WHAT DOES PUMP SETS ELECTRIFICATION CHANGE?

IMPACTS ON CROPPING PATTERNS, PRODUCTIVITY AND INCOMES IN WEST BENGAL

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INTRODUCTION

- Learning **gaps** in impact evaluation
  - Impact evaluation of **natural resources management policies**
  - Impact evaluation of **electrification**
    - *Khandker, Barnes & Samad (2013)*
    - *Khandker, Barnes, Samad & Minh (2009)*
    - *Dinkelman (2011)*

⇨ Focus on the welfare impact of energy access
Focus on residential / domestic connections

What are the potential impacts of the electrification policy for agriculture in West Bengal from a micro-level farmer perspective?

What are the impacts of electric pump ownership on agricultural cropping choices, cropping intensity, yields, value added and water consumption?

OUTLINE

- 1 - Background: untapped potentialities of West Bengal
- 2 - Policy changes and descriptive statistics on the implementation
- 3 - Theoretical model: expected impacts and limitations
- 4 - Empirical model: impact evaluation design and results
- 5 – Conclusion and ways forward

BACKGROUND
Agricultural stagnation

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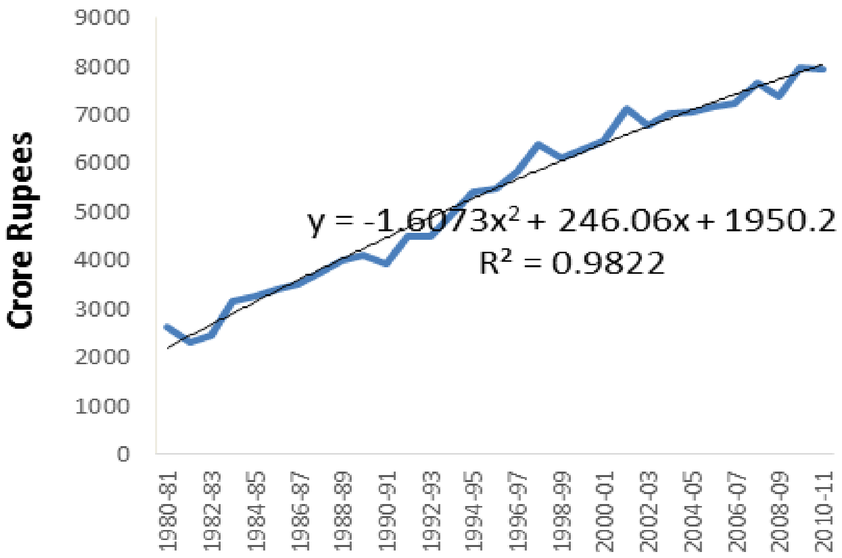


Fig 1 - Agricultural Net Domestic Product (factor cost) in West Bengal, 1980-2011 (at constant price 1980, 1 crore= 10 million)

Before 1980s

- Century long agricultural stagnation in West Bengal
- Regressive agrarian structure as culprit

From 1980s to mid 1990s

- Average annual growth rate of agricultural sector: 5.4% in the 1980s , 4.56% in the 1990s
- Land reform
- Institutional reform
- Green revolution and diffusion of HYV
- Access to private irrigation

Since 2000s

- Average annual growth rate of agricultural sector: 2.2% in the 2000s.
- Slow-down in the production of most of the main crops produced in West Bengal (rice, wheat, pulses, sugar cane, jute), with the exception of oil seeds.

BACKGROUND
Boro paddy cultivation

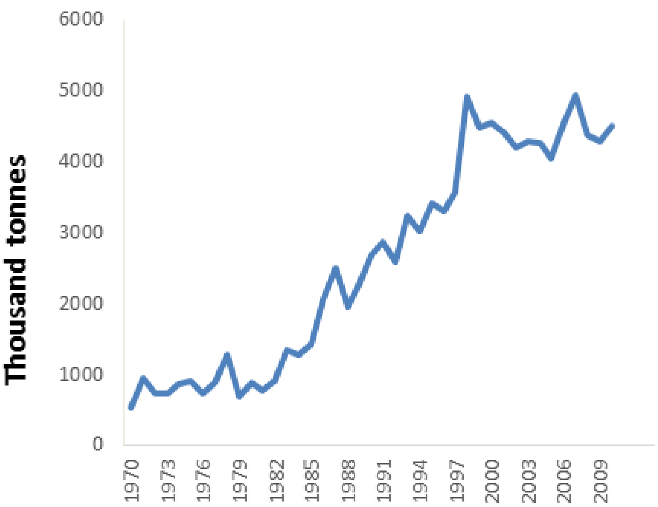


Fig 2 - Quantity of *boro* rice produced in West Bengal, 1970-2010, in thousands of tonnes

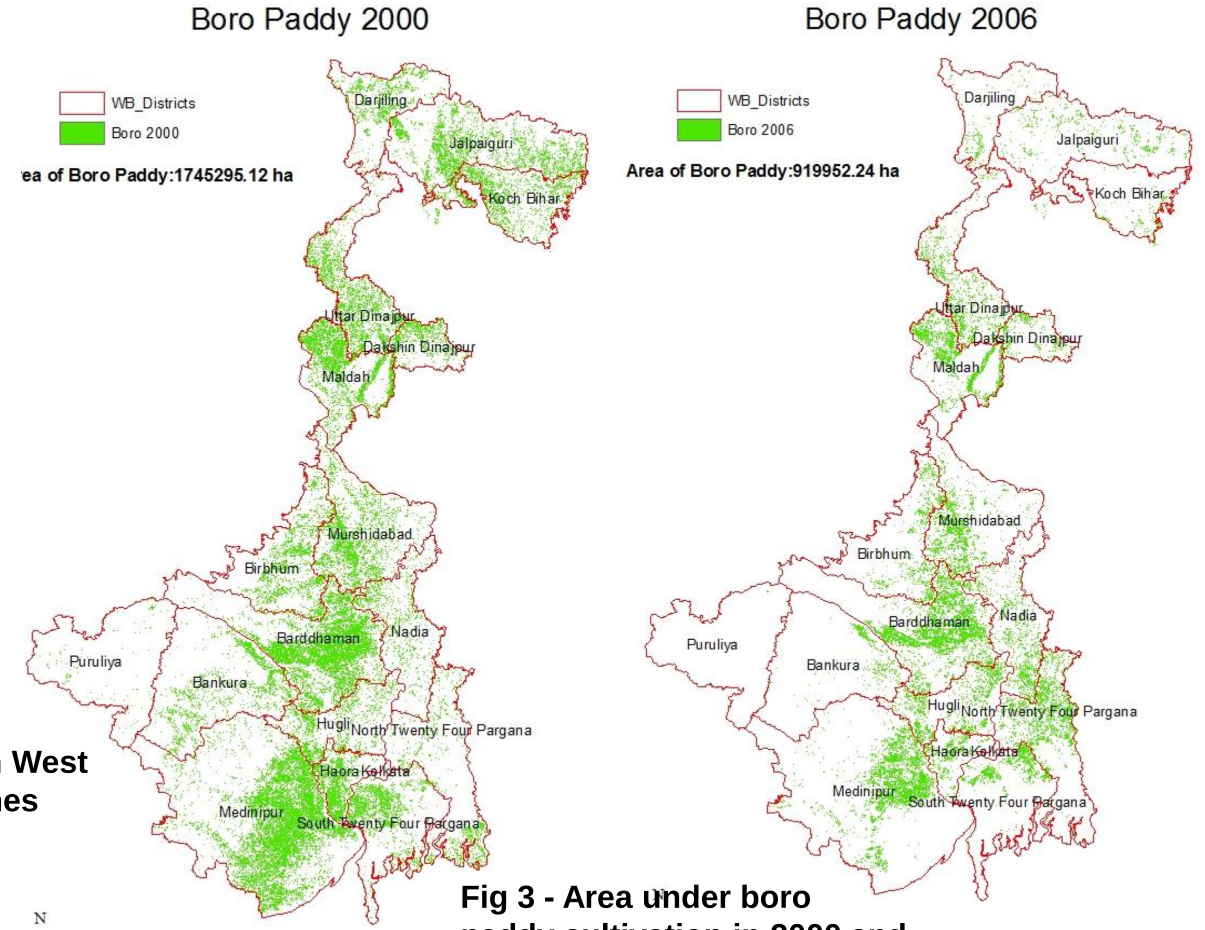
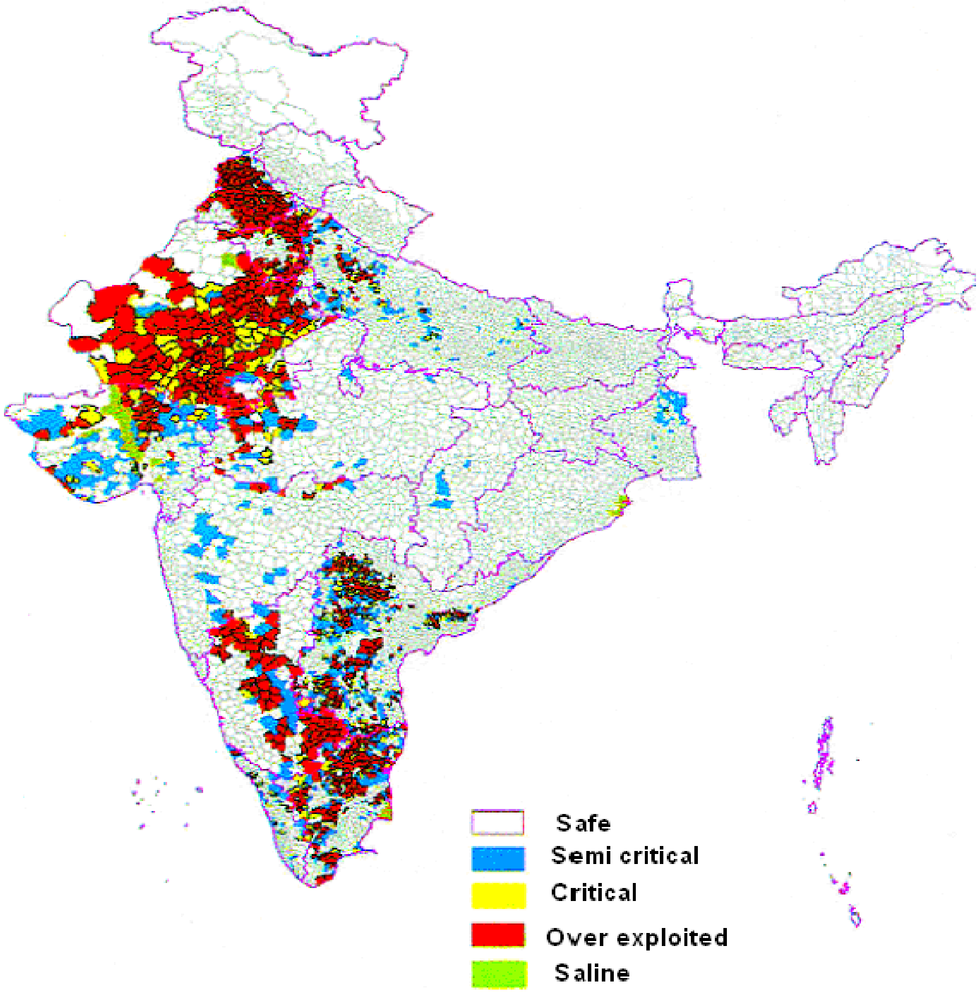


Fig 3 - Area under boro paddy cultivation in 2000 and 2006

BACKGROUND
Groundwater potential



- 40.1% **stage of groundwater development** in 2009, 50.9% in 2000
- 38 semi-critical blocks in 2009
- 53 critical blocks and 26 semi-critical blocks in 2000

- **Decline of the number of tubewells** in the 2000s (Minor Irrigation Census)

BACKGROUND
Energy squeeze

- Less than **one fourth of the shallow tubewells** are **electrified**

- Sharp increase in the **diesel prices**, from 8 Rs per litre in 1995 to 52 Rs in 2012

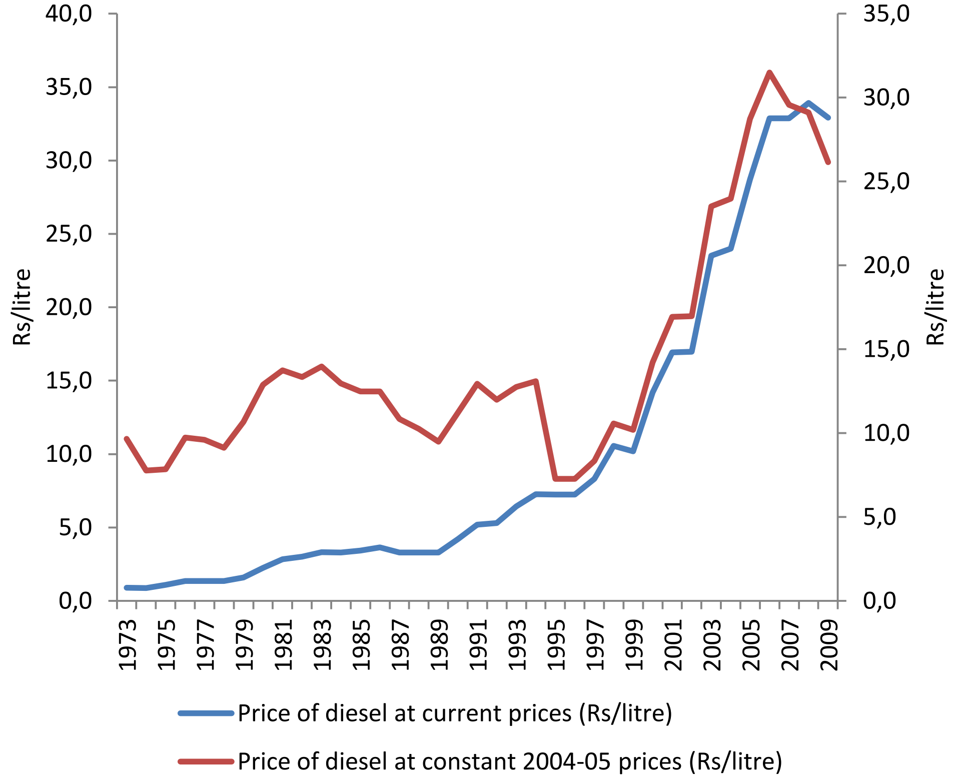


Fig 5 – Diesel prices in West Bengal from 1973 to 2009

BACKGROUND
Slow down in the electrification

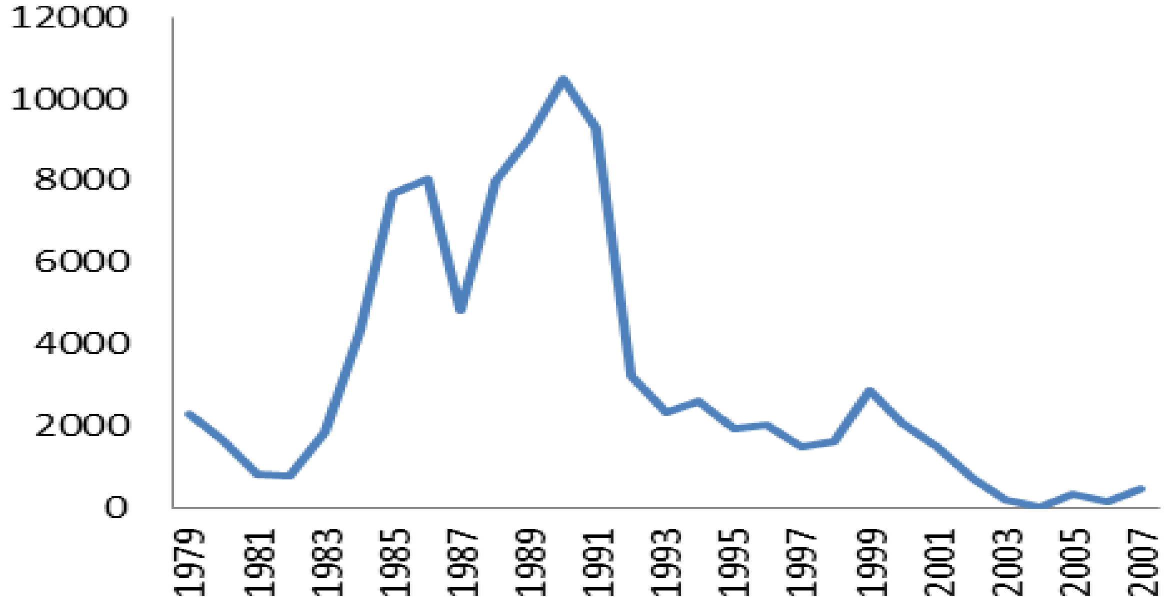


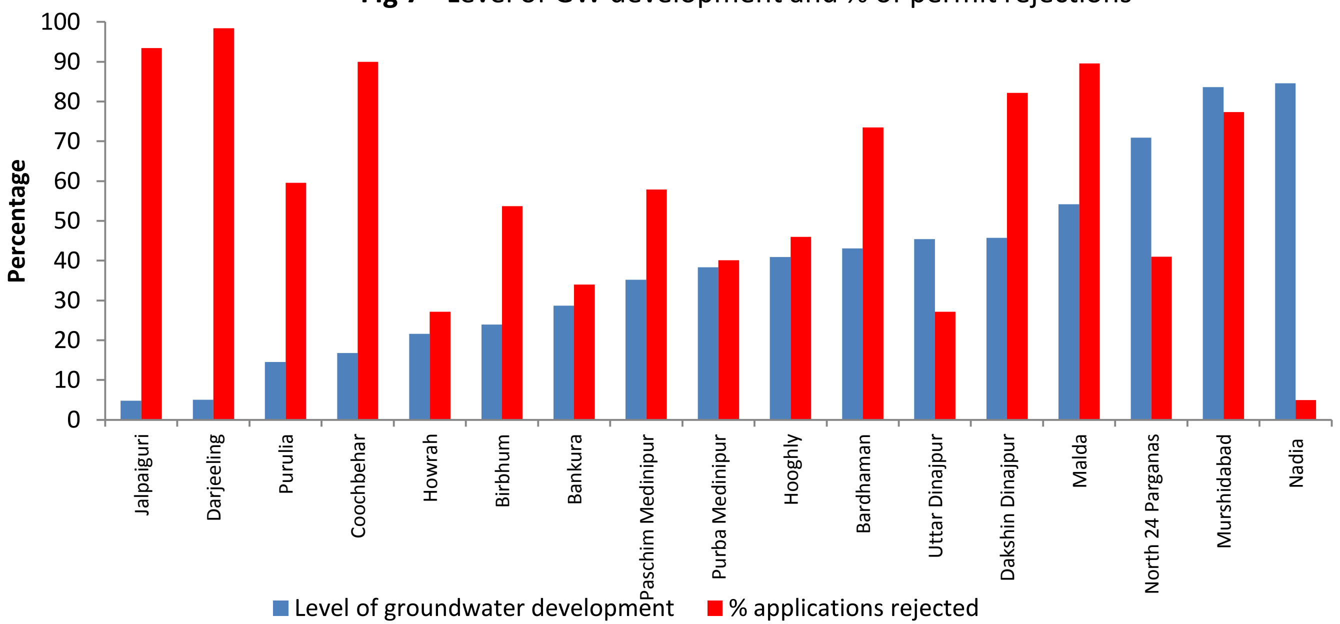
Fig 6 - Number of electric tubewells newly electrified each year in West Bengal and Bangladesh

BACKGROUND
Permit constraints

Groundwater Act (2005), farmers required a **permit** from SWID before applying for an electric connection

- Administrative hassle
- Rent seeking issues

Fig 7 - Level of GW development and % of permit rejections



- 64% of the applications were **rejected**
- **Inconsistency** between the level of GW development and the acceptations/ rejections of permits

BACKGROUND
High cost of investment

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Farmers had to pay the **full cost of the investment** (poles, wires, transformers)

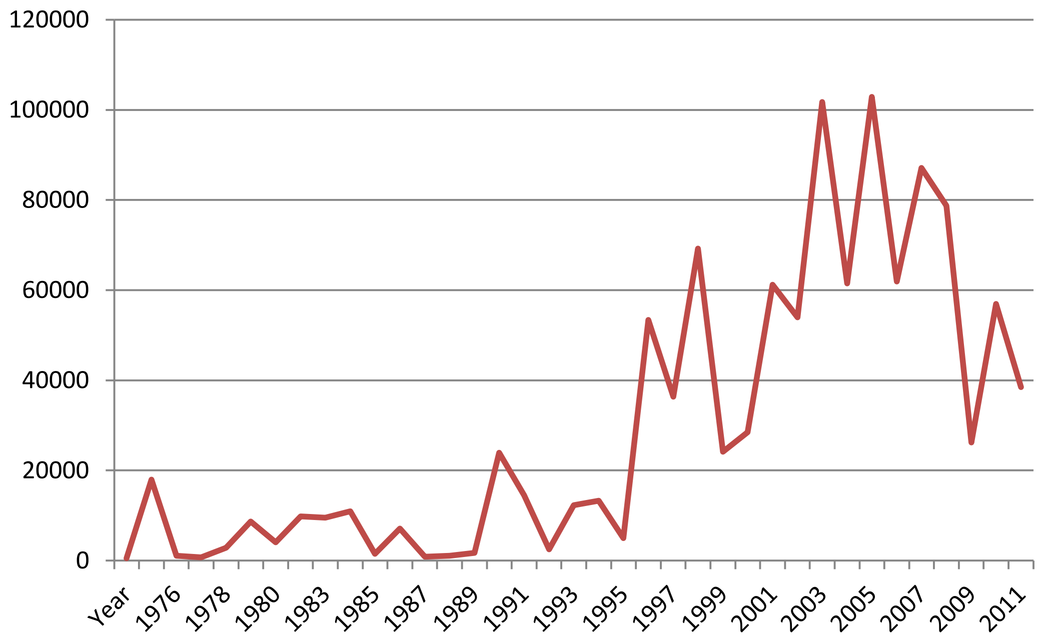

Fig 8 - Investment cost for the electric connection, in Rs (current prices)

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POLICY CHANGES

Amendment of the Groundwater Act

- **WRIDD, memo dated 9 November 2011**
- Change of a provision of the West Bengal Groundwater Resources Act 2005

Farmers located in "safe" groundwater blocks (301)
owning pumps of less than 5 horsepower (HP)
tubewells with discharge less than 30m3/hour

No longer need permits from the SWID to obtain an electric connection

One Time Assistance for Electrification of Agricultural Pump-sets

- **OTA-EAP, Department of Agriculture, November 2012**

Subsidy is available for pump-set electrification
Payment of a **lumpsum** from 8,000 to 10,000 Rs

No longer need to pay the full cost

POLICY CHANGES
Number of electric connections

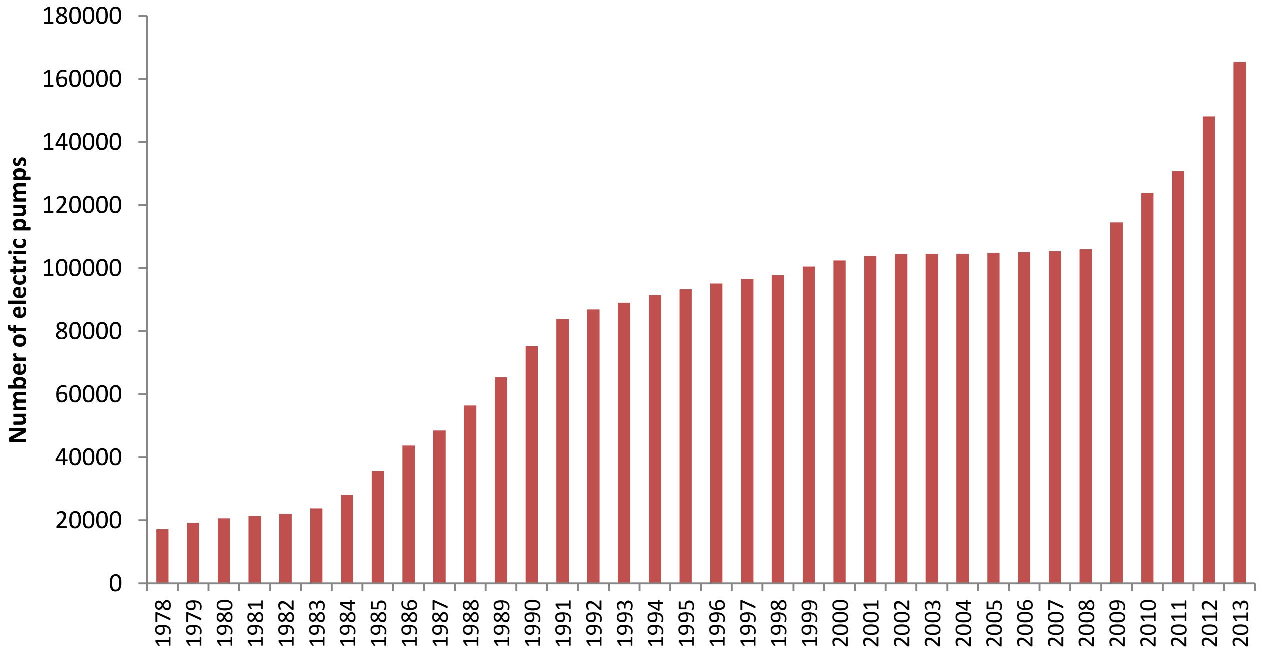
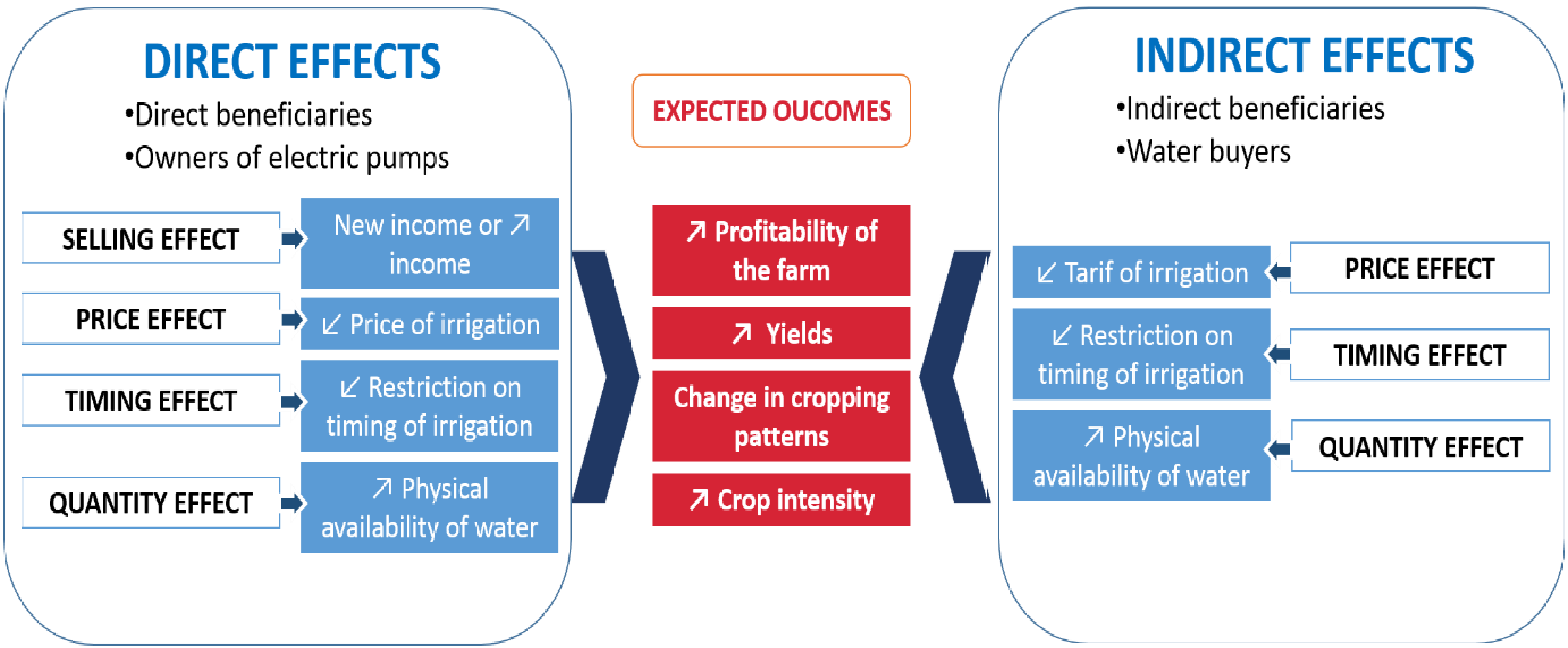


Fig 9 - Number of shallow tubewells permanently electrified

→New sharp increase in the number of electric connections provided

THEORETICAL MODEL
Expected impacts – Micro level



THEORETICAL MODEL
Impact impeders, limitations

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- Conversion
  - Conversion from diesel to electric pumps
  - Conversion from temporary to permanent electric connections
- Regularization of unregistered connections
- Demand outstrips supply and increasing gap
  - Budget allocation
  - Supply chain constraints
  - New connections given in a limited number of districts
- Awareness of the policy change

Groundwater Act (2005)	12.12
Removal of the SWID permit clearance (2011)	14.84
One time assistance for electrification of pump-sets (2012)	21.73

Tab 1 – Percentage of households aware of different agricultural policies

EMPIRICAL MODEL
Challenge of selection biais

Objective: Comparing a situation with electrification policy with what would have happen without the policy

Challenge

- Unobserved 'perfect' counterfactual
- Observed non treated units ≠ Treated units in terms of observable and unobservable characteristics

→**Identification of a counterfactual**

Combination of quasi-experimental impact evaluation methodologies

Regression discontinuity design (RDD) → Selection of the blocks

Propensity score matching (PSM) → Selection of the households

EMPIRICAL MODEL
Regression discontinuity design (1)

Selection of safe (treated) and semi-critical blocks (non-treated) with the same characteristics, only the policy differs.

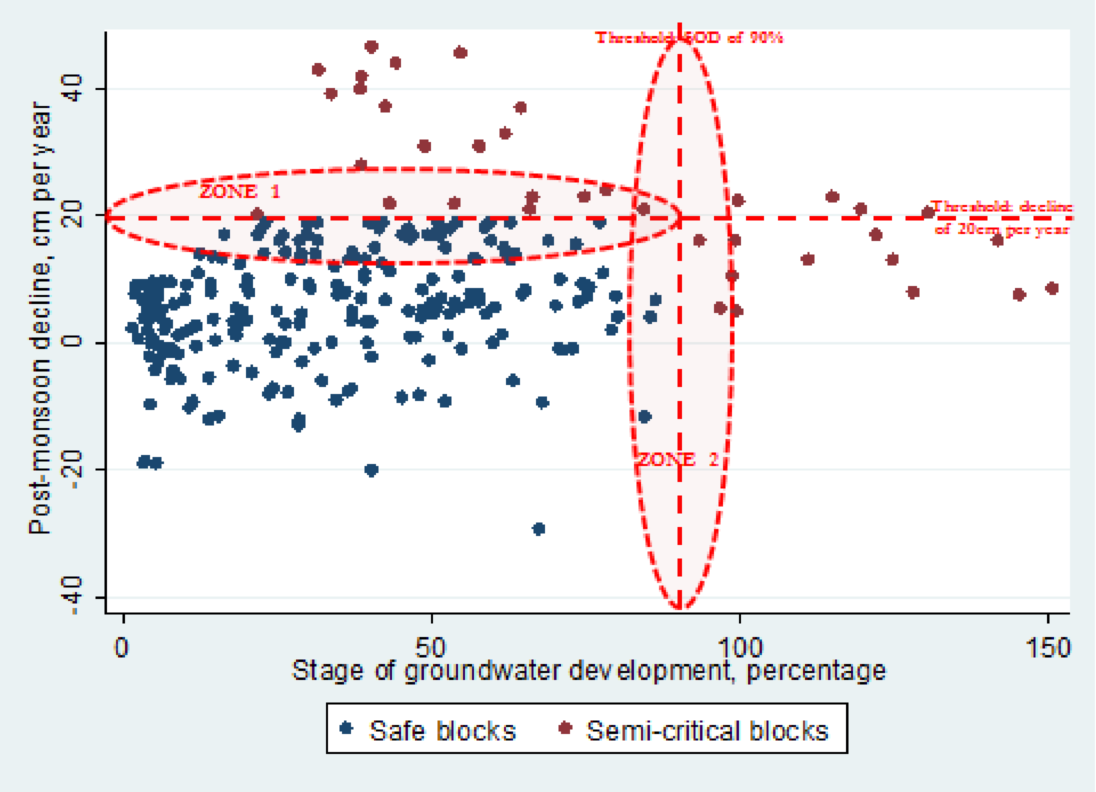

Fig 12 – Categorization and selection of the blocks

Assignement variables for block categorisation (SEC 97)

- Stage of groundwater development (SOD), percentage of extraction to net renewable recharge
- Decline of groundwater level before and after monsoon

EMPIRICAL MODEL
Regression discontinuity design (2)

Survey in
14 safe blocks
10 semi-critical blocks

Survey in
93 villages
1395 households

Survey conducted in
May and June 2013

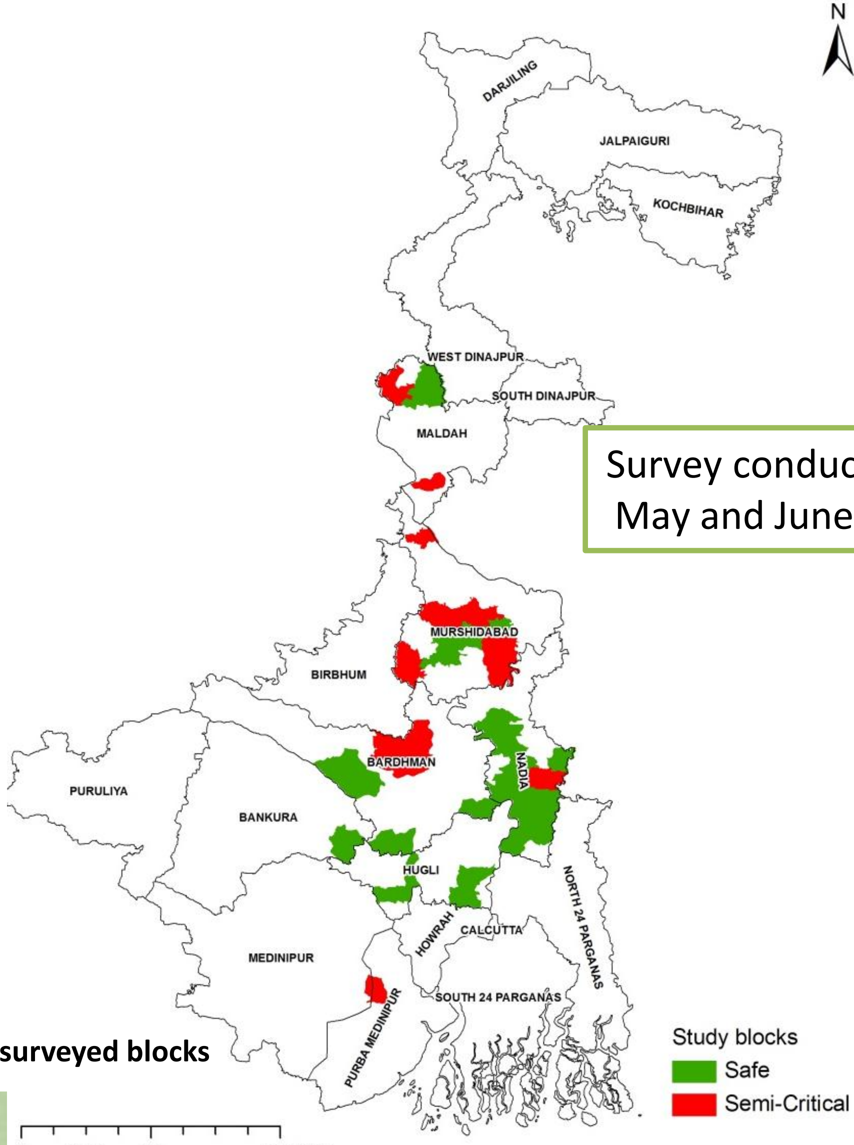

Fig 13 – Map of the surveyed blocks

EMPIRICAL MODEL
Propensity score matching

Selection of electric pump owners (treated) and non electric pump owners (non-treated / counterfactual) with the same characteristics

- Estimation of **model of treatment**
  - **Independant variable -** Dummy equal to 1 if the household is an electric pump owner
  - **Dependant variables** - 4 sets of determinants:
    - **Interest.** Is there any advantage for this farmer to become a pump owner? *Land size, productive assets index, number of pump owners in the village*
    - **Social ability**. Is this farmer able to undertake the steps required to get an electric connection? *Age, level of education, social capital*
    - **Economic solvability.** Is this farmer economically able to invest in the pump set and in the connection? *Poverty level*
    - **Environmental suitability**. Are the groundwater trends in the villages favourable? *SOD, pre/post monsoon decline*

EMPIRICAL MODEL

Results – *Cropping patterns*

		(1) ATE	(2) Weighted OLS
crop_intensity		**10.673****	**19.962*****
		[5.519]	(4.559)
p_aman		**0.0691*****	**0.0601*****
		[0.0259]	(0.0236)
p_mustard		0.0389**	0.0133
		[0.0188]	(0.0183)
p_potato		-0.0377**	-0.0164
		[0.0177]	(0.0172)
p_boro		**0.210*****	**0.273*****
		[0.0319]	(0.0283)
Common support sample	*Non treated*	1014	
	Treated	354	
Sample size			920

Note: Figures in brackets are the bootstrapped standard errors (50 replications) and figures in parentheses are the standard errors, *** stands for 1% of significance, ** for 5% and * for 10%.

Tab 3 - Impact on cropping patterns

Electric pump ownership has a significant and **positive impact** on the **cropping intensity**.

Proportion of cultivated area under boro paddy is significantly **higher** for electric pump owners.

EMPIRICAL MODEL
Results – *Aman paddy*

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		(1) ATE	(2) Weighted OLS
output_aman_kg_ac		73.864*	68.669
		[42.413]	(44.963)
VA_aman_ac		845.951*	811.774)
		[494.488]	(512.309)
nb_irri_aman_ac		**12.281*** **	**11.7405*** **
		[4.335]	(3.892)
Common support sample	*Non treated*	761	
	Treated	323	
Sample size			784

Note: Figures in brackets are the bootstrapped standard errors (50 replications) and figures in parentheses are the standard errors, *** stands for 1% of significance, ** for 5% and * for 10%.

Tab 4 - Impact on yield, value added and irrigation for aman

No significant impact on yields or value added for aman.

Being an electric pump owners has a significant **positive impact on the number of irrigation for aman**.

EMPIRICAL MODEL
Results – *Boro paddy*

Impact on the yields of boro is not robust.

Significant and positive impact on the value added of boro, price effect.

		(1) ATE	(2) Weighted OLS
output_boro_kg_ac		139.769**	97.888
		[68.0566]	(69.272)
VA_boro_ac		**2901.441****	**1906.495***
		[1160.535]	(1067.701)
nb_irri_boro_ac		**30.686*****	**36.484*****
		[10.370]	(11.356)
Common support sample	*Non treated*	363	
	Treated	237	
Sample size			470

Note: Figures in brackets are the bootstrapped standard errors (50 replications) and figures in parentheses are the standard errors, *** stands for 1% of significance, ** for 5% and * for 10%.

Tab 4 - Impact on yield, value added and irrigation for boro

Being an electric pump owners has a significant **positive and high impact on the number of irrigation for boro**.

CONCLUSION

Combination of quasi-experimental methods of impact evaluation to estimate the impact of policy change, revival of electrification policy in West Bengal

Results - Impact of tubewells electrification

- Change in cropping patterns, more water intensive crops (boro) and higher cropping intensity
- Higher value added, price effect confirmed for boro
- No effect on the yields, quantity effect not confirmed
- Positive impact on the number of irrigation

Risk - Overuse of groundwater, negative impact on water productivity ?

- More analyses required to understand the causality between electrification of pumpsets and groundwater depletion
- Recommendation for rising the unitary price of kWh for larger consumers for create economic incentives to preserve the resource

THANK YOU

Your comments and questions are most welcome.

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