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Efficiency of Water Use in Groundwater Markets: The case of Peninsular India

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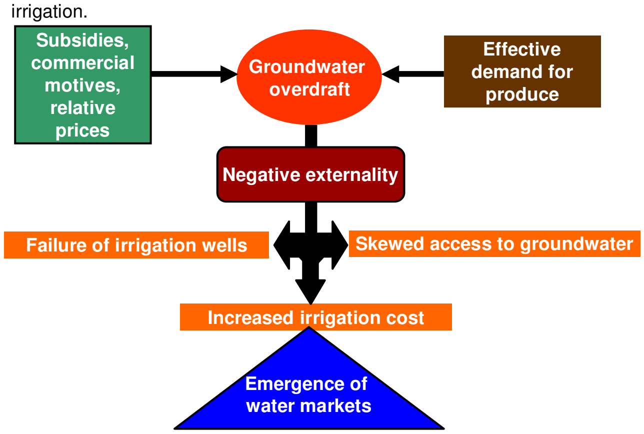
Introduction

- In India, the green revolution, which was responsible for countering the country's food deficit, has largely been successful due to groundwater irrigation.



- In the light of this backdrop, this paper examines whether groundwater markets contribute to improved efficiency by introducing a price.

Data and Model

- About, 90 sample farmers, 30 in each category (water sellers, water buyers & control farmers/neither buyers nor sellers) were randomly selected from Malur taluk of Karnataka located in Peninsular India.
- Data pertaining to 2007-08 agricultural year.
- Data Envelopment Analysis (DEA), is non-parametric and deterministic, applies mathematical programming to measure efficiency.
- Input oriented approach and Constant Returns to Scale(CRS) & Variable Returns to Scale(VRS) specifications considered.
- The DEA model to calculate the technical efficiency (TE) is found using the equation (Speelman et al., 2008):

$$Min_{\theta\lambda}\theta^k$$

Subject to:

$$-y_i + Y\lambda \geq 0$$

$$\theta_k x_i^k - X^k \lambda \geq 0$$

$$xi^{n-k} - X^{n-k}\lambda \geq 0$$

$$N1'\lambda = 1$$

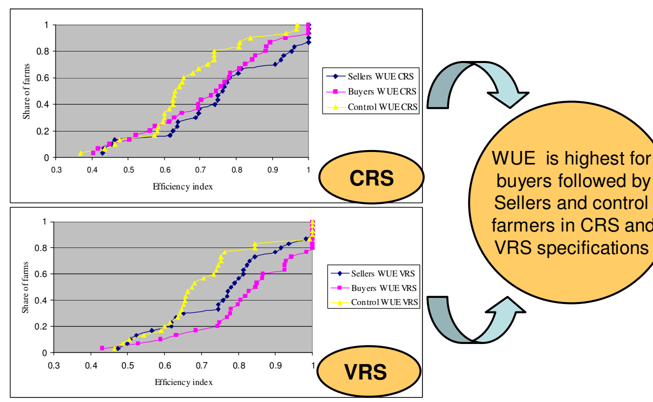
$$\lambda \geq 0$$

- Where **θ** is a scalar and λ is an vector of constants. Using the variables λ and **θ**, the model is solved once for each farm.
- **θ^k** is the maximum possible reduction of input k keeping all other inputs and output constant.
- The statistical significance of the difference in subvector efficiency is estimated using a non-parametric Kruskal-Wallis test.

Results

- 83 % of water sellers are large farmers & 61 % of buyers are small farmers, thus promoting equity in water use.
- Water sellers and control farmers used higher inputs (water, labour, machines for land operations, manure and fertilizers) compared to water buyers.
- The average Water Use Efficiencies (WUE) are highest among the water buyers (0.77-CRS and 0.84-VRS), followed by the water sellers (0.73-CRS and 0.77-VRS). The control group has the lowest WUE (0.67-CRS and 0.72-VRS).

Cumulative efficiency distribution for water subvector efficiency

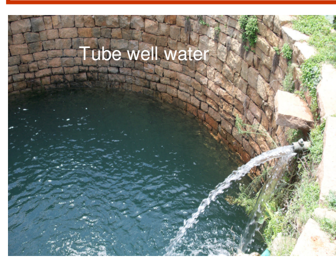


Kruskal-Wallis tests for differences in water use efficiency

Efficiency measure	Hypothesis	CRS		VRS	
		χ^2 value	P-value	χ^2 value	P-value
Technical Efficiency (groundwater)	$H_0 : \theta_w^1 = \theta_w^2 = \theta_w^3$; $H_1 : \theta_w^1 \neq \theta_w^2 \neq \theta_w^3$	6.646	0.0360	9.455	0.0088

Note: 1 = control farmers, 2= water sellers and 3=water buyers;
θ_w = technical sub-vector efficiency for water

- WUE under CRS is significantly different at the critical 5% level & under VRS at 1% level



Conclusions

- Farm efficiency is higher for farmers engaging in water markets
- In the light of proposed changes in groundwater legislation and policies for improving water use efficiency these results provide crucial information to policy makers.

Reference

- Speelman, S., D' Haese, M., Buysse, J. & D' Haese, L. (2008). A measure for the efficiency of water use and its determinants, a case study of small-scale irrigation schemes in North-West Province, South Africa. *Agricultural Systems* 98: 31–39.

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