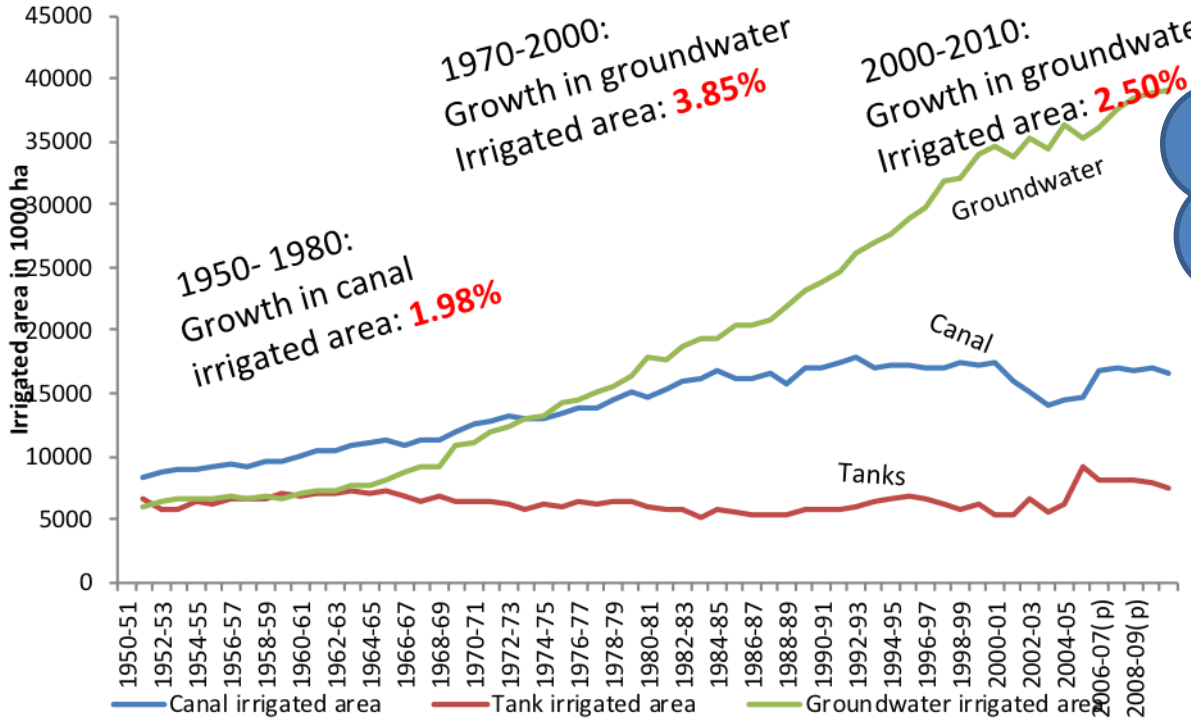
Water Energy and Food (WEF) Nexus in Eastern Ganges

Discussion points

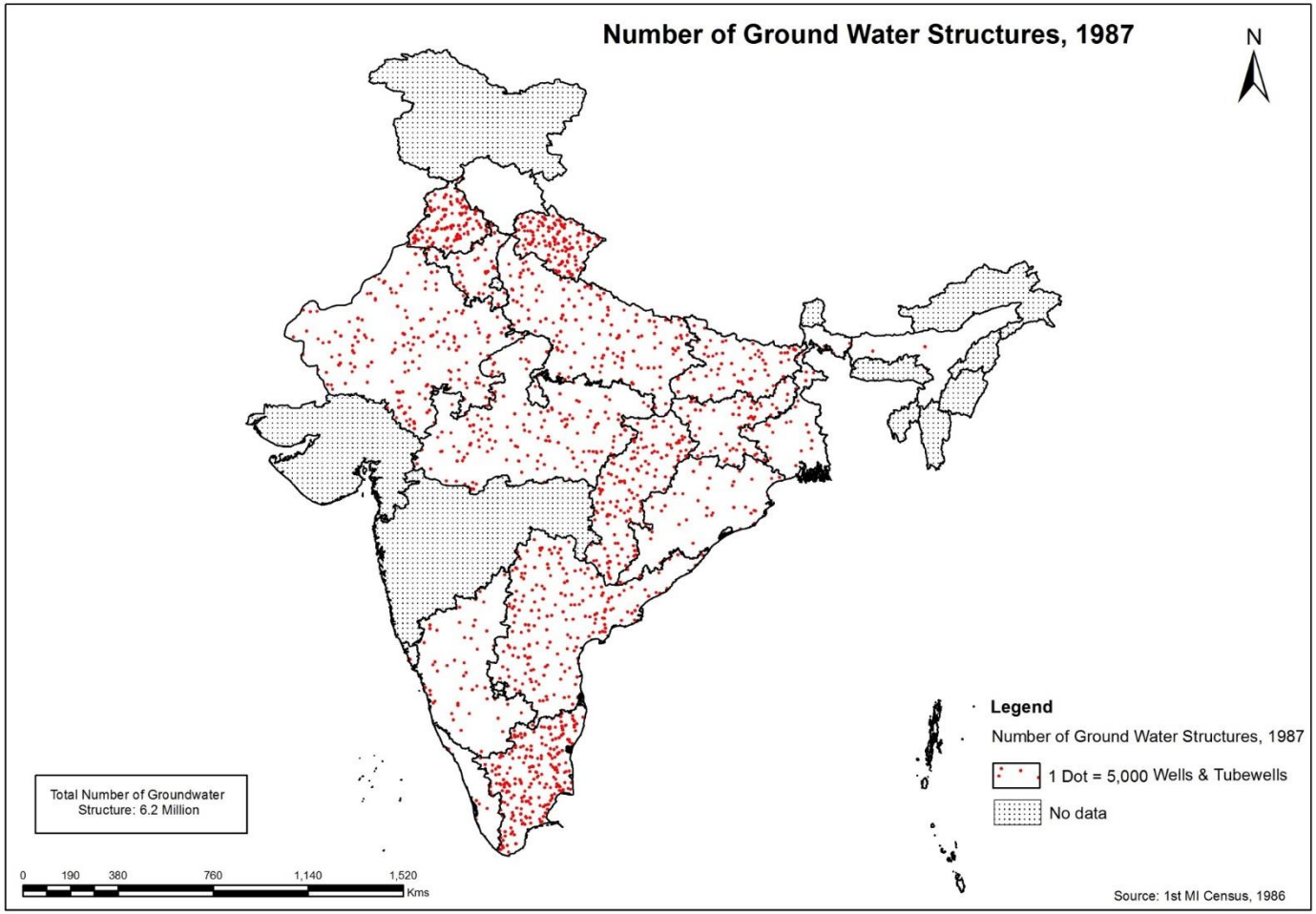
- What are the big issues in WEF nexus in eastern Ganges?
  - Groundwater irrigation and its linkages with food production
- Why are they important for future of agri-food business?
  - Access to irrigation is central to agriculture and agri-food business
- What we know and don’t know?
  - New policies –e.g., high electricity tariffs, provisions to prevent deepening of wells in West Bengal, accelerated electrification in Bihar, impact of solar pumps; sustainability issues – both quality and quantity
- What are the critical tradeoffs?

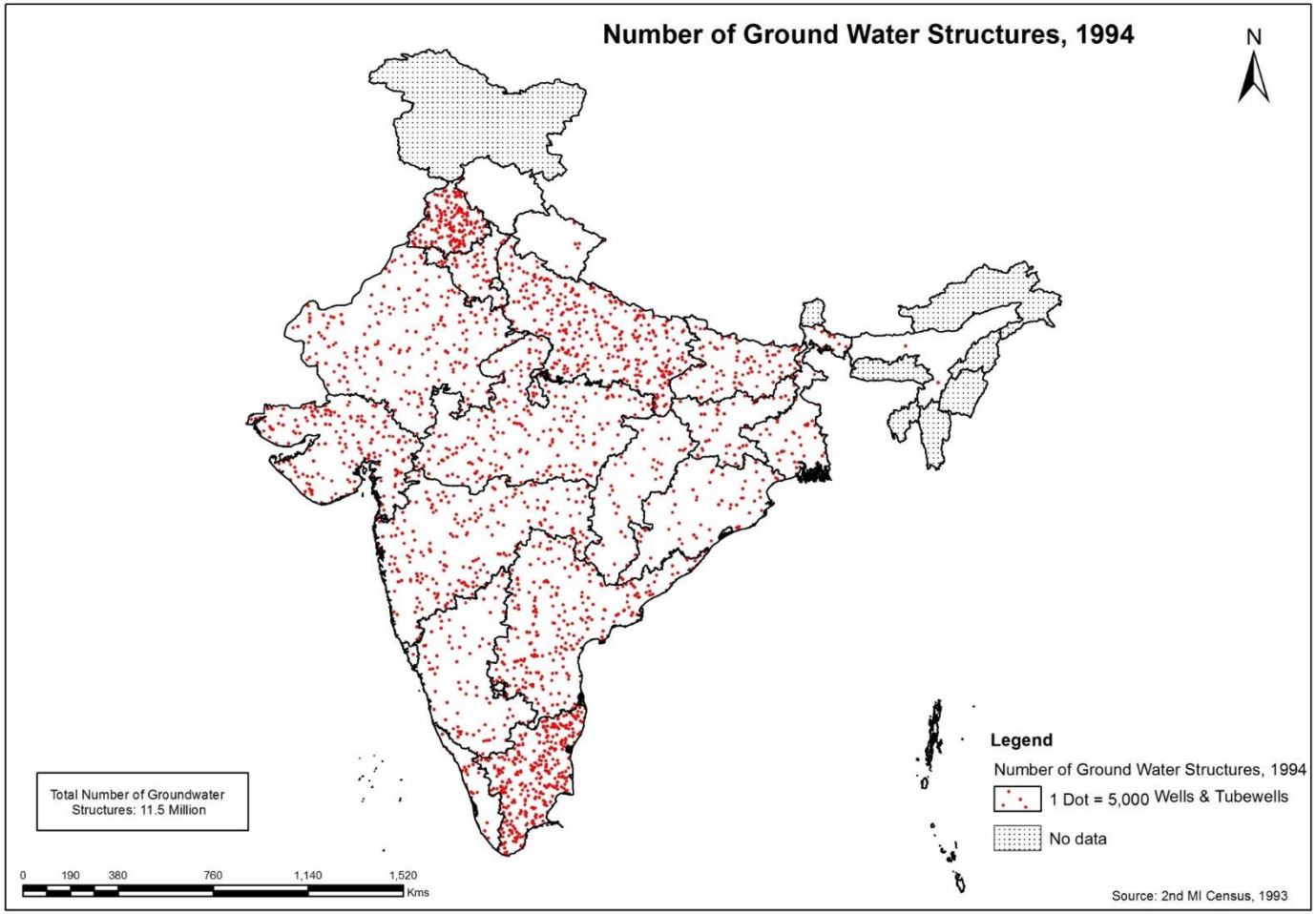
The irrigation story of India….



Since 1970s, groundwater irrigated area has increased, as has number of wells and tubewells….

Mukherji, A., S. Rawat and T. Shah. 2013. Major insights from India's Minor Irrigation Censuses: 1986-87 to 2006-07. *Economic and Political Weekly*, Vol 48(26 & 27): 115-124


Number of Ground Water Structures, 1987
N
Legend
Number of Ground Water Structures, 1987
1 Dot = 5,000 Wells & Tubewells
No data
Total Number of Groundwater Structure: 6.2 Million
0 190 380 760 1,140 1,520
Kms
Source: 1st MI Census, 1986


Number of Ground Water Structures, 1994
N
Total Number of Groundwater Structures: 11.5 Million
0 190 380 760 1,140 1,520
Kms
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Number of Ground Water Structures, 1994
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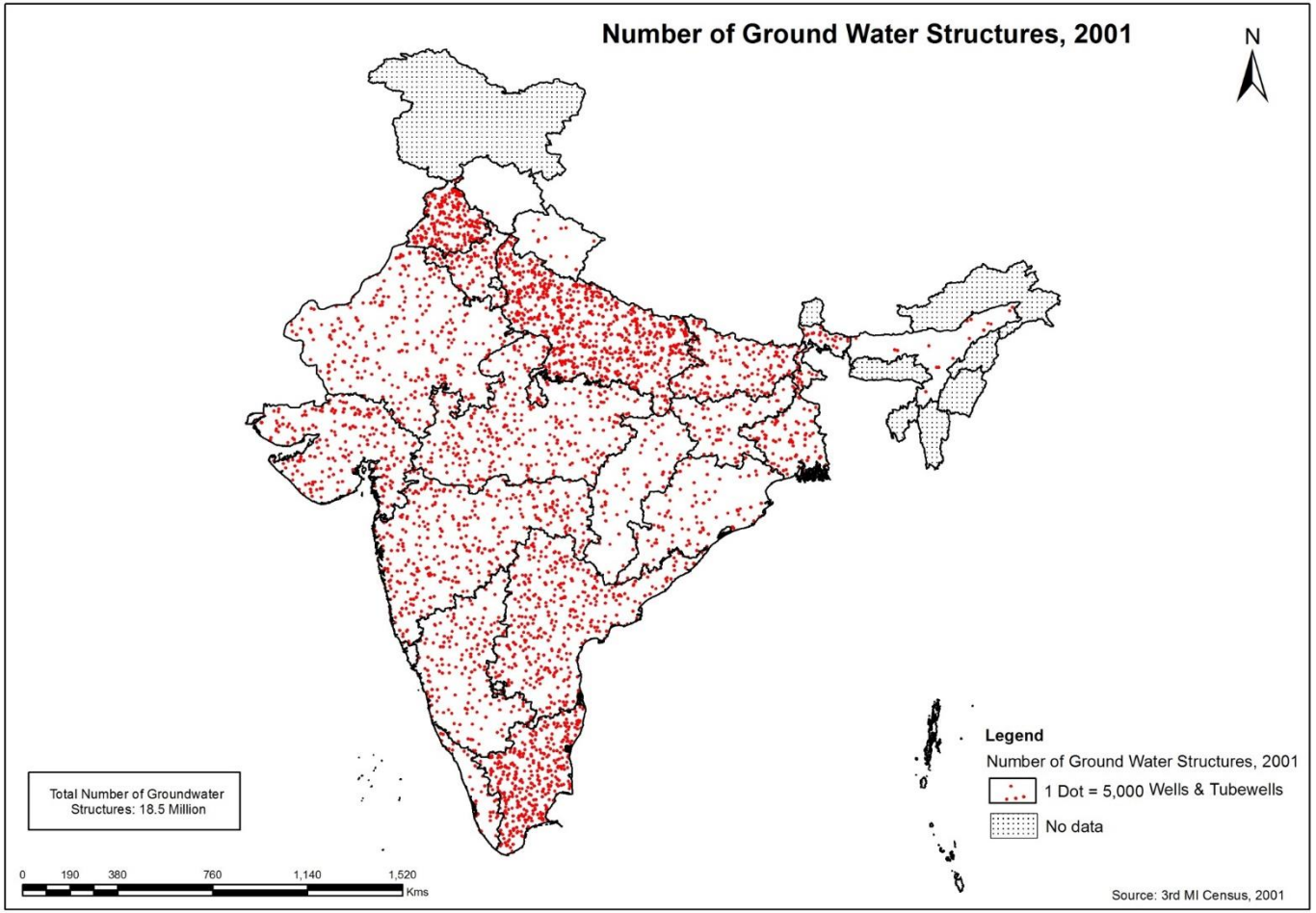
No data
Source: 2nd MI Census, 1993


Number of Ground Water Structures, 2001
N
Total Number of Groundwater Structures: 18.5 Million
0 190 380 760 1,140 1,520
Kms
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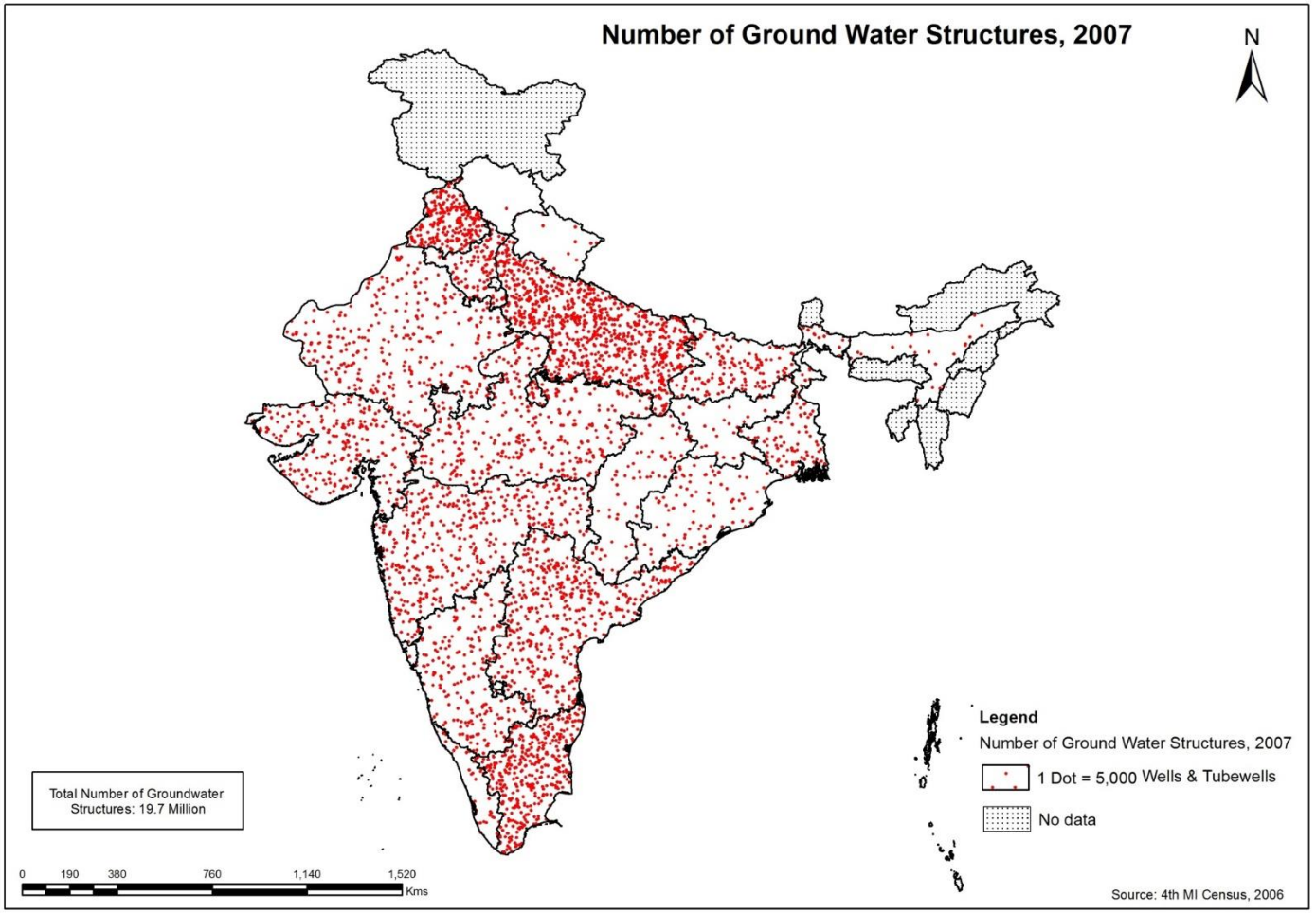
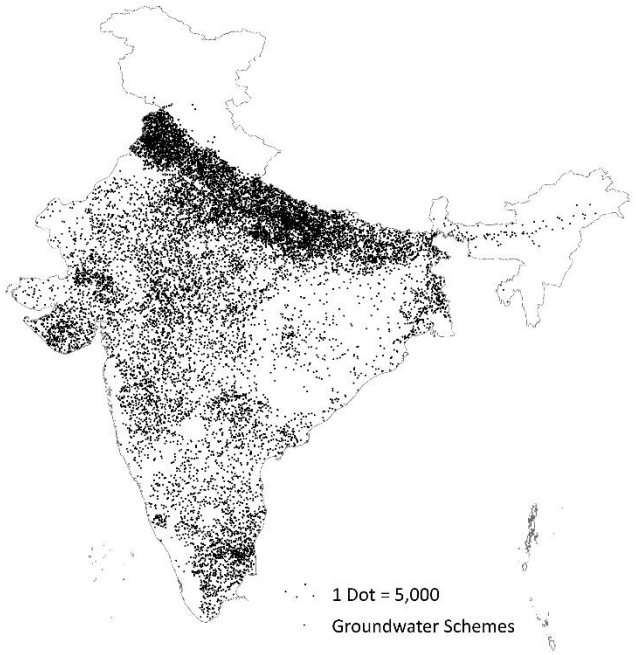
Number of Ground Water Structures, 2001
1 Dot = 5,000 Wells & Tubewells
No data
Source: 3rd MI Census, 2001

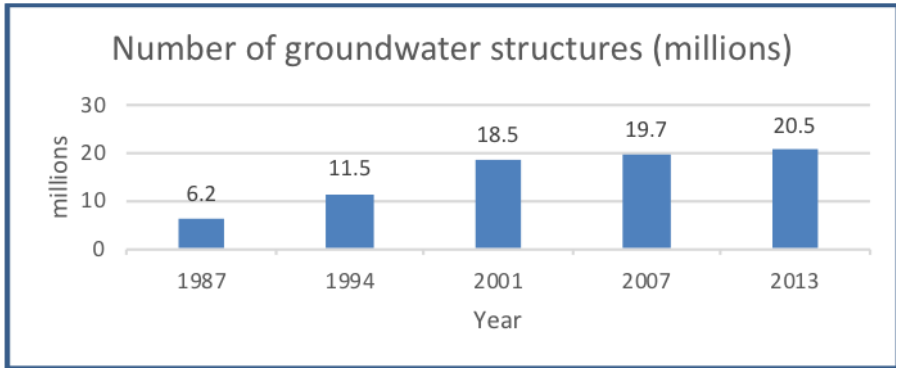

Number of Ground Water Structures, 2007
N
Legend
Number of Ground Water Structures, 2007
1 Dot = 5,000 Wells & Tubewells
No data
Total Number of Groundwater Structures: 19.7 Million
0 190 380 760 1,140 1,520
Kms
Source: 4th MI Census, 2006

Number of groundwater structures, 2013



Total number of GW structures:
20.5 million

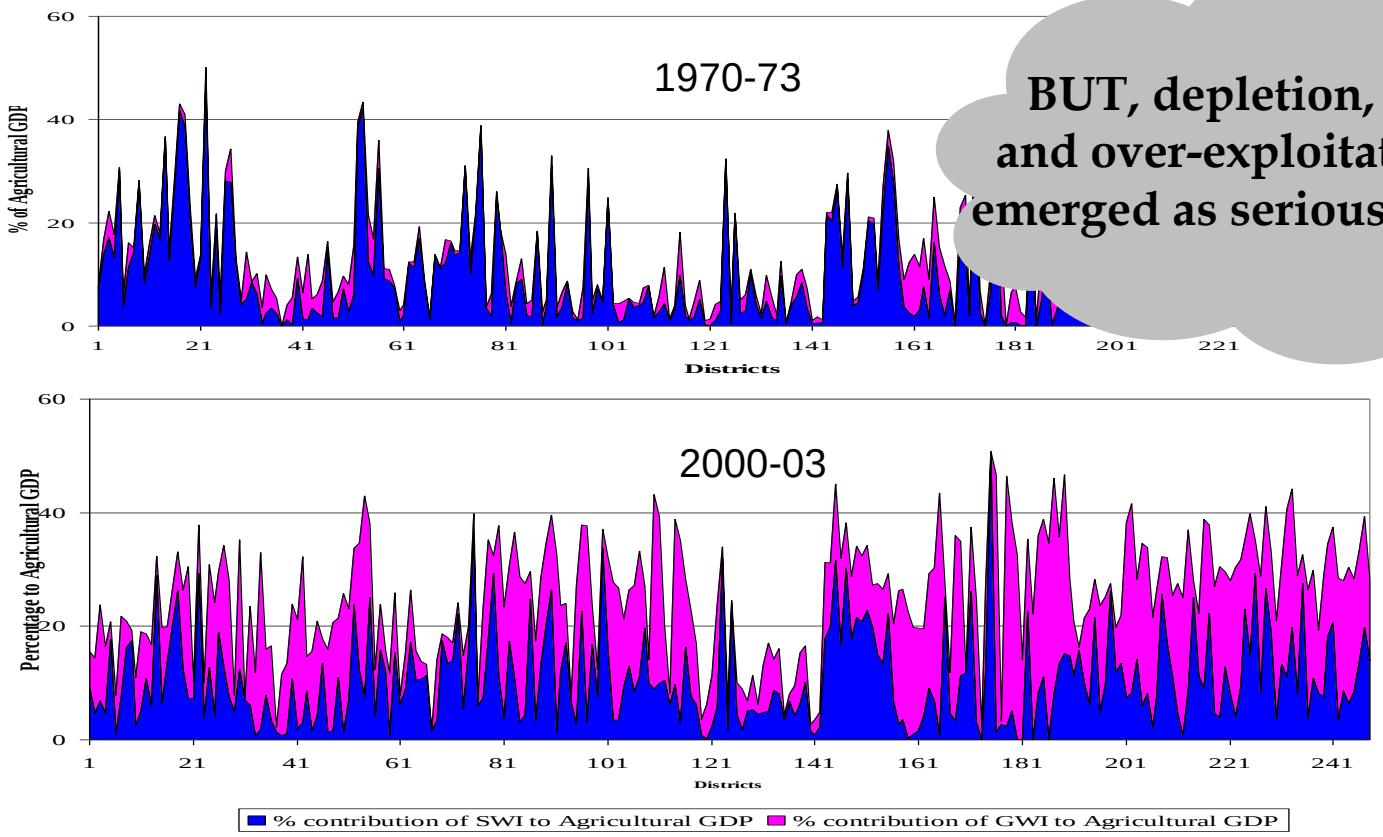
Source: 5th MI Census, 2013



- Pace of growth in India's groundwater structure is slo
- But number of deep wells is on the rise
- There are deep regional divides

Mukherji, A. 2016. Evolution of irrigation sector, *Economic and Political Weekly*, Vol 51(52): 44-47

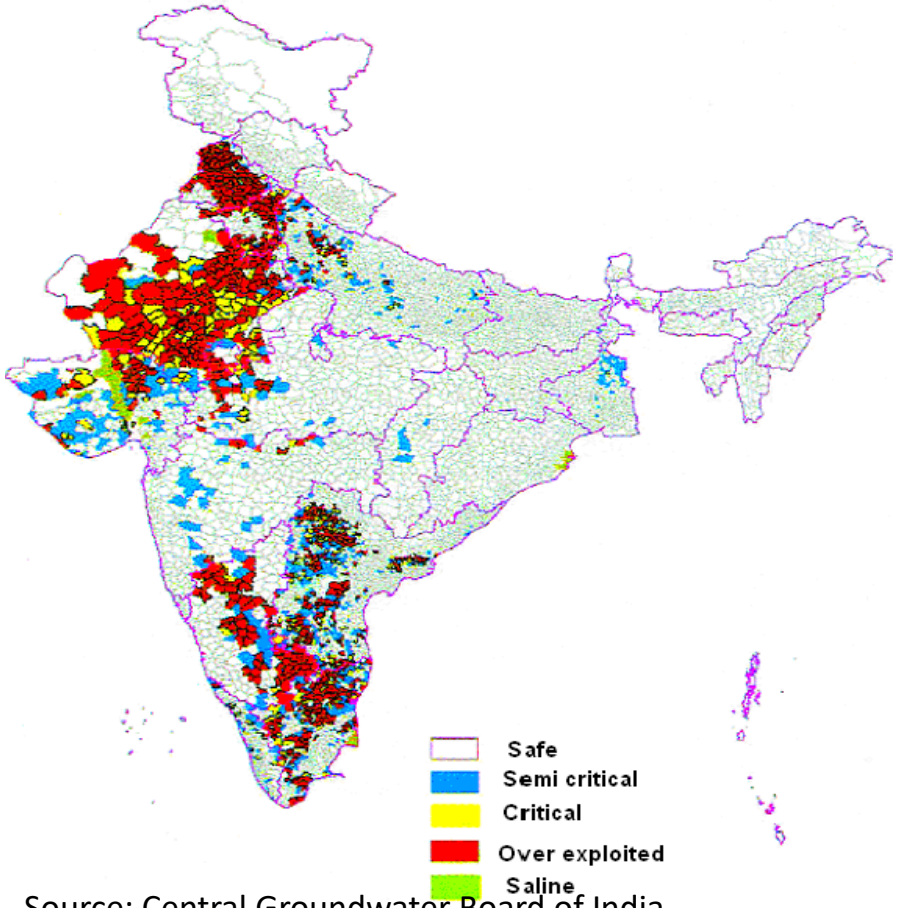
Rising contribution of groundwater in agriculture



BUT, depletion, scarcity and over-exploitation have emerged as serious problems

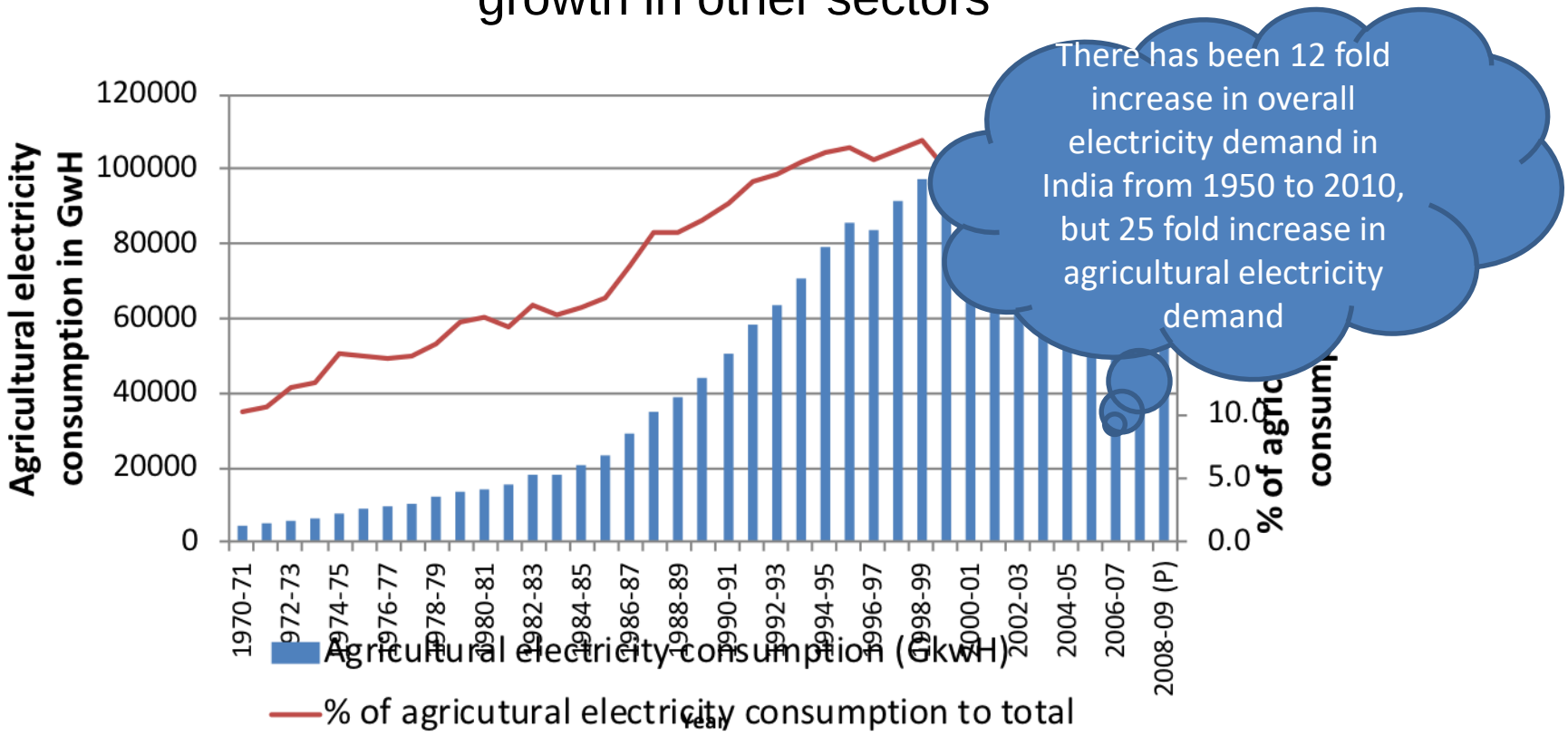
Deb Roy A. & T. Shah (2003): 'Socio-ecology of Groundwater Irrigation in India', in Llamas, R & E. Custodio (eds) *Groundwater Intensive Use: Challenges and Opportunities,* Swets and Zetlinger Publishing Co., The Netherlands

However, groundwater over-exploitation in India has clear regional dimensions: Eastern India has ‘under-developed’ groundwater resources

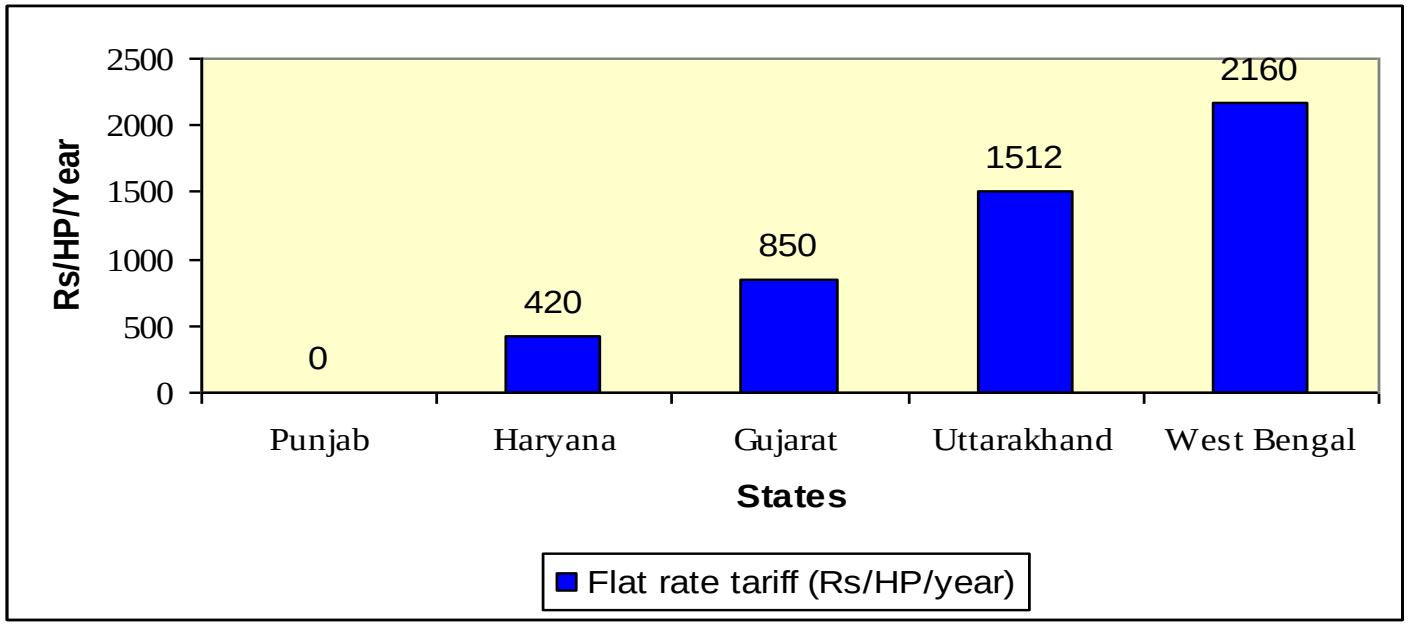


Source: Central Groundwater Board of India

Growth in electricity consumption in agriculture has outpaced growth in other sectors

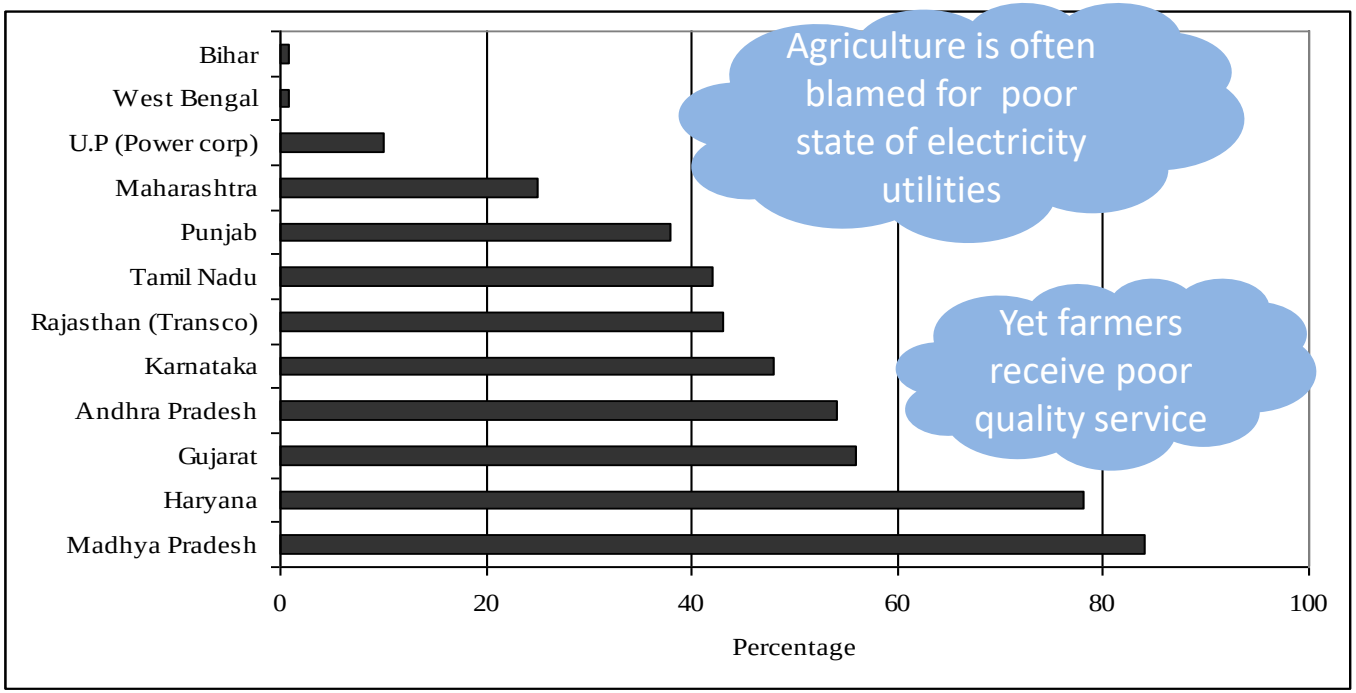


Farmers get free or highly subsidized electricity in most states (though not all).



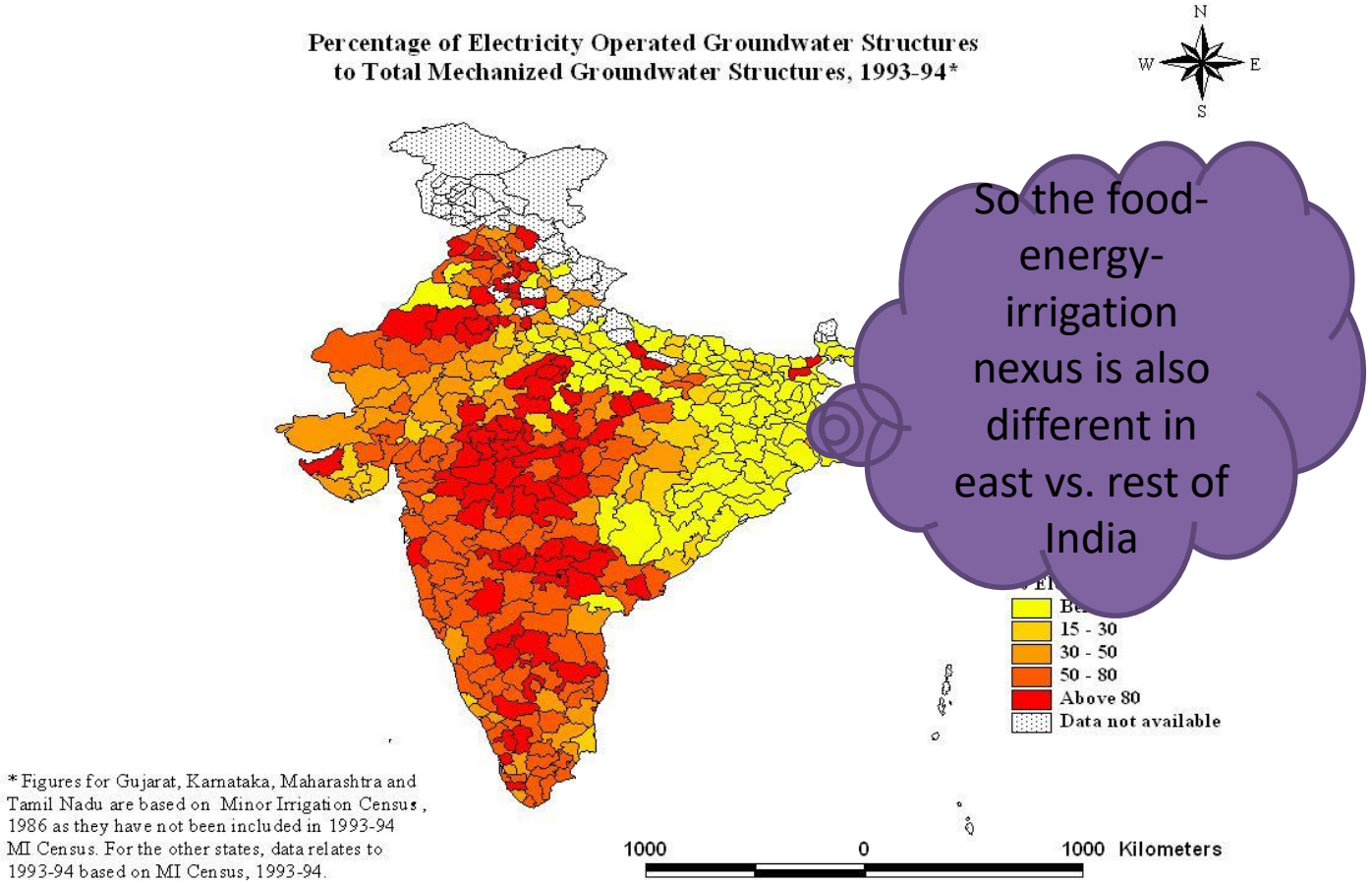
Even when farmers pay for electricity, they pay it on a flat tariff basis. Only exception is the state of West Bengal where agricultural tubewells are Metered and farmers pay a time of the day (TOD) tariff

Electricity subsidy as percentage of state fiscal deficits is very high in some states



BRISCOE, 2005, Data pertains to 2002

But then, there is the energy divide: Farmers in eastern India depend pre-dominantly on diesel pumps, while rest of India has electric pumps

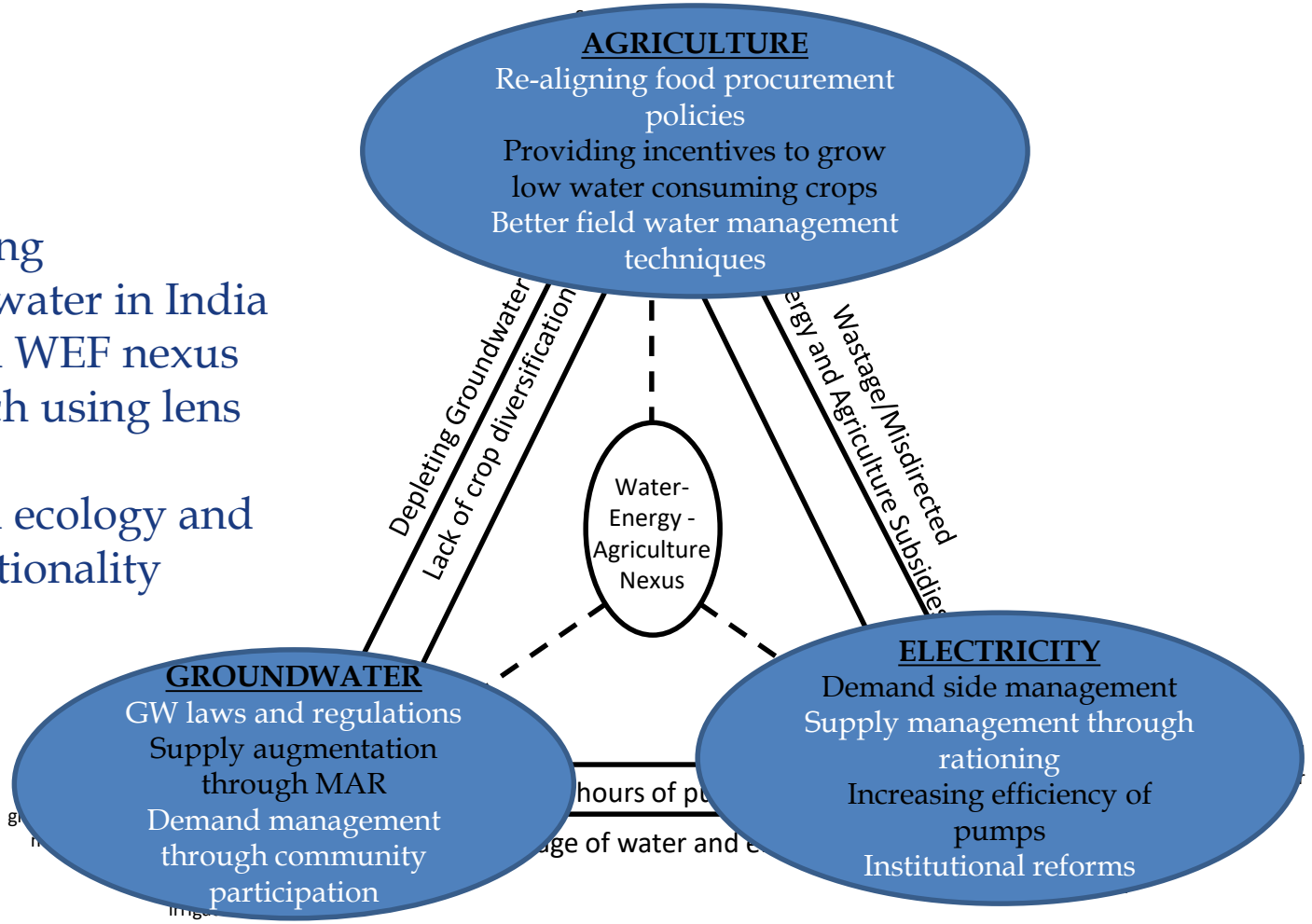


So the food-energy-irrigation nexus is also different in east vs. rest of India

To sum up…what is WEF nexus ?

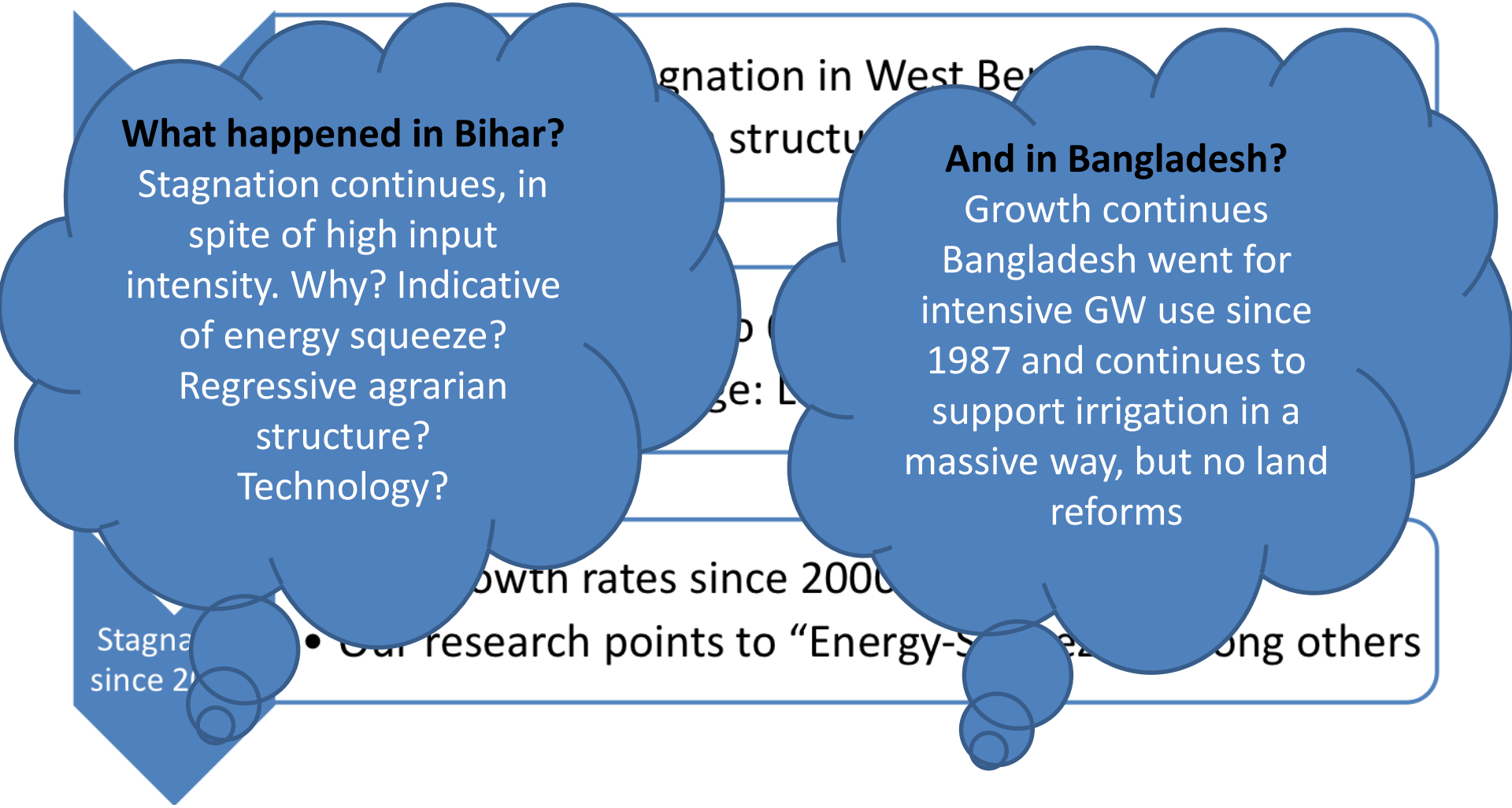
- India's irrigation sector is dependent on groundwater
- Much of this groundwater is pumped using electricity
- Groundwater use is more than sustainable recharge in most states leading to groundwater over-exploitation
- Electricity is subsidized in most (though not all) states
- This creates a nexus where one sector (agriculture) is dependent on unsustainable trends groundwater and electricity sectors

Managing groundwater in India through WEF nexus approach using lens of political ecology and intersectionality



Adapted from Sinha, Sharma and Scott, 2006

Agrarian growth and stagnation in West Bengal



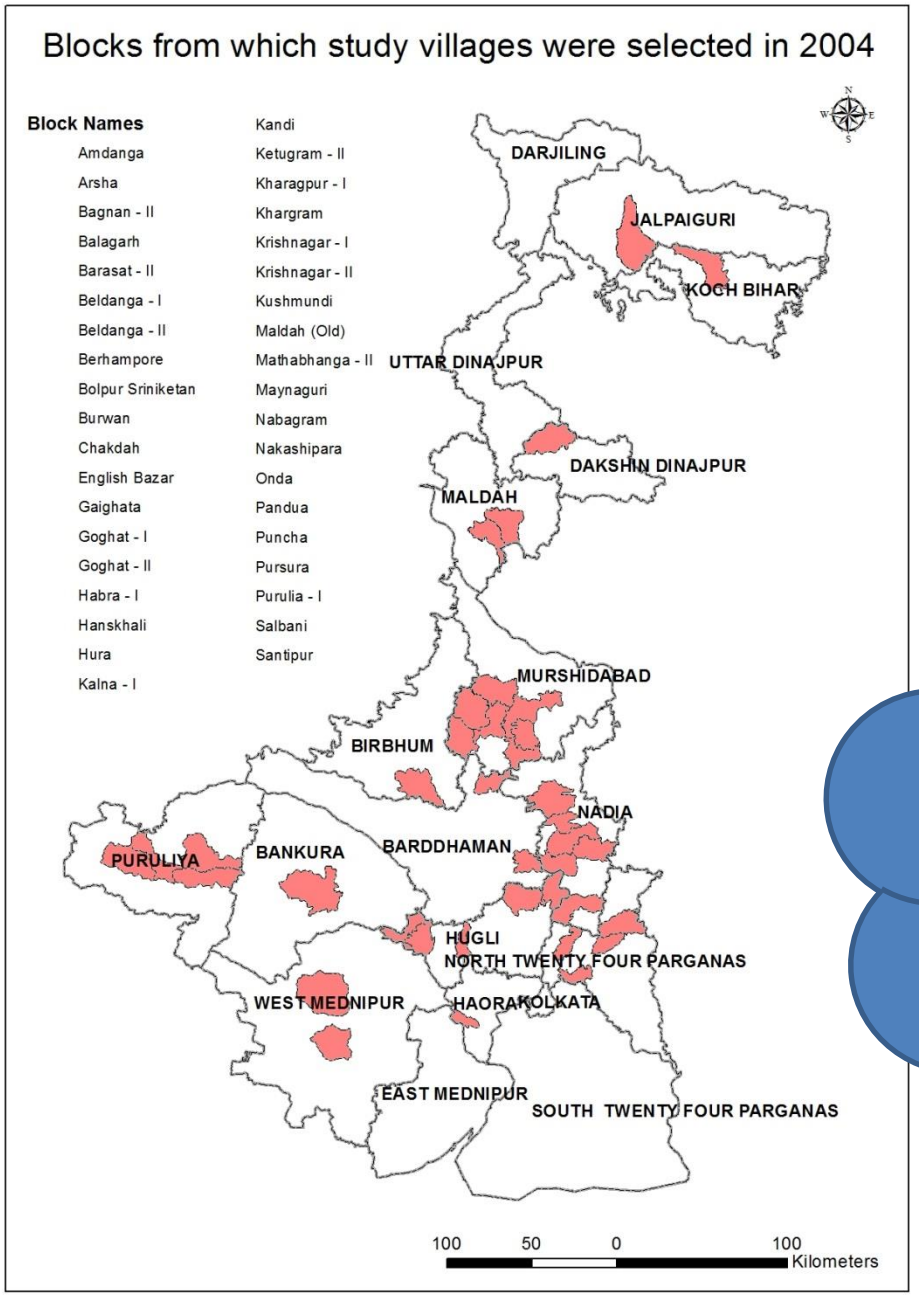
Looking for why's?

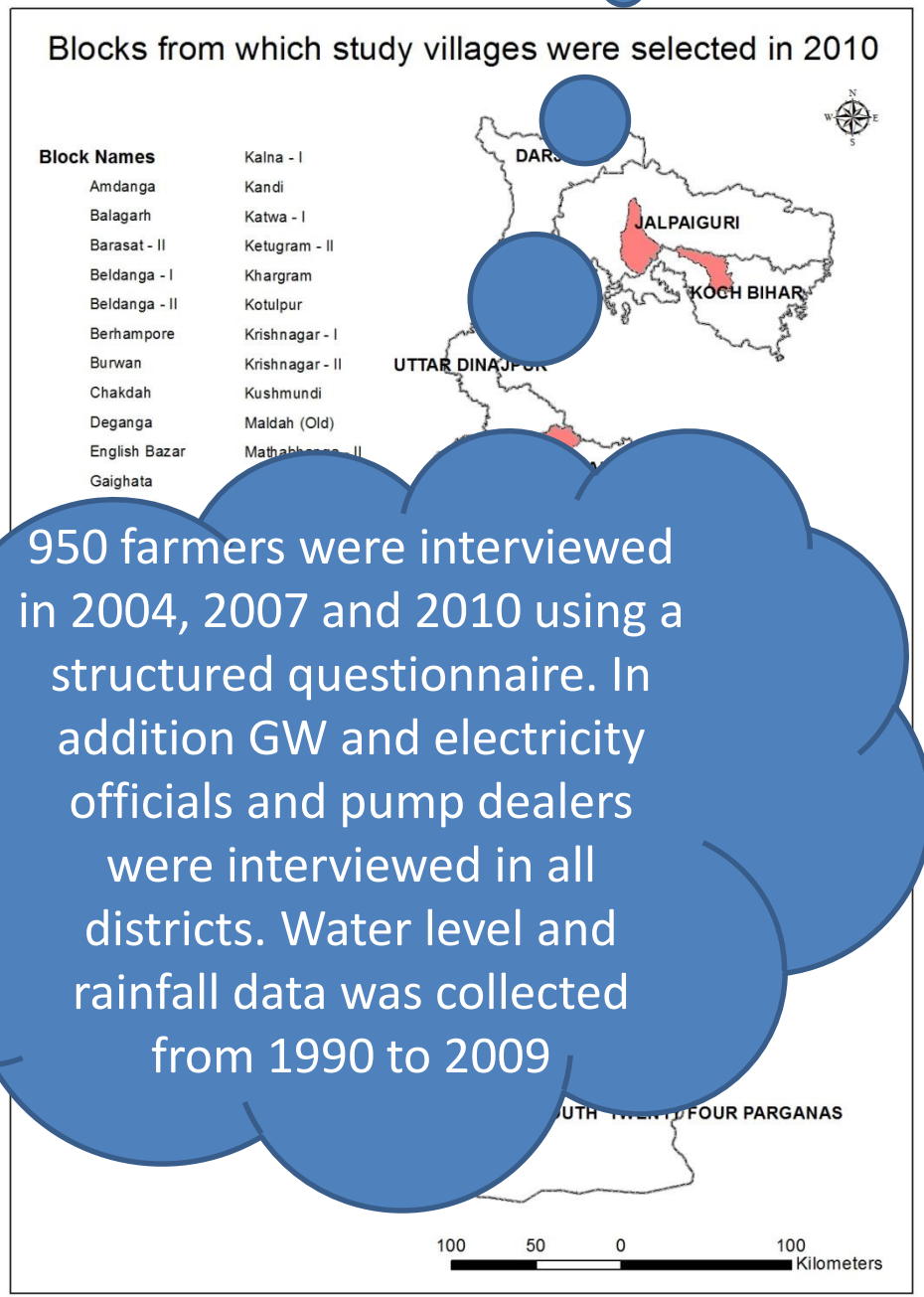
- Data collected from hundreds of farmers since 2004 points to lack of affordable access to water as a reason

- A paradox: Why do farmers in water abundant West Bengal not have access to water while their counterparts in water scarce Gujarat and Punjab have?

- This set us on a research trail which we have been pursuing for the last 18 years

Study locations from which data was collected in 2004, 2007 and 2010

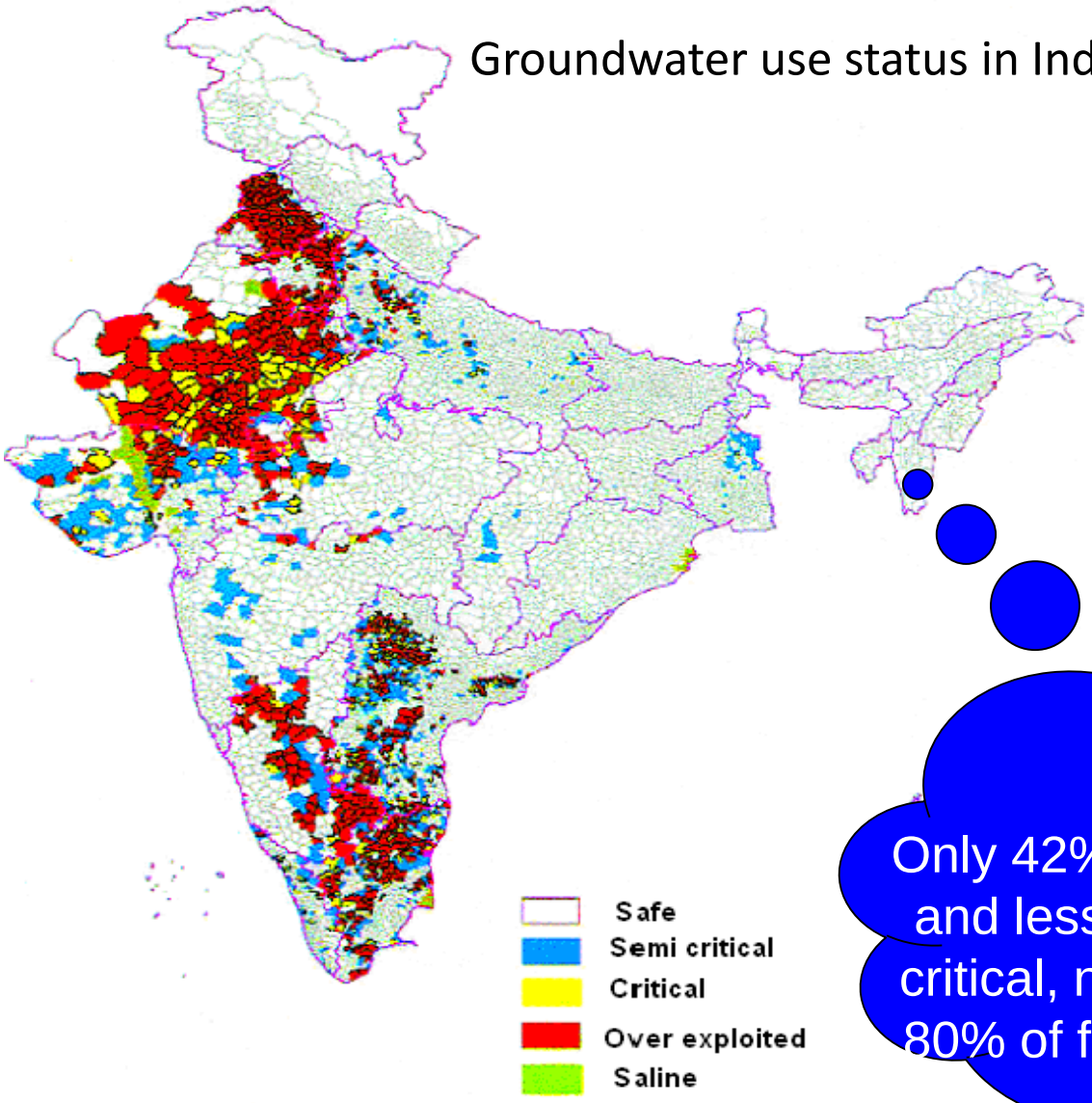




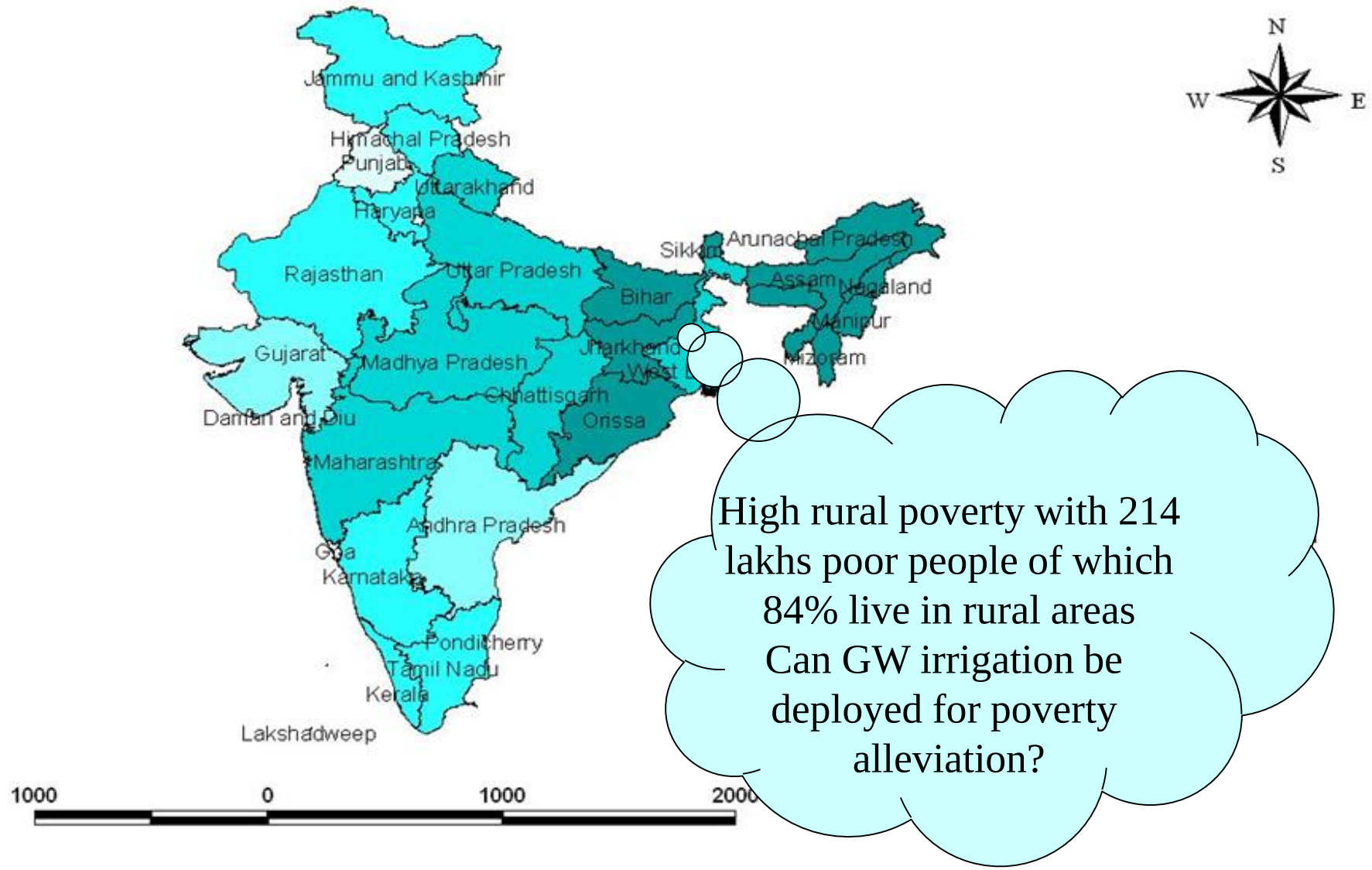
950 farmers were interviewed in 2004, 2007 and 2010 using a structured questionnaire. In addition GW and electricity officials and pump dealers were interviewed in all districts. Water level and rainfall data was collected from 1990 to 2009

Why did we think of groundwater based solution for Bengal?

Groundwater use status in India



High
GW potential
Only 42% of its potential is used
and less than 10% blocks are
critical, none are over-exploited
80% of farmers depend on GW


N
W
E
S
Jammu and Kashmir
Himachal Pradesh
Punjab
Uttarakhand
Haryana
Rajasthan
Uttar Pradesh
Sikkim
Arunachal Pradesh
Assam
Nagaland
Manipur
Mizoram
Bihar
Jharkhand
West Bengal
Gujarat
Madhya Pradesh
Chhattisgarh
Orissa
Daman and Diu
Maharashtra
Andhra Pradesh
Goa
Karnataka
Pondicherry
Tamil Nadu
Kerala
Lakshadweep
1000
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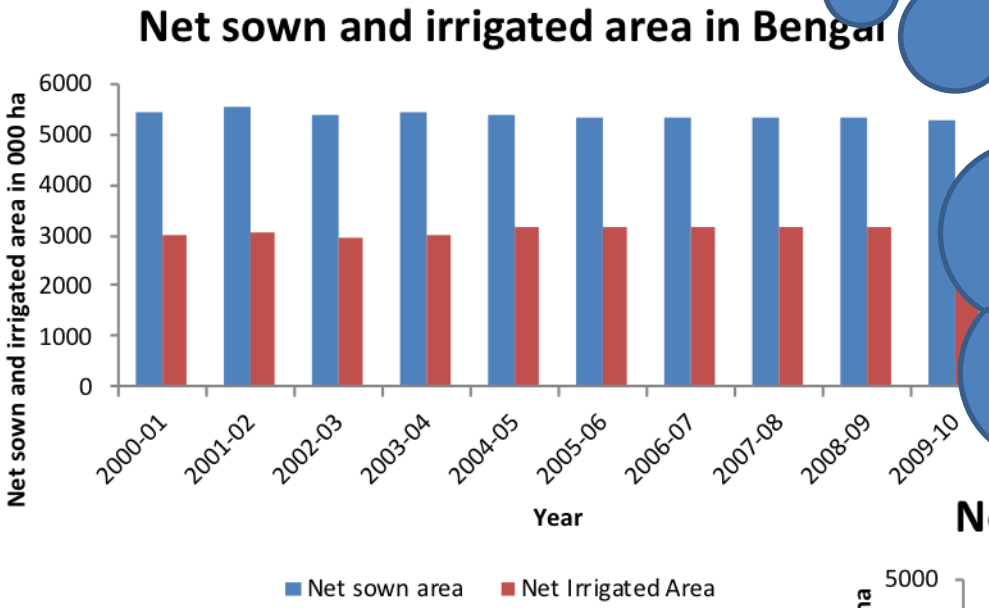
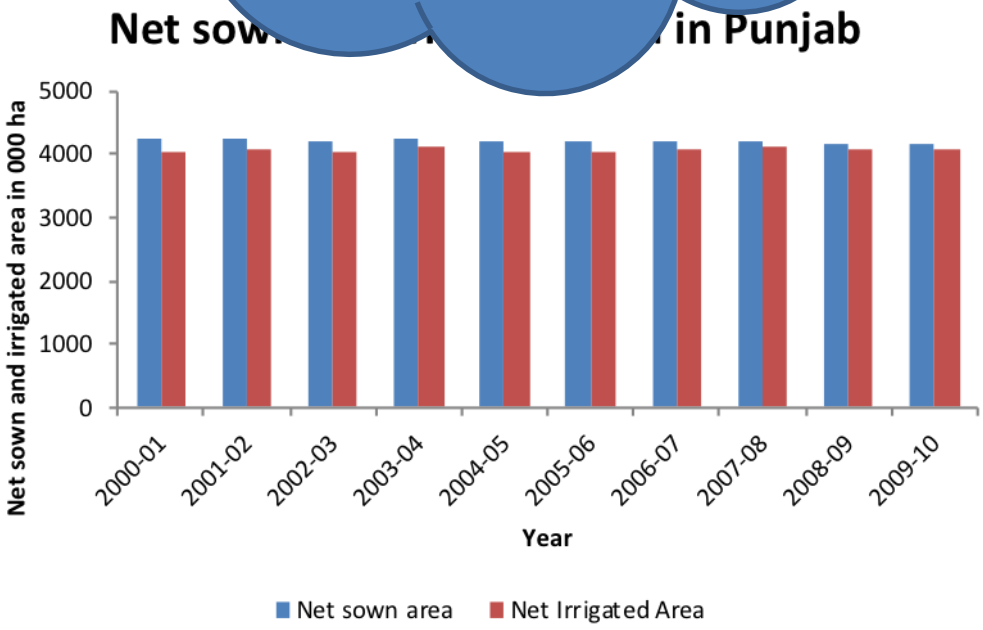
2000
High rural poverty with 214 lakhs poor people of which 84% live in rural areas
Can GW irrigation be deployed for poverty alleviation?

What are the agricultural water management (AWM) problems? Almost half of Bengal's net sown area is un-irrigated

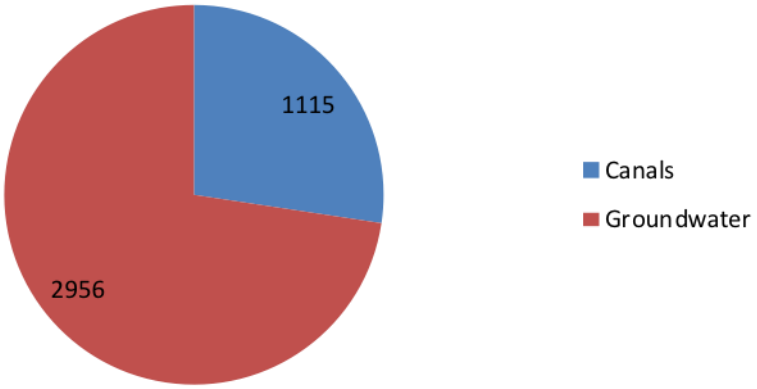


West Bengal is not Punjab. It receives 1500 to 2000 mm rainfall, Punjab just 400 to 600 mm. Pressure on land is 3 times in Bengal and therefore farmers need to intensify. Irrigation helps intensify

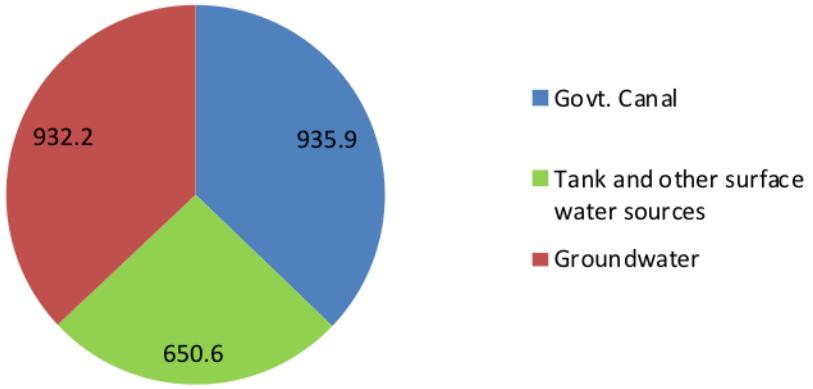


Groundwater irrigates less than 40% of net irrigated area of Bengal as against 73% in Punjab

Sources of irrigation in Punjab, 2009-10



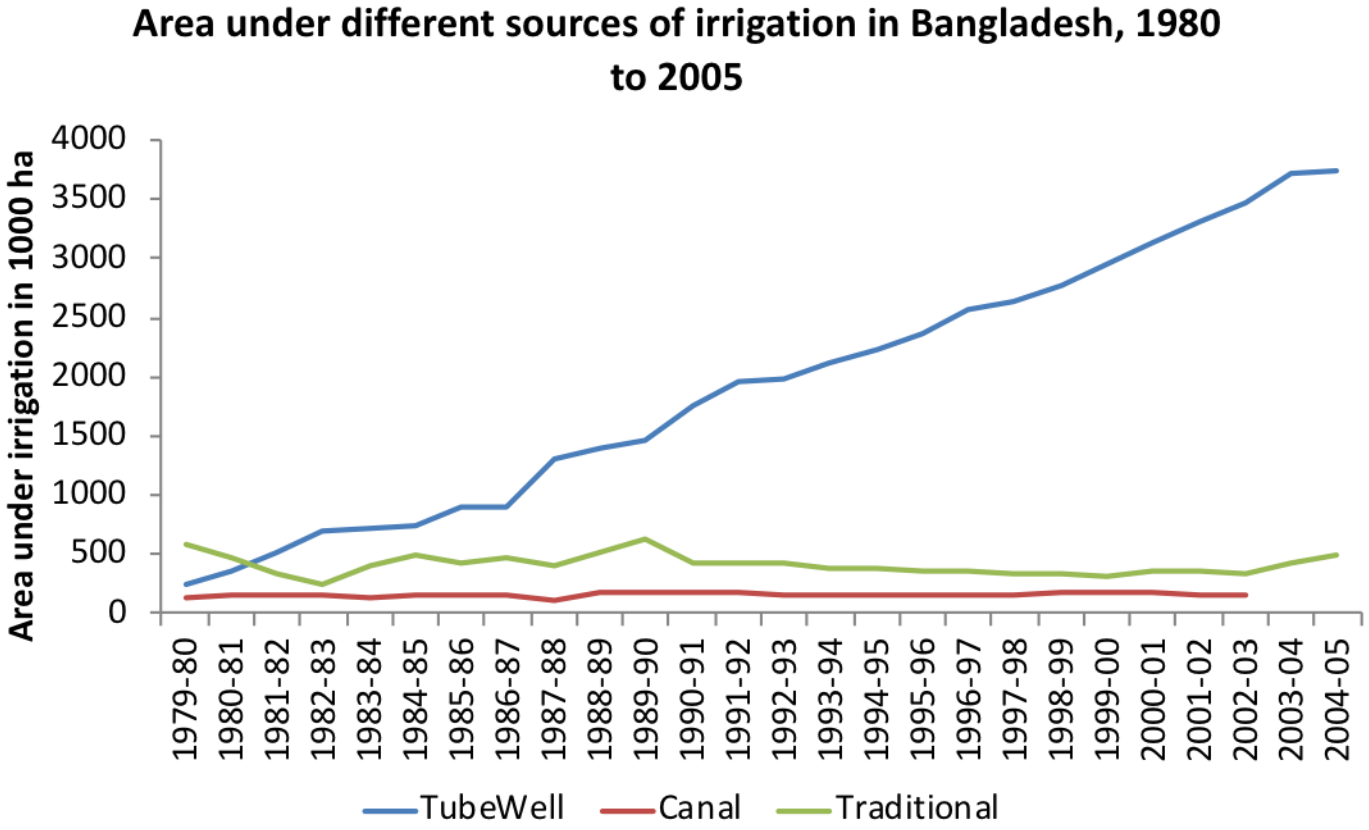
Sources of irrigation in Bengal, 2005-06



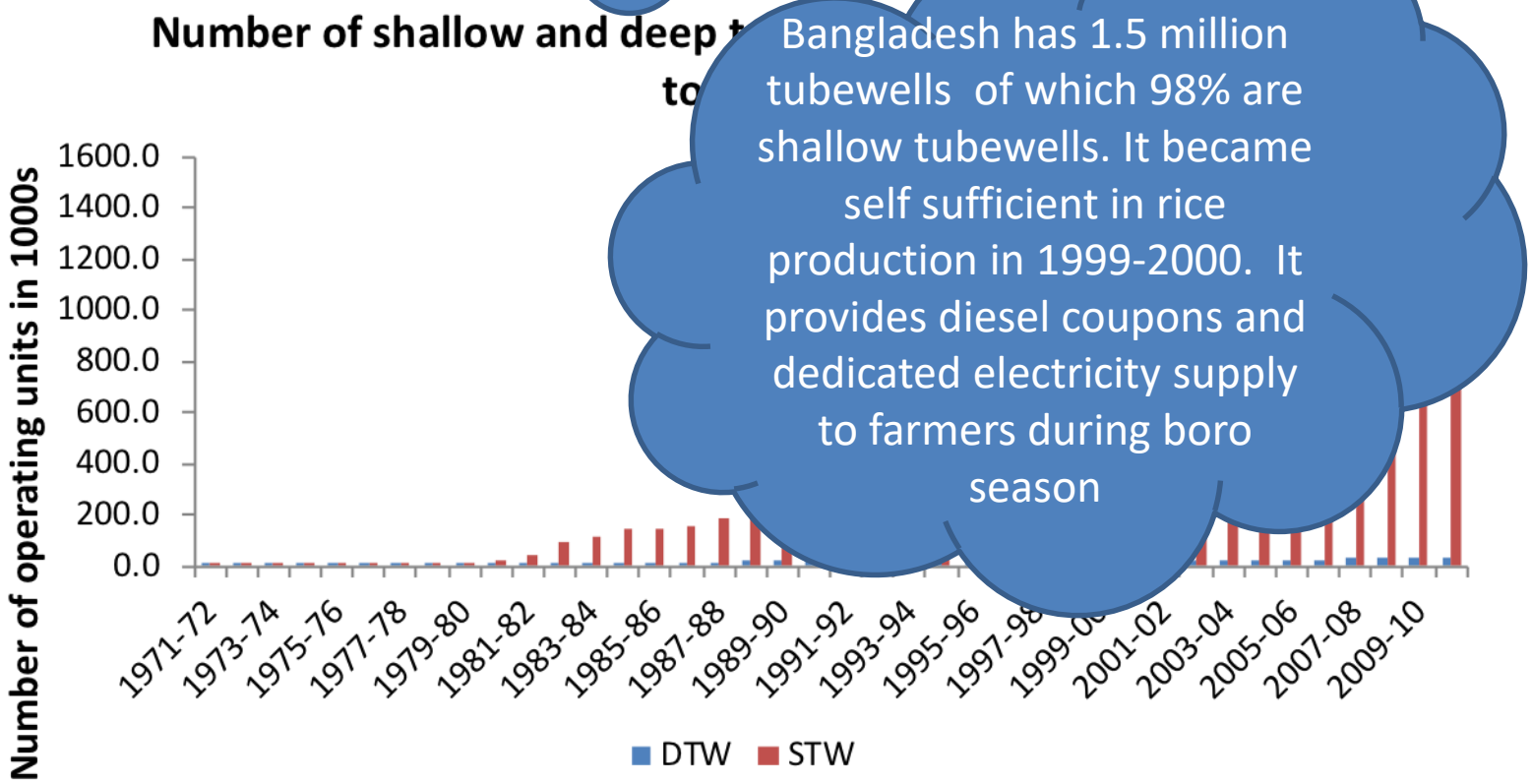
Groundwater is the only source of irrigation that provides all year round irrigation on demand. Given small farm sizes (average farm size is 0.79 ha), farmers in Bengal have to grow 2 to 3 crops a year for mere survival. All year round irrigation makes that possible.

West Bengal has a net groundwater availability of 27.46 BCM, of which 40% is utilized

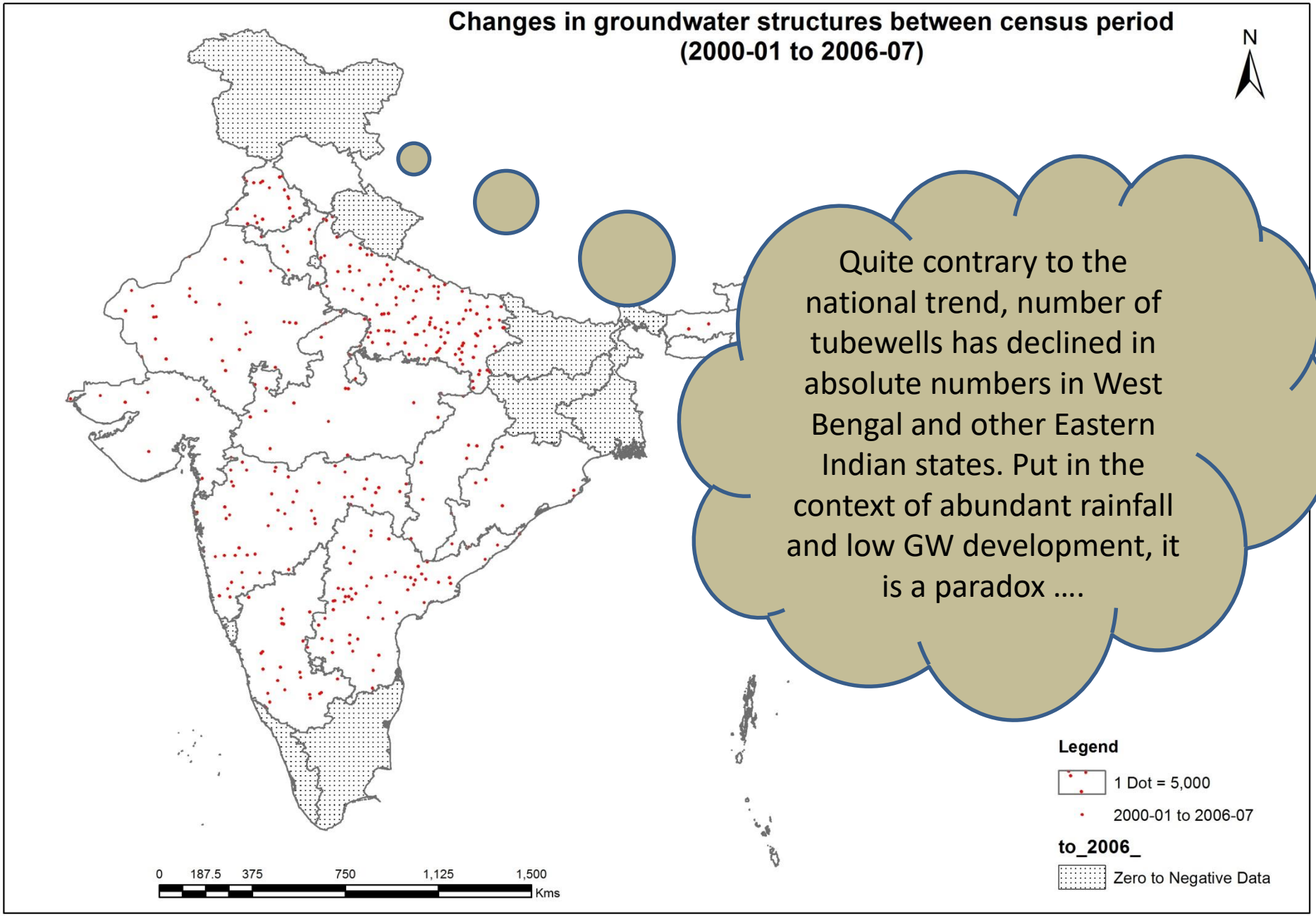
Bangladesh, with very similar climate and agro-ecology as Gangetic Plains and North Bengal relies mostly on groundwater for irrigation



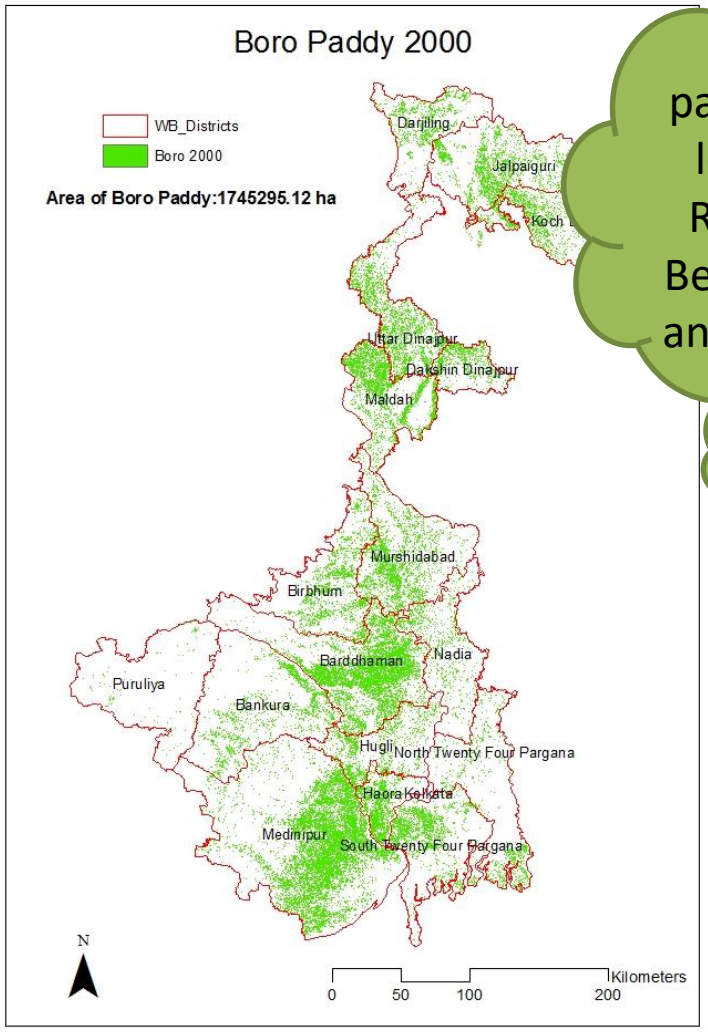
After liberalization of pump imports in 1987 and removal of spacing norms, number of pumps increased rapidly in Bangladesh



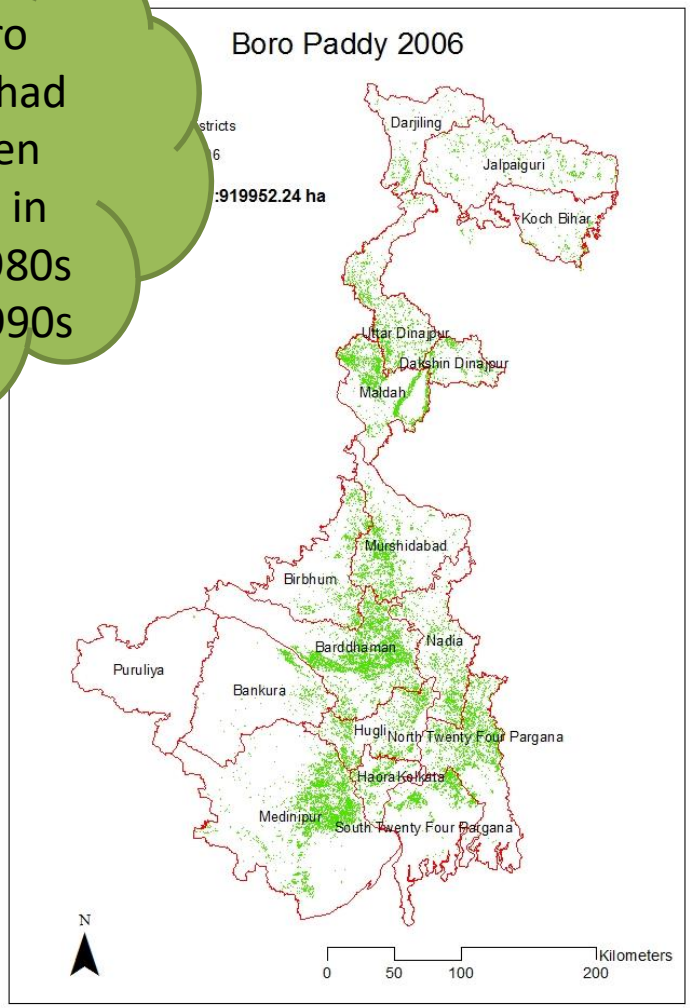
Bangladesh has 1.5 million tubewells of which 98% are shallow tubewells. It became self sufficient in rice production in 1999-2000. It provides diesel coupons and dedicated electricity supply to farmers during boro season


Changes in groundwater structures between census period
(2000-01 to 2006-07)
N
Quite contrary to the national trend, number of tubewells has declined in absolute numbers in West Bengal and other Eastern Indian states. Put in the context of abundant rainfall and low GW development, it is a paradox ….
0 187.5 375 750 1,125 1,500
Kms
Legend
1 Dot = 5,000
2000-01 to 2006-07
to_2006_
Zero to Negative Data

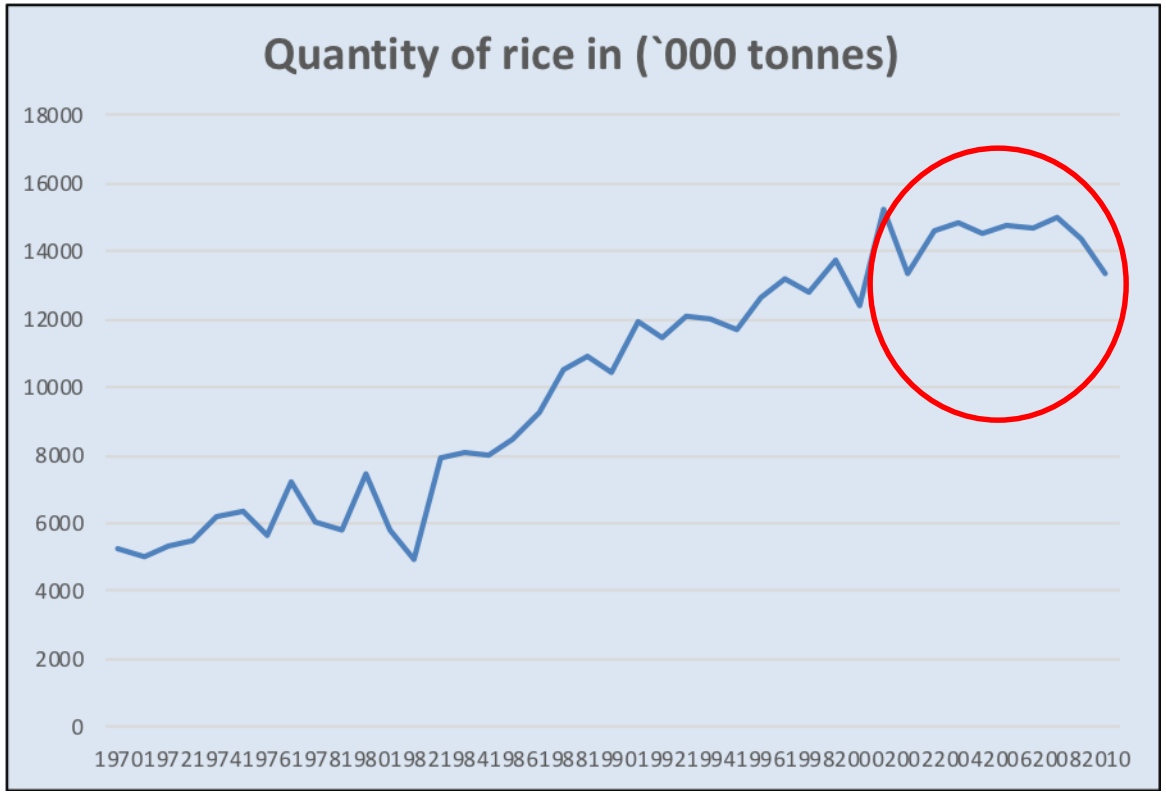
As a result, area under boro paddy declined from 1.7 mha to less than 1 mha from 2000 to 2006, but recovered somewhat in 2011-12



It was boro paddy that had led to Green Revolution in Bengal in 1980s and early 1990s



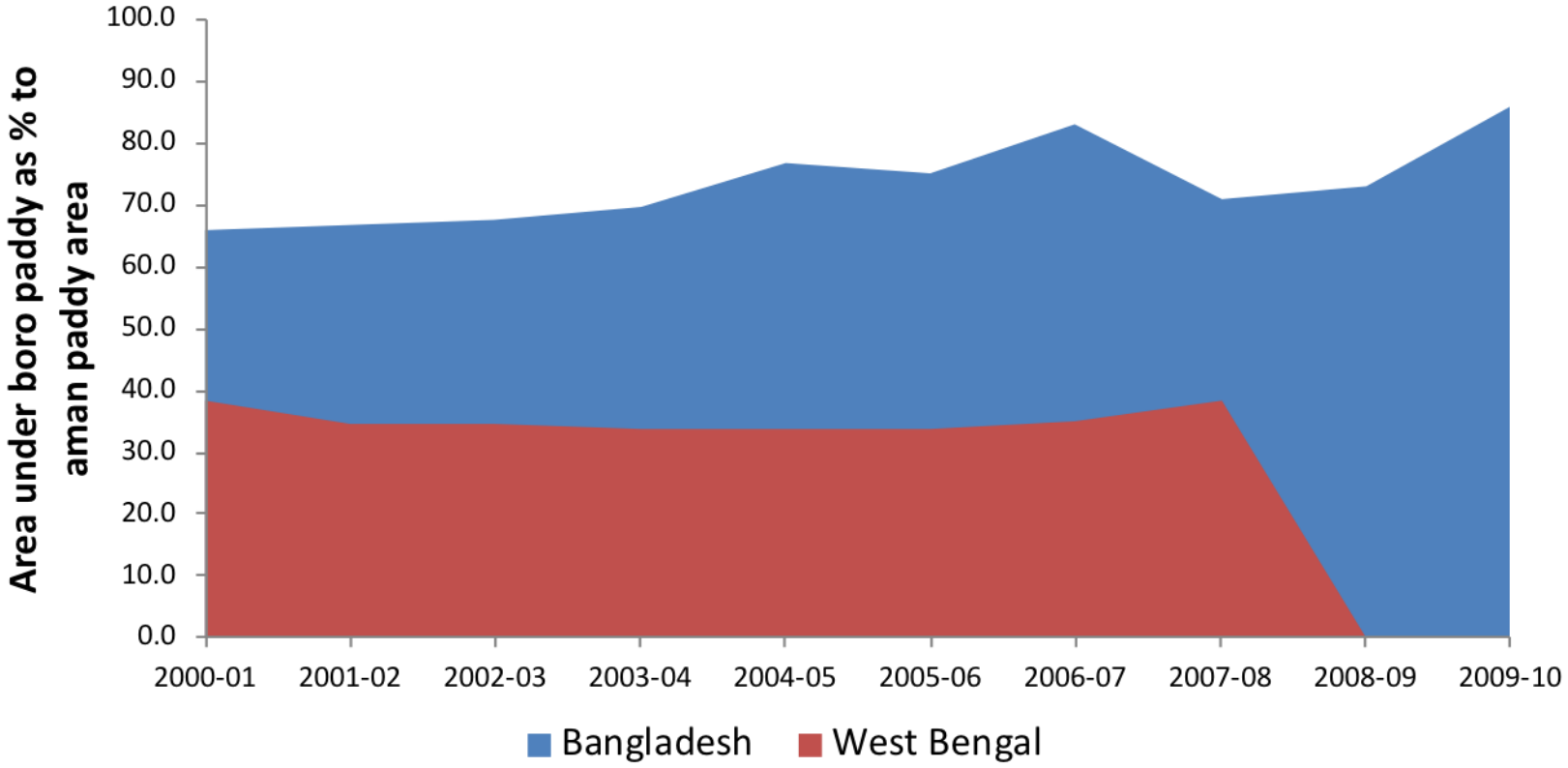
This is reflected in declining rate of growth in paddy production in 2000s



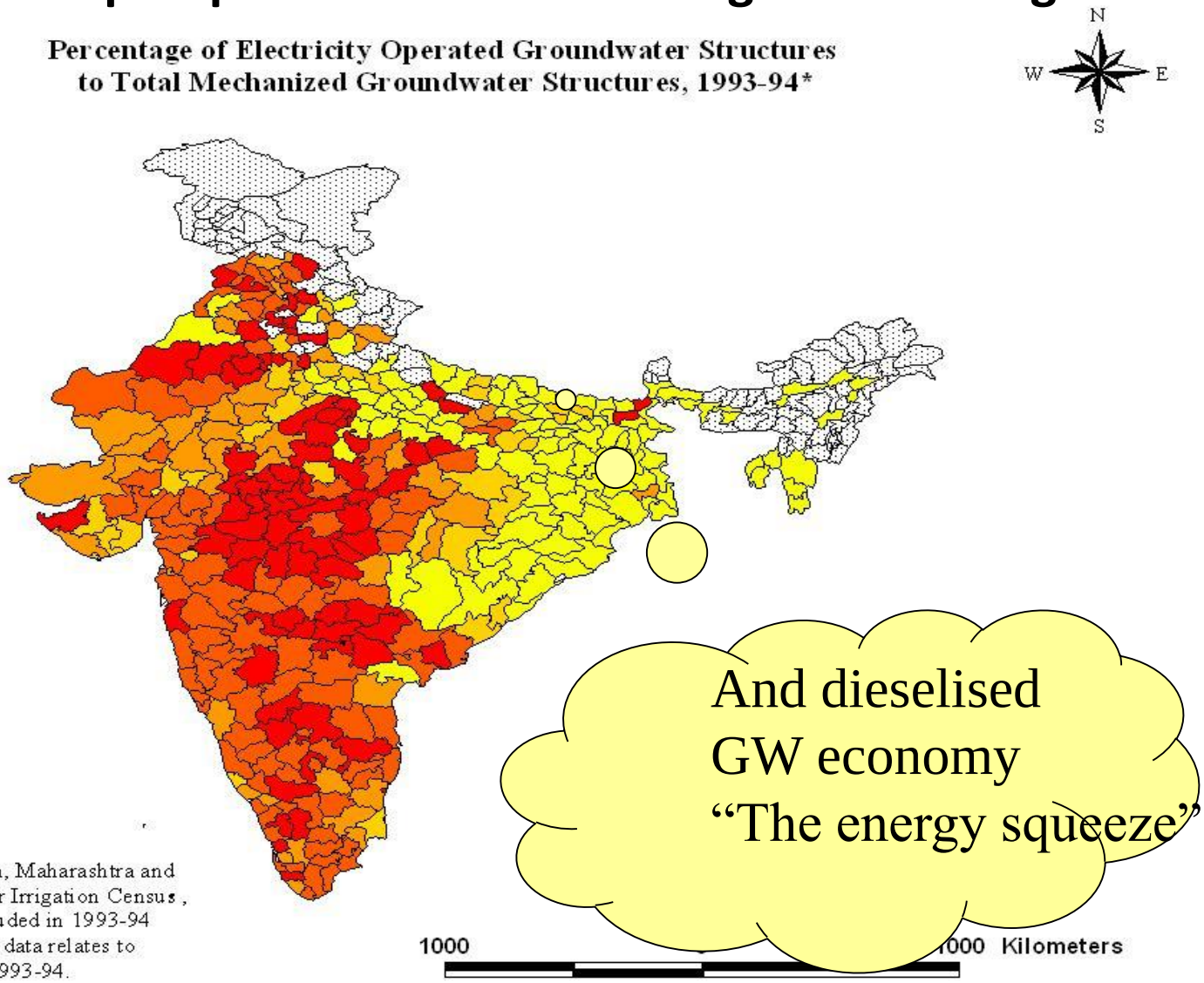
Decade	CAGR of rice production (%)
1970s	1.08
1980s	4.32
1990s	3.12
2000s	1.6

Graph prepared by Archisman Mitra, IWMI

Bangladesh grows boro rice on 86% of area on which it grows aman rice, in West Bengal, boro is grown is less than 40% of aman area – so there is some scope for expansion in boro area and production



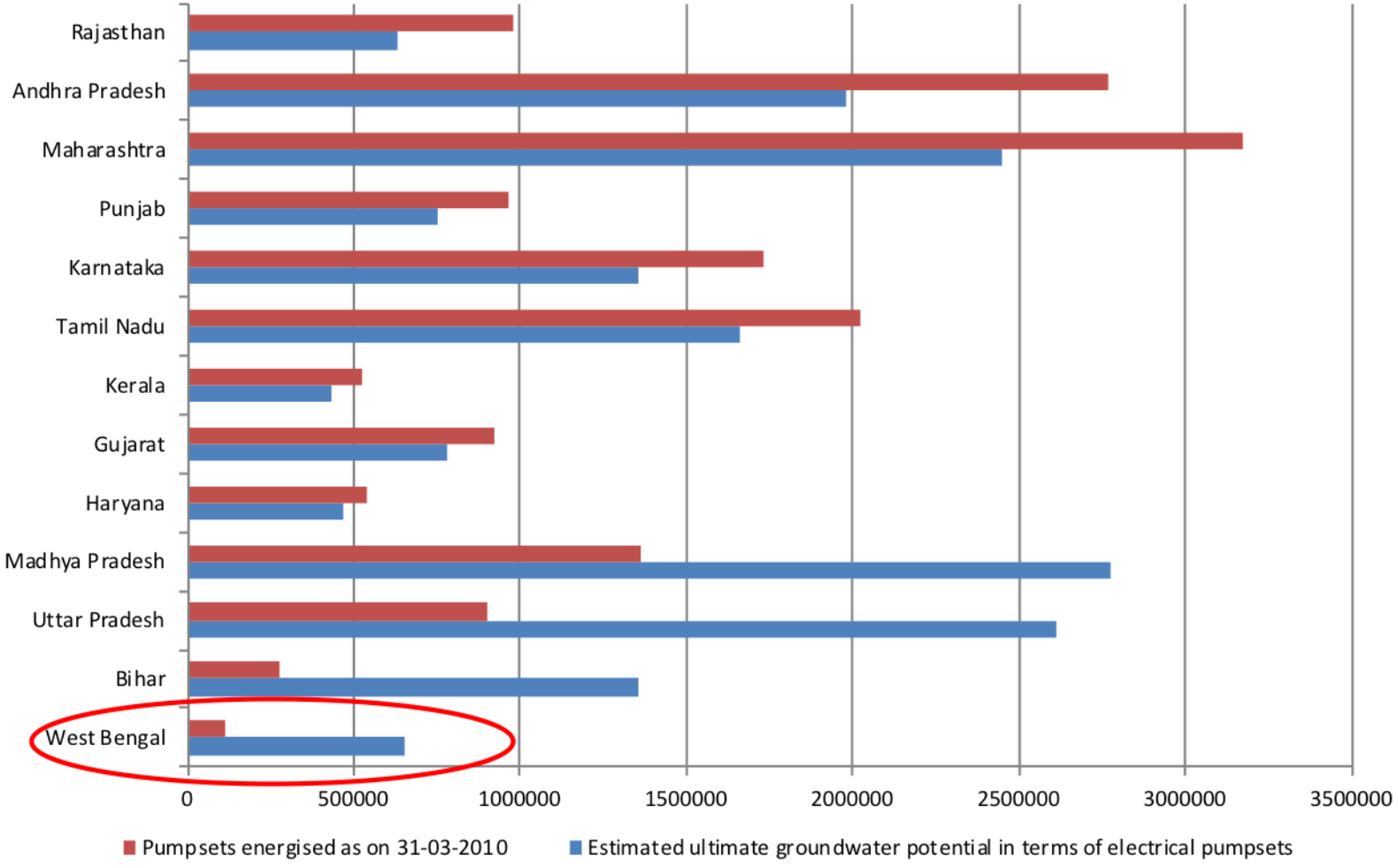
But what is the impediment?
Low rates of pump electrification and high cost of irrigation



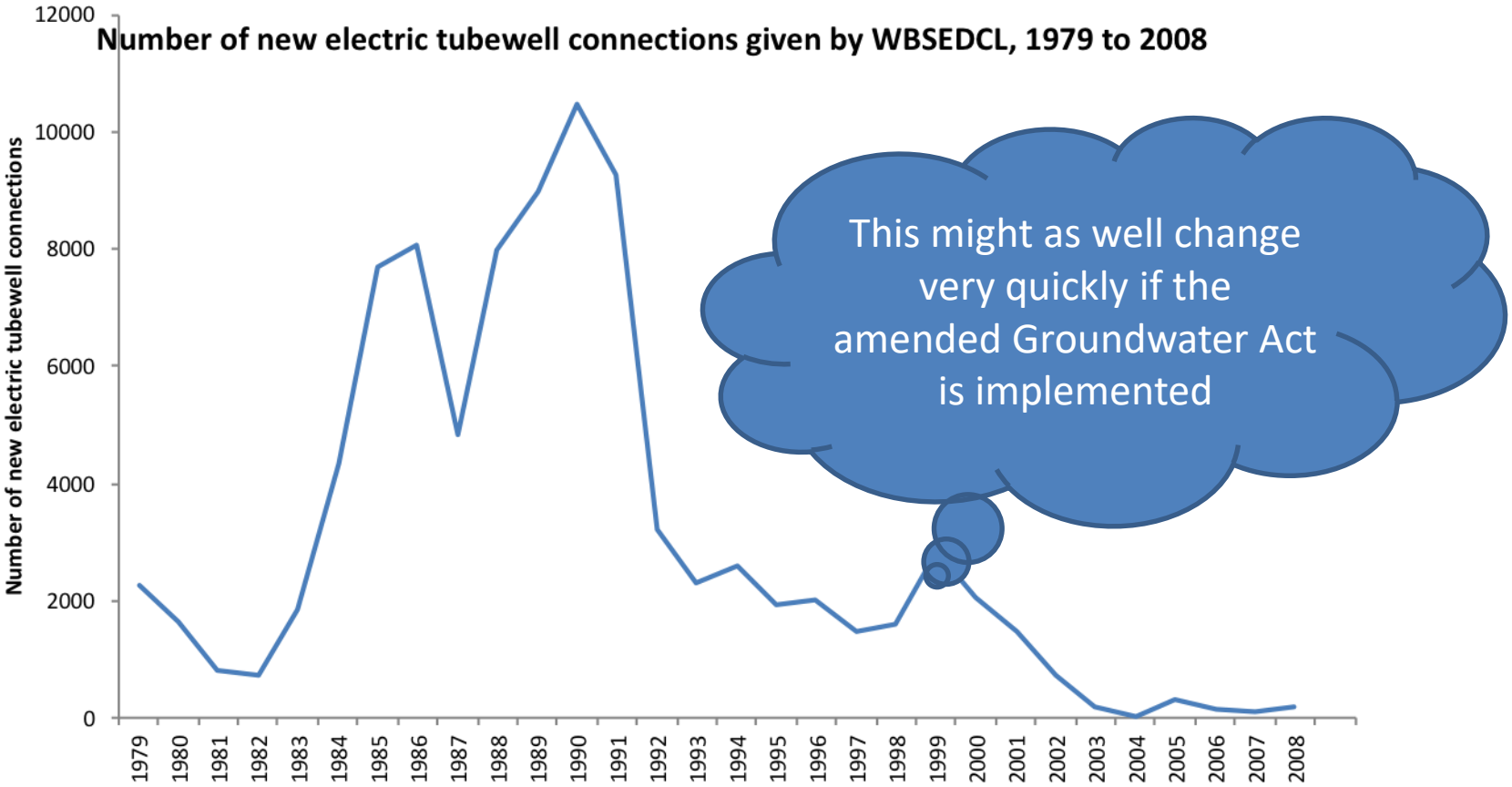
And dieselised
GW economy
"The energy squeeze"

* Figures for Gujarat, Karnataka, Maharashtra and Tamil Nadu are based on Minor Irrigation Census, 1986 as they have not been included in 1993-94 MI Census. For the other states, data relates to 1993-94 based on MI Census, 1993-94.

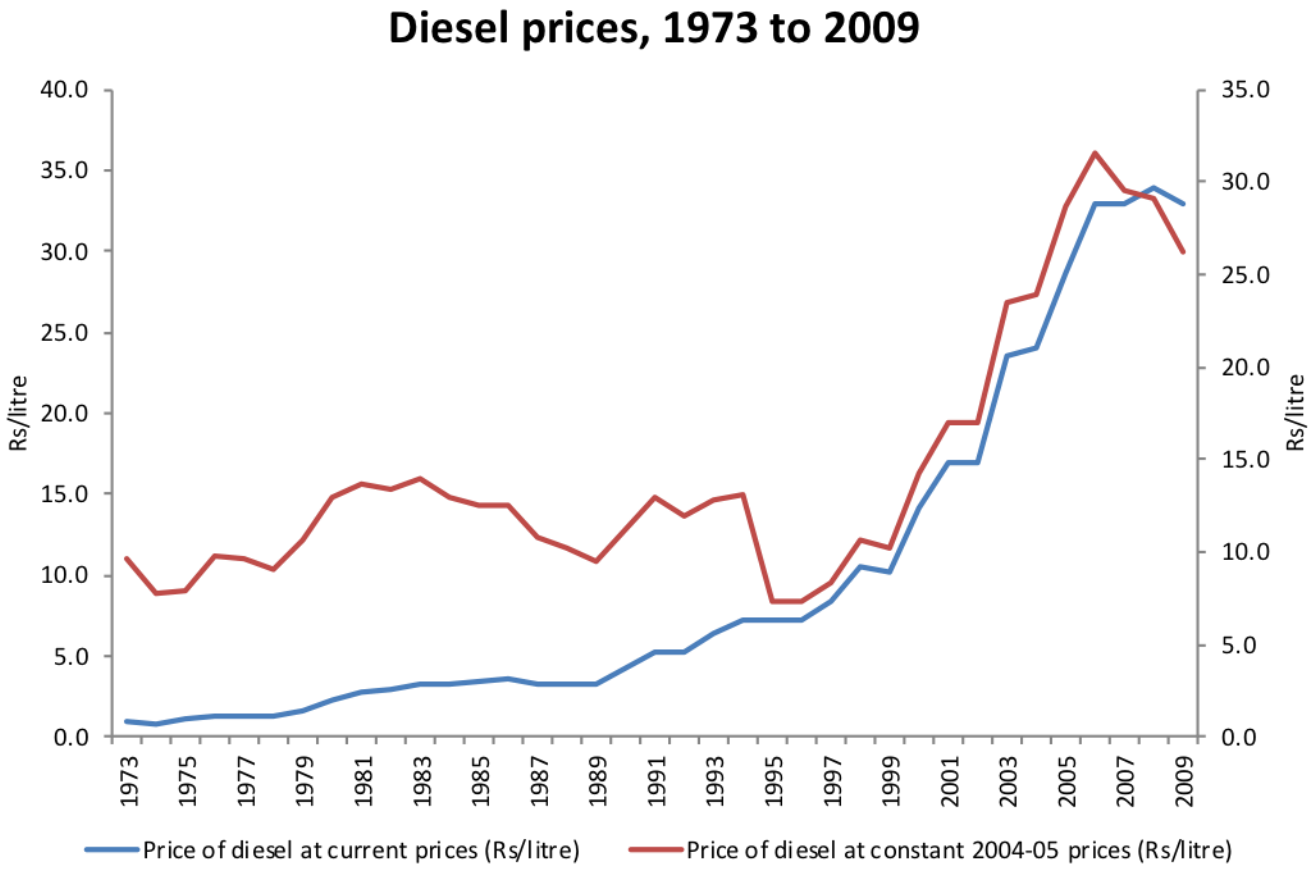
Number of electric pumpsets is less than 1/5th of its potential of 650,000 in West Bengal (CEA, 2010)



Number of new electricity connections for tubewells has gone down over the years, though since 2008 onwards, a lot of temporary boro connections have been given

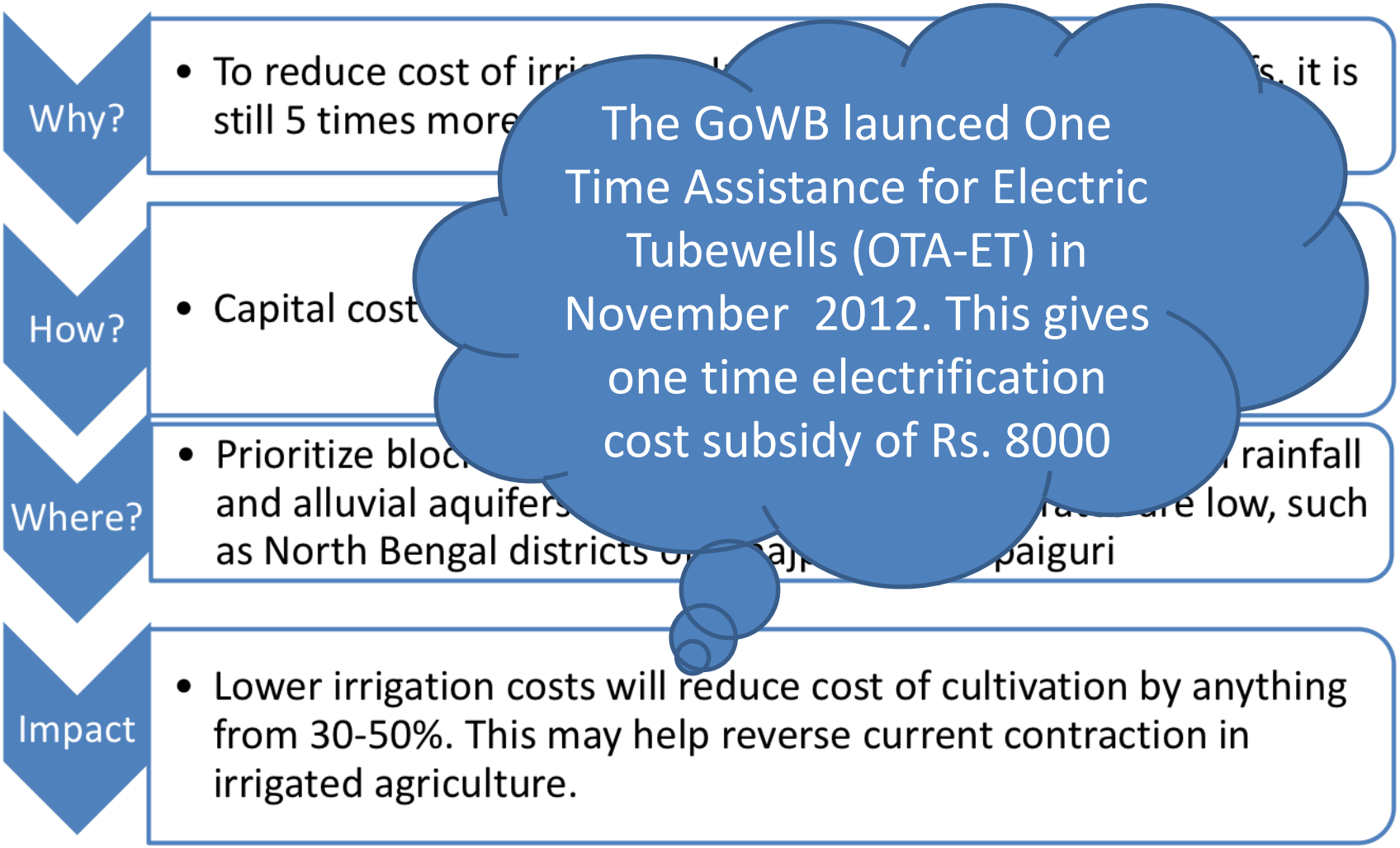


Ever rising diesel prices and the fact that 85% of pumps in the state are diesel run results in high cost of irrigation. Those with diesel pumps cannot grow water intensive boro paddy or vegetables – both of which are relatively profitable crops



At the heart of agrarian crisis in Bengal is the energy squeeze its farmers face in accessing relatively abundant groundwater resources. Given acute land scarcity and high population pressure, farmers have to grow 2 to 3 crops in a year to make a living. They cannot do so if they depend only on rainfall or on surface water sources. All surface water bodies like ponds dry up by late February or early March. Canals like DVC, Mayurakshi and Kangsabati can supply irrigation in summer only once in every 2 years. Groundwater is indispensable to farmers in Bengal – it enables them to intensify and grow relatively remunerative crops like boro and vegetables

Electrify or solarize groundwater wells and tubewells



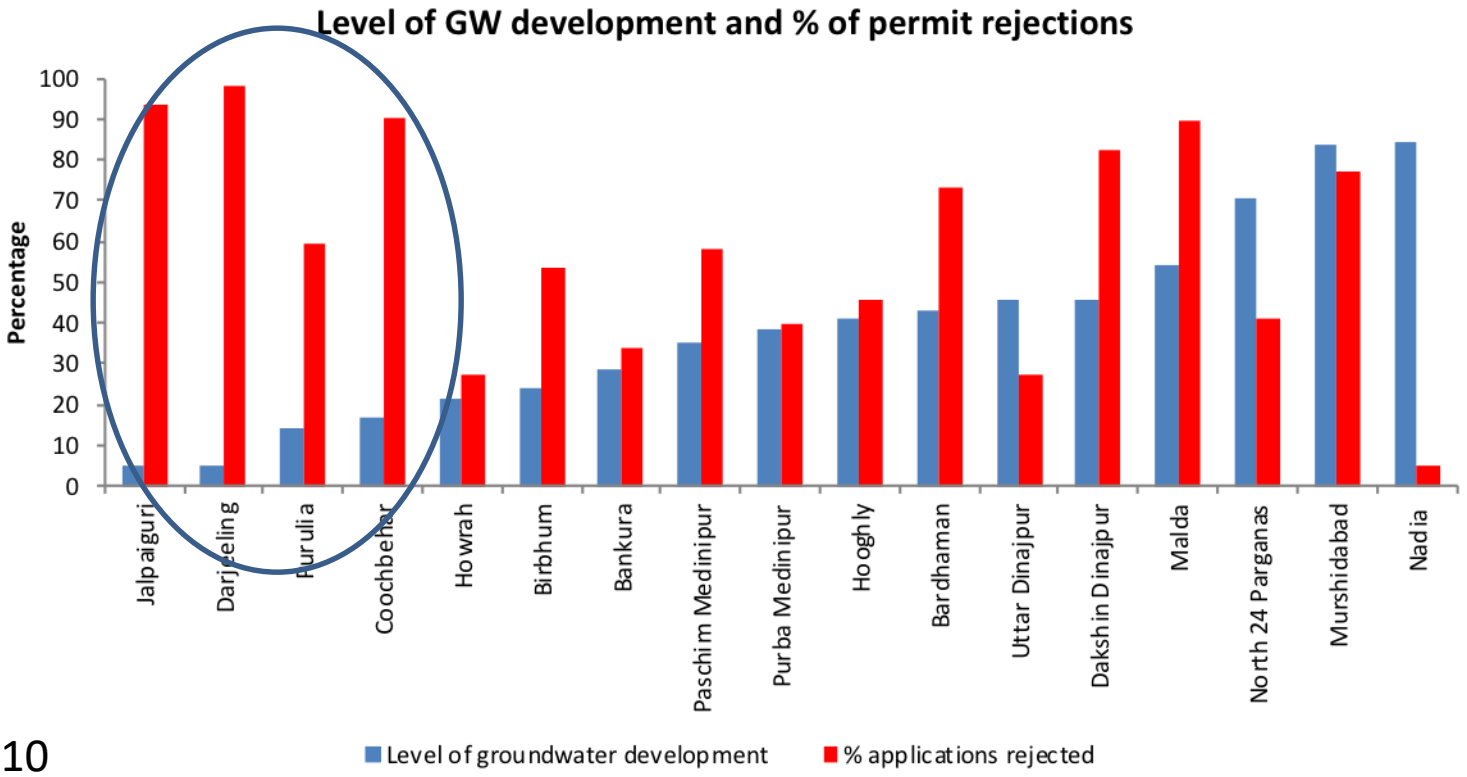
Some preliminary estimates on additional area under boro cultivation and electricity requirement if we used 50% of GW available for future use

Scenarios	100% use of GW left for "future"	70% use of GW left for "future"	50% use of GW left for "future"
Net Groundwater available for future use in 1000 ha m			790.7
Additional possible area under boro paddy in lakhs ha (@ 12000 m3 water applicati			6.4
Additional production of b paddy in lakh tonnes (@ 3.5 tonnes/ha)			22.4
Electricity needed to irrigate this land (in MU) (@ 300 hrs/ha and 3.5 units/hour)		945	672
Number of new tubewells required in lakhs	2.6	1.8	1.3

If only 50% of available groundwater left for the future was to be utilized, then we can bring additional 6.4 lakhs ha under boro paddy, grow additional 22.4 lakhs tonnes of paddy. For this, we will need 672 MU of electricity and 1.3 million electric tubewells

Impediments to pump electrification

GW Act of 2005 required that farmers take prior permit from authorities before they can apply for an electric connection. Majority (64%) of such applications are rejected, even in districts with very little groundwater use…



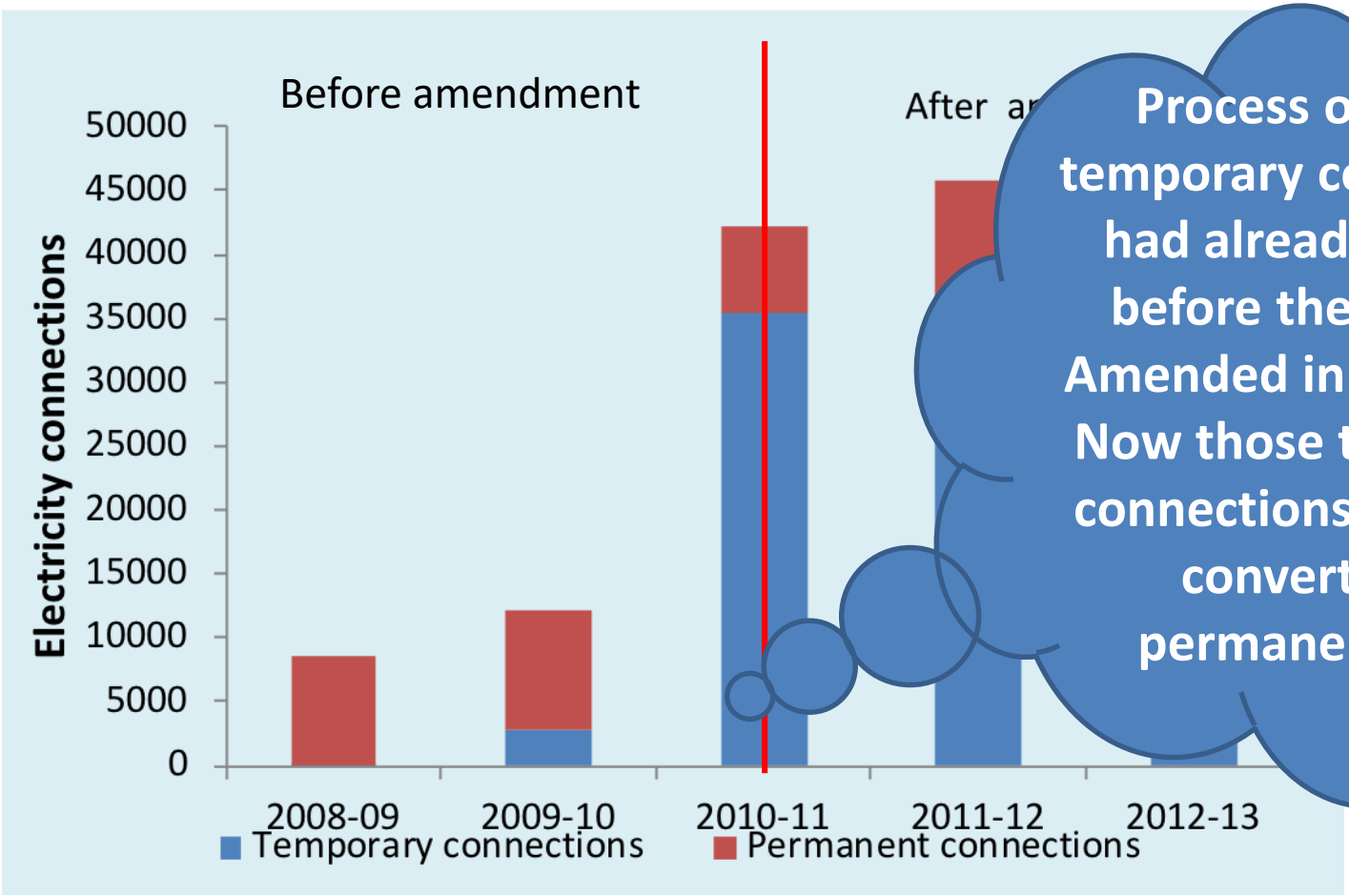
SWID, 2010

An executive order was passed in November 2011 to ease access to groundwater

- Now farmers in safe blocks with pumps of 5 HP or less and discharge of 30 m^3/hr or less will not need prior permission from the SWID for applying for electricity, but those in critical and semi-critical areas will still need it. There are 38 semi-critical blocks and 79 arsenic affected blocks and there is some amount of overlap between the two.

- With this, one of the major impediments has been removed.

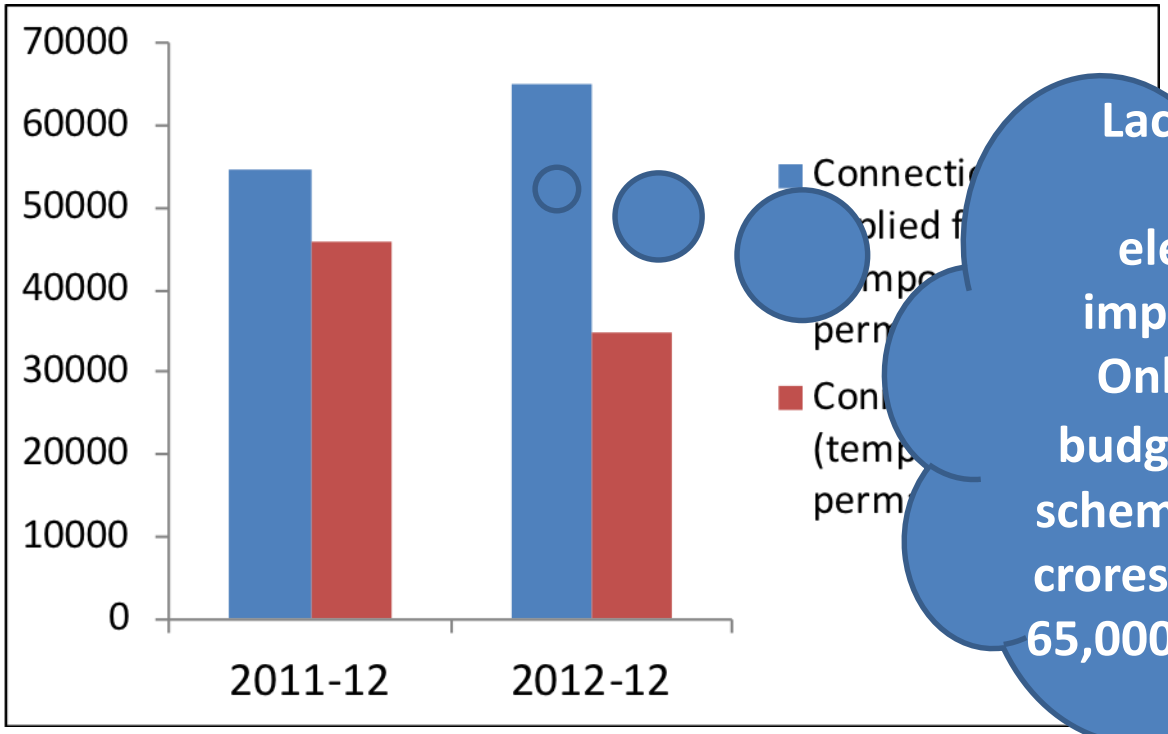
Current status of implementation of amended GW Act



Process of giving temporary connections had already started before the Act was Amended in Nov 2011. Now those temporary connections are being converted to permanent ones

Source: Data from WBSEDCL

But demand for new electricity connections outstrips supply and the gap between the two is increasing



Lack of dedicated budget for electrification is impeding progress. Only Rs. 30 crores budgeted for OTA-ET scheme, when Rs. 1300 crores is needed to give 65,000 new connections

Evaluate the impact of amended GW Act, 2011 on an urgent basis in all safe blocks

Why?

- To measure the impact of changes in groundwater and electricity policies on food systems

How?

- Panel data analysis – use panel data from the past and do new surveys

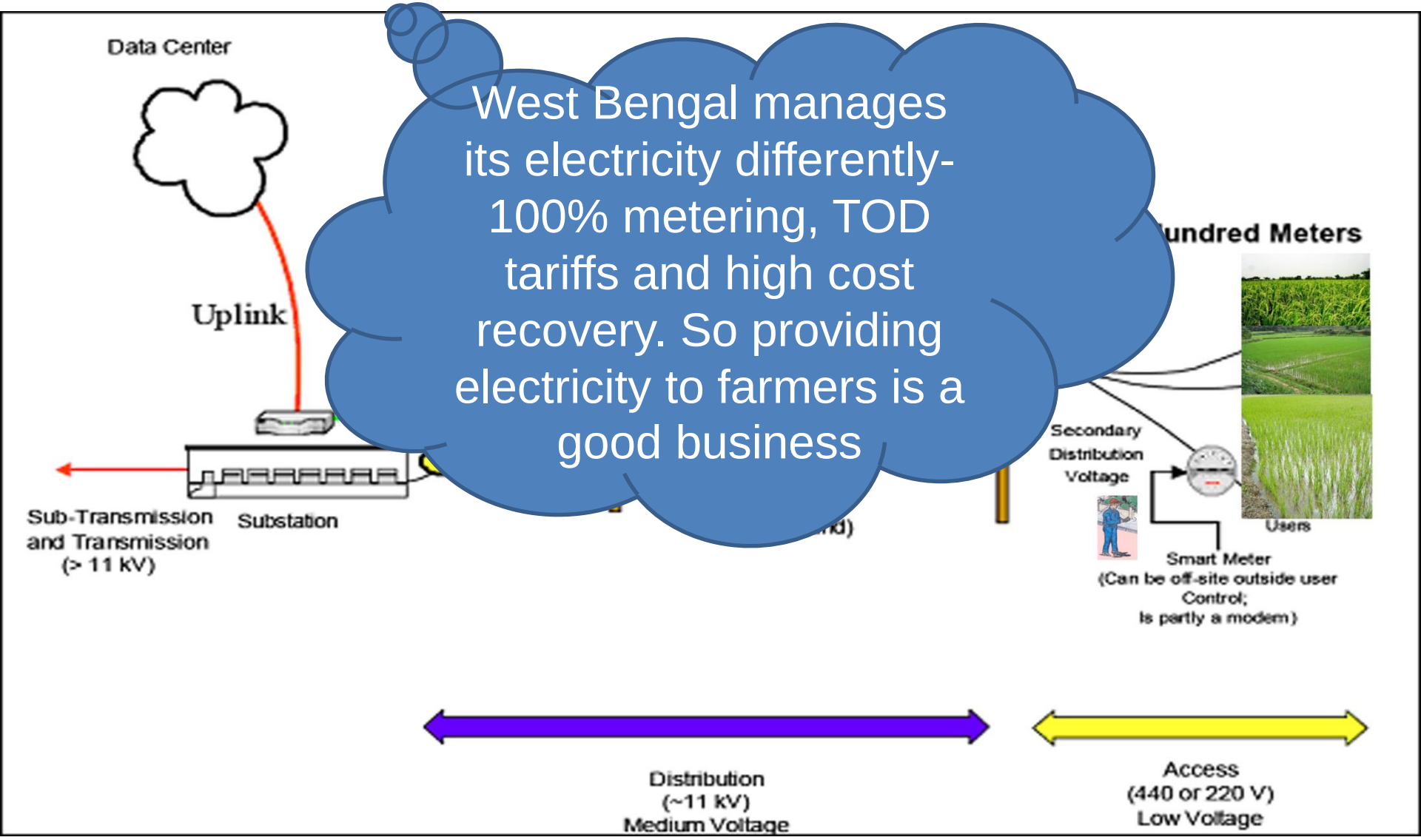
Where?

- In all blocks, except critical and semi-critical blocks which are outside the purview of the amended Act. Give special attention to North Bengal

Impact

- Lower irrigation costs will reduce cost of cultivation by anything from 30-50%. This will help reverse current contraction in irrigated agriculture, increase area under boro and propel the state on a path of Second Green Revolution – Did any of this happen?

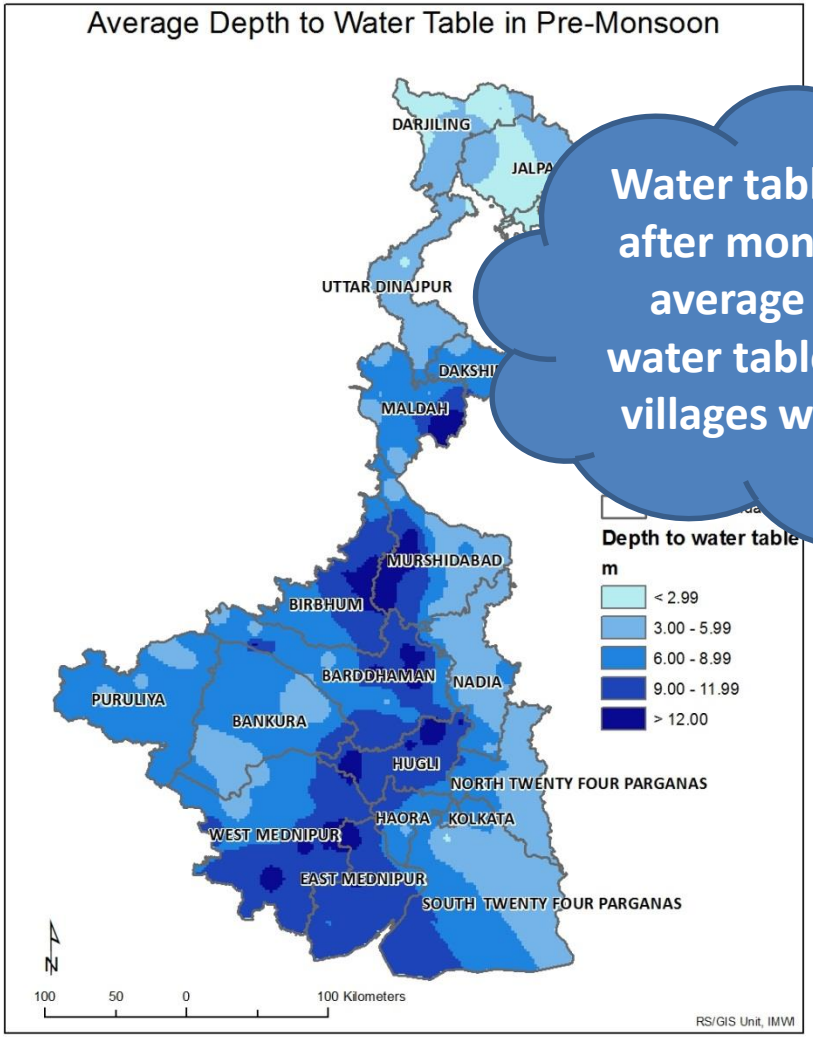
More electric connections will mean more income for WBSEDCL because electricity is metered



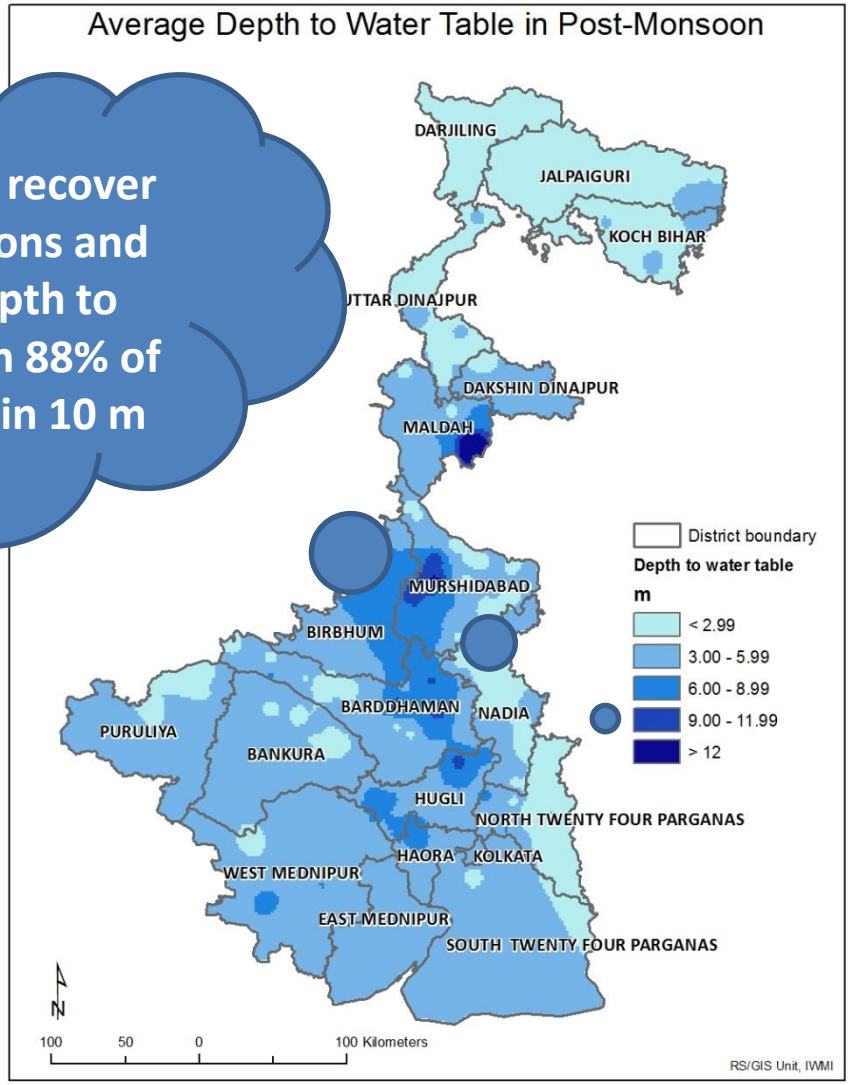
Issues of sustainability: Quality and quantity of groundwater

1. While strategies unroll, monitor groundwater quality and quantity closely and take corrective measures
2. Provide arsenic free drinking water in all arsenic affected areas.
3. Set up a Groundwater Mission for detailed aquifer mapping.

Average depth to water tables before and after monsoons, 1990-2009



Water tables recover after monsoons and average depth to water table in 88% of villages within 10 m



Water levels are constant in over 70% of wells in pre-monsoon and 80% of wells in post monsoon

Water level trends (1990-2009)		Pre-monsoon			
		Constant	Falling	Rising	Total
Post-monsoon	Constant	335 (65.9%)	61 (12.0%)	16 (3.1%)	412 (81.1%)
	Falling	18 (3.5%)	**67 (13.2%)**	0 (0%)	85 (16.7%)
	Rising	5 (1.0%)	0 (0%)	6 (1.2%)	11 (2.2%)
	Total	358 (70.5%)	128 (25.2%)	22 (4.3%)	508 (100%)

Of concern are wells with falling trend in both pre and post monsoon seasons. There are 13.2% such tubewells mostly in semi-critical and critical clocks – anyway exempt from the new Act. Even in these wells, average depth to water table is 9.59 m. Wells in these blocks needs to be monitored

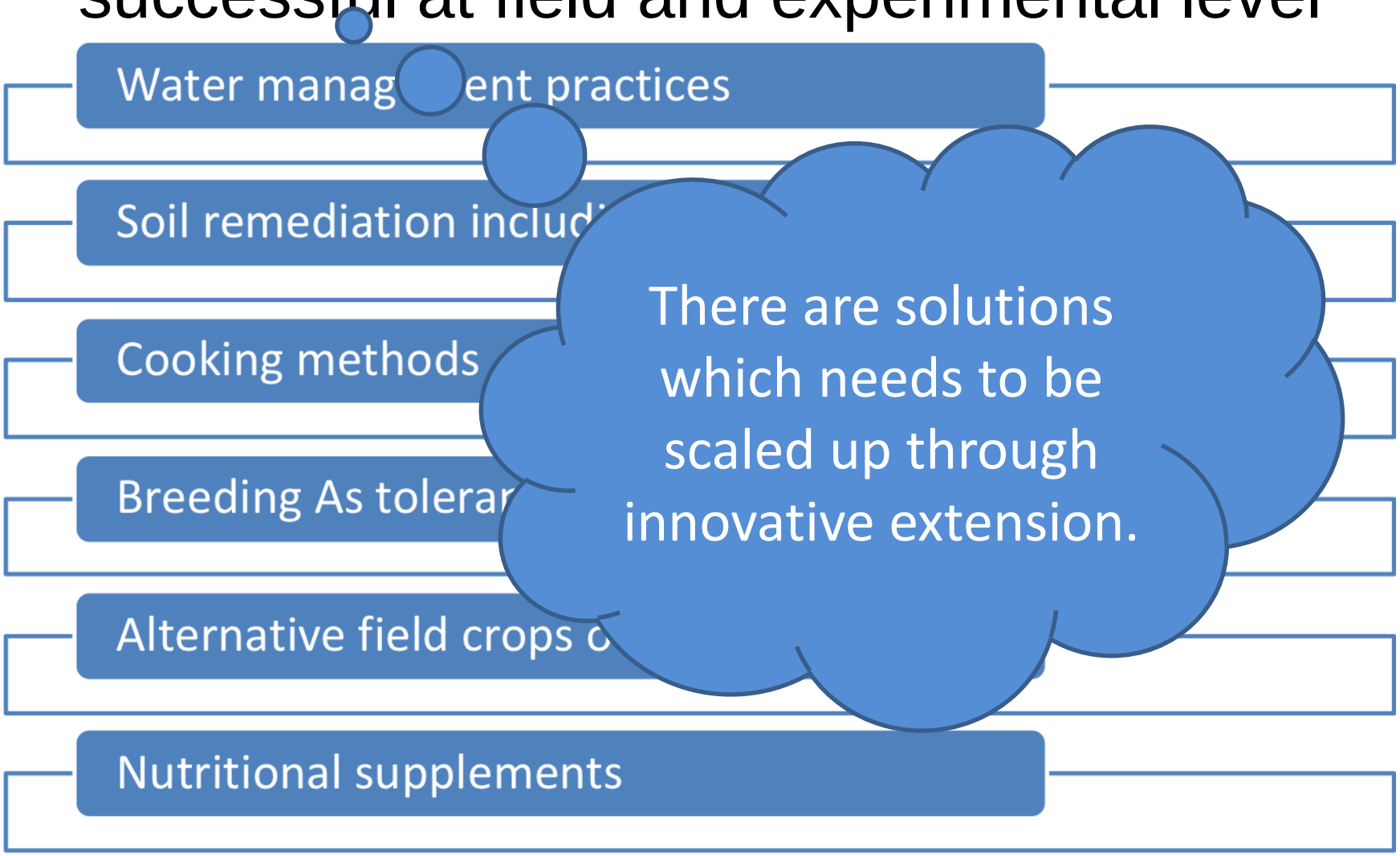
Concerns about arsenic

- Parts of Bengal plains and delta are naturally arsenic rich regions
- Debate on what causes arsenic – huge literature
- But the fact remains there is arsenic and farmers use that As Groundwater for irrigation
- There is no viable alternatives to groundwater irrigation, especially in the dry season

So what can we do?

- Assuming farmers will continue to use GW
- We need to understand its impact on uptake by soil, crops and yields
- And we need to mitigate ill effects of arsenic in food chain

Mitigation measures that have been successful at field and experimental level



Senanayake, N and **A. Mukherji**. 2014. Irrigating with arsenic contaminated groundwater in West Bengal and Bangladesh: A review of interventions for mitigating adverse health and crop outcomes. *Agricultural Water Management*. 135 (2014) 90– 99.

Solution 2: Rainwater Harvesting and Groundwater Recharge *using MGNREGS funds*

In-situ water harvesting in dry western districts and desilting of ponds in alluvial districts using MGNREGA funds

Why?

- In dry western districts with hard rock and sedimentary aquifers, due to shortage of water, farmers can grow only one crop/year

How?

- Use MGNREGS funds for constructing PRADAN like individual happa structures on farmers field

Where?

- Prioritize blocks with hard rock aquifers, undulating terrains and where cropping intensity is low, or where groundwater is saline such as coastal districts

Impact

- Help farmers in these dry districts of Purulia, Bankura, Birbhum and Paschim Medinipur and coastal South and North 24 Parganas to grow at least 2 crops in a year.

Strategy 3: ‘Water plus’ investment strategies

1. Revamp food procurement system in the state and increase procurement of paddy from 8% to at least 30% by next 5 years.
2. Invest in cold storages and food processing units to help farmers add value to their crops. Lack of electricity is a major bottleneck now.
3. Invest in rural roads to help farmers market their crops better and quicker

Green Revolution in Eastern India needs big public policy shifts

- High on poli… …k of understan…
- Follow… …roviding mini-kits…
- Technologies… …able in the market
- Farmers in easter… …ndia have done all that could be done with private initiative

But, now big ticket public policy support is needed.

What are those big ticket items?

Rural electrification and alternative energy, e.g solar pumps

Public Procurement

Innovative extension services

Thank you

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