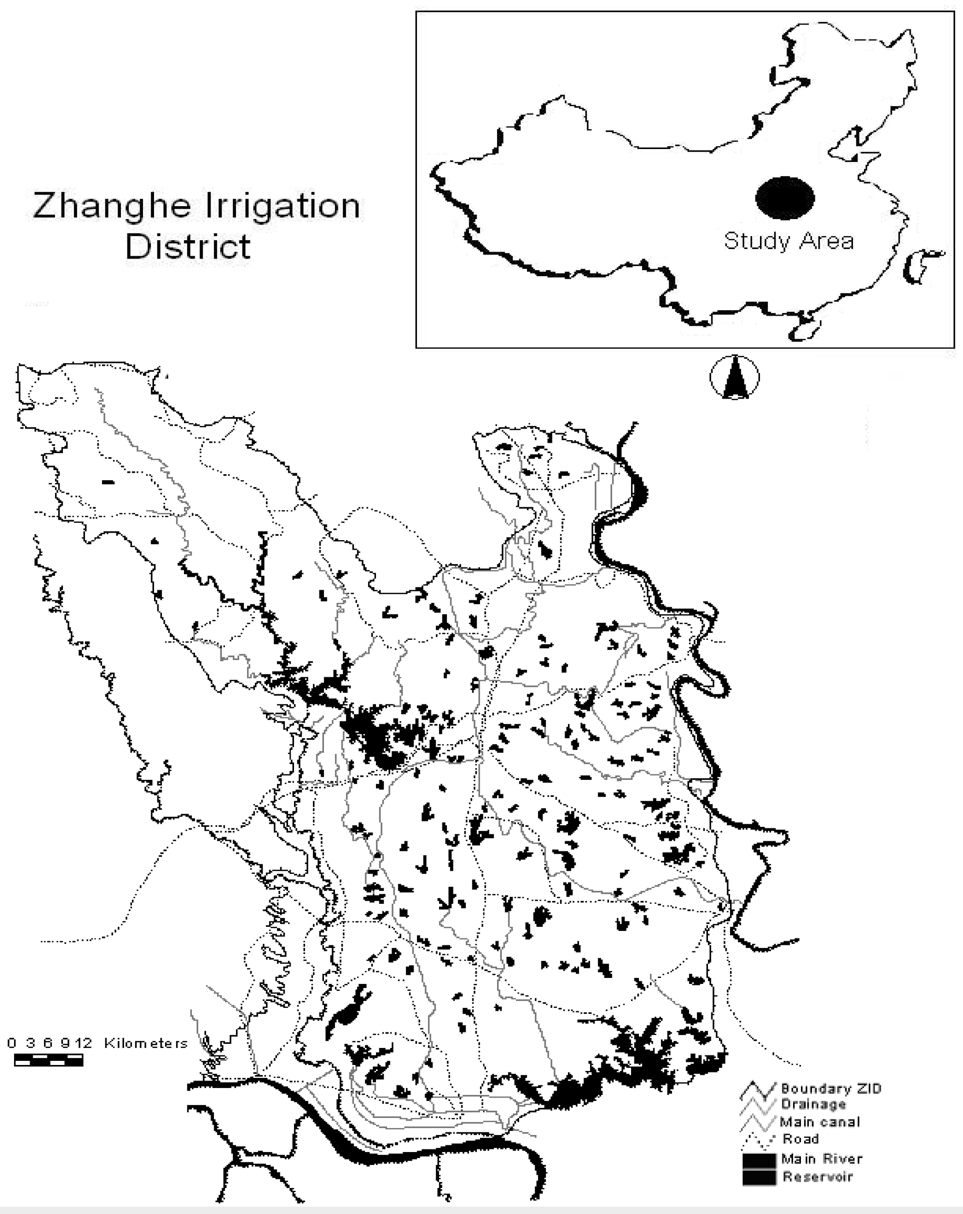
- ✓China has the world's biggest population and rice is the major stable food. Consequently, China has the largest rice area in the world but it also consumes large quantities of water.
- ✓The water availability for irrigation is declining due to climate change and variability, and increased competition between the municipal and industrial water use are further shrinking the water for agriculture.
- ✓Water savings or "producing more rice with less water" are crucial for food security and the economy
- ✓Alternative water saving irrigation (AWD) practices are herald as a possible solution for increasing to meet the food demands
- ✓This paper evaluates the role of reliable water supply in the adoption of AWD irrigation practice

AWD Irrigation Practice

AWD irrigation practice is characterized by: a) mid-season drainage during the later tillering stage of the crop and b) periodic soil drying 2-4 days in between irrigation events from panicle initiation to the harvest. In the mid-season drainage, the soil is dried out for 10-15 days, depending on the weather condition until some fine cracks appear in the soil. A graphical description of the AWD irrigation regime is presented below.



Study Area



2 Models and Measurement of Variables

AWD SCORE

Irrigation is a continuous process applied during the entire cropping season. Therefore, a binary variable (0, 1) does not give the true picture of adoption. Therefore, to measure AWD adoption a variable, AWDSCORE, was calculated using the following equation:

$$AWDSCORE = \frac{X*1 + Y*0.5 + Z*0}{X+Y+Z}$$

Where $X = 1$ stands for the number of times a farmer irrigates when the soil is dry, $Y = 0.5$ stands for number of times a farmer irrigates when the soil is wet or saturated, and $Z = 0$is the number of times a farmer irrigates when the soil is in standing water

The score then will indicate if the farmer tends to practice AWD or not, with the higher score indicating a greater adoption of AWD

Reliability Definition

Reliability implies secure, in terms of time and space, availability of water according to the crop schedule.

Two approaches:

Subjective (REL1):Based on farmer's perceptions. A value of 0, 1, 2 indicates "Highly unreliable" 'unreliable" and "reliable" water availability.

Objective (REL2)" variable based on the dependency of different water sources for irrigation. Reliability index was developed based on total number of irrigations from each source

$$REL2_i = \frac{Total\ number\ of\ irrigation_i - numbers\ of\ time\ soil\ was\ left\ dry\ due\ to\ lack\ of\ water_i}{Total\ number\ of\ irrigation_i}$$

Where $REL2_i$ reliability index, indicate the reliability of water source (i = pond, ZIS canal, and small reservoir water). $REL2_i$ varies between 0 and 1; a higher value of *REL2* implies greater reliability and a low value of *REL2* implies poor reliability

Models

Censored Tobit model because AWD score range between 0 and 1

The empirical model:

$$AWDSCORE(Y_i^*) = \alpha_0 + \alpha_i RELW_i + \beta_i X_i + \varepsilon_i$$

where *AWDSCORE* (Y_i*) is the alternate wetting and drying score, $RELW_i$ is the reliability of water sources (ZIS canal, pond, and small reservoir water) estimated through subjective and objective approaches, X_i is the vector of exogenous variables and ε_i is an error term

3 Results and Discussion

Tobit estimates of subjective reliability of water sources (REL1)

VARIABLE	Tobit estimate of marginal effect			Elasticity
	Coefficient	Standard error	P value	
INTERCEPT	0.43	0.126***	0.00	
REL1POND	0.01	0.017	0.68	0.019
REL1ZIS	0.01	0.020	0.75	0.013
REL1RES	0.04	0.027	0.22	0.064
FARMSIZE	-0.01	0.002***	0.00	-0.100
LQUALITY	0.04	0.018***	0.01	-0.118
ELEVATON	0.03	0.023	0.13	-0.099
WSITRAIN	0.01	0.055	0.82	0.001
EDUCATON	0.00	0.006	0.73	-0.020
FARMEXP	0.00	0.001	0.14	0.060
WEALTH	0.01	0.021	0.73	0.020
DVILAGE1	0.02	0.040	0.62	0.006
DVILAGE3	0.09	0.050**	0.04	0.033
DVILAGE4	0.13	0.047	0.00	0.051
Sigma (σ)			0.113***	
Log likelihood function (unrestricted)			-47.18	
Log likelihood function (restricted)			-73.87	
Likelihood ratio			53.58***	
Scale factor for marginal or total effect F(z)			0.82	
Conditional mean of dependent variable at sample point			0.66	
Pseudo R^2			0.36	
Total observations			98	

*** and ** refer to significance at the 1% and 5% level, respectively.

Tobit estimates of objective reliability of water sources (REL2)

Variables	Tobit estimate of marginal effect			Elasticity
	Coefficient	Standard error	P value	
INTERCEPT	0.650***	0.087	0.000	
REL2POND	0.123*	0.031	0.089	0.068
REL2ZIS	0.054	0.028	0.152	0.019
REL2RES	0.018	0.045	0.692	0.002
FARMSIZE	-0.006***	0.002	0.007	-0.095
LQUALITY	-0.031**	0.016	0.053	-0.083
ELEVATON	-0.043**	0.020	0.030	-0.127
WSITRAIN	0.012	0.045	0.782	0.001
EDUCATON	-0.002	0.005	0.647	-0.020
FARMEXP	0.001	0.001	0.450	0.036
WEALTH	-0.004	0.018	0.797	-0.012
DVILAGE1	0.024	0.032	0.447	0.008
DVILAGE3	0.082**	0.035	0.020	0.029
DVILAGE4	0.110***	0.032	0.001	0.038
Sigma (σ)			0.106***	
Log likelihood function (unrestricted)			-47.16	
Log likelihood function (restricted)			-80.79	
Likelihood ratio			67.22***	
Scale factor for marginal or total effect F(z)			0.89	
Conditional mean of dependent variable at sample point			0.73	
Pseudo R2			0.42	
Total observations			98	

*** and ** refer to significance at the 1% and 5% level, respectively.

Discussion

It was hypothesized that access to reliable water sources would increase the likelihood of practicing AWD for rice cultivation, no solid empirical evidence to support the proposition. However, weaker empirical evidence shows that access to reliable water supply from local ponds positively influences AWD practices. The results show that the adoption of AWD is not driven by farmer's self choice but rather they are adopting AWD to mitigate risk in the face of increasing water scarcity. The policy implication is that imposing institutional water scarcity could be a way to promote the adoption of water-saving irrigation practices.

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