

A Food-Energy-Water
Nexus Lens to

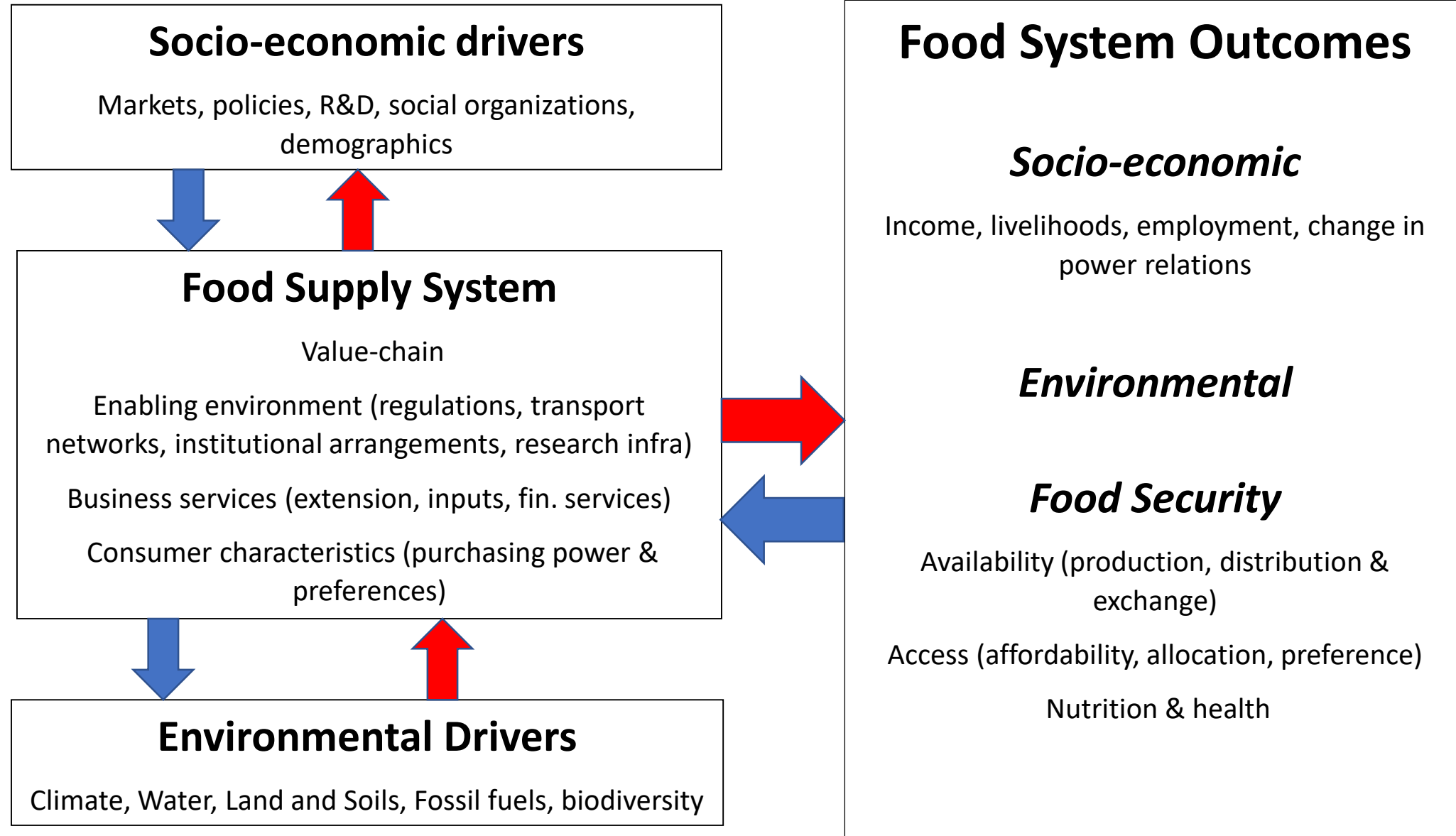
Food Systems in Eastern Gangetic Plains

The Food systems approach (FSA)

Actors with competing interests & goals

Activities influenced by changes in natural resources, markets, policies, technologies, organizations, and information

Outcomes in different domains and trade-offs among them



Steps in FSA

- Highlight the connections among different food supply chain sectors
 - inputs and production; processing and distribution; consumption and waste
- Identify underlying drivers of food system dynamics: current and likely future drivers
 - Demographics, dietary changes, food policies, natural resource base, climate change, market regulations, subsidies and taxes, trade policies
- Consider a range of potential outcomes
 - in key domains (environment, socio-economic, food security)
 - potential trade-offs among them
 - 4 dimensions of outcomes
 - Quantity & quality; distribution; and resilience
- Analysis, synthesis and reporting
 - At a scale appropriate for problem(s) at hand and
 - To address critical concerns of policy makers and other stakeholders
 - Stakeholders can: help identify issues not obvious to us; validate methods/metrics/models; and even provide data not easily available otherwise

Problem Statement

Goals, objectives and research questions

Challenges of future food systems

- Produce enough food to meet the increasing and changing consumer demand
 - Not everything needs to be produced locally;
 - exploit comparative advantage better: land-scarce; labour and water rich
- in an inclusive way
 - Farmers' income, including tenants and women farmers
 - Dignified work and living wages to women and men farm labourers
 - Greater opportunity for off-farm employment in the food economy
 - Affordable access to healthy and nutritious food to all consumers
- While conserving natural resources
 - Especially, soil, water & air quality
- And improving resilience to climate change and mitigating harmful emissions
- Growth, equity, sustainability and climate-resilience

Goal of this FSA

- Goal
 - to create an evidence base for informed foresight4food exercises
- Objectives
 - Describe the food system and try to explain what causes it to function as it does
 - Develop rationale for where detailed empirical analysis is merited, and where it is not
- Specific questions
 - What are the key drivers of changes in the food system?
 - Things we know and things we do not know about these drivers and uncertainties in them?
 - What are the most important aspects/relationships/outcomes of food systems and their future for policy-makers and other key stakeholders?

Scope

System boundaries, components, processes, and linkages

Setting boundaries for the FSA

- Comprehensive analysis of the entire food system across all effect domains and dimensions to account fully for dynamics, complexities and uncertainties is not possible
- What domains are more important?
 - E.g., we will focus more on socio-economic and environment outcomes
 - Will not include health and nutrition outcomes
- What are the important feedback processes and interactions?
 - Energy, water and food policies
 - More on input policies, on-farm activities and marketing (less on consumption and waste*)
- What heterogeneities matter the most?
 - Landowners vs. tenants; women vs. men
- What are the key leverage points (or interventions) that may lead to interesting alternate scenarios
 - Energy supply and pricing policies; machine subsidy reforms; public procurement and public distribution systems; market deregulation

Ag. Subsidies: Energy, Fertilizer, Capital, **MSP*** & trade restrictions

Welfare Programs: NFA, MGNREGS

Financial Services: Credit; Insurance

Investments: Ag. Electrification, transport, markets

Formal Institutions: Extension system, farmer institutions, business process reforms

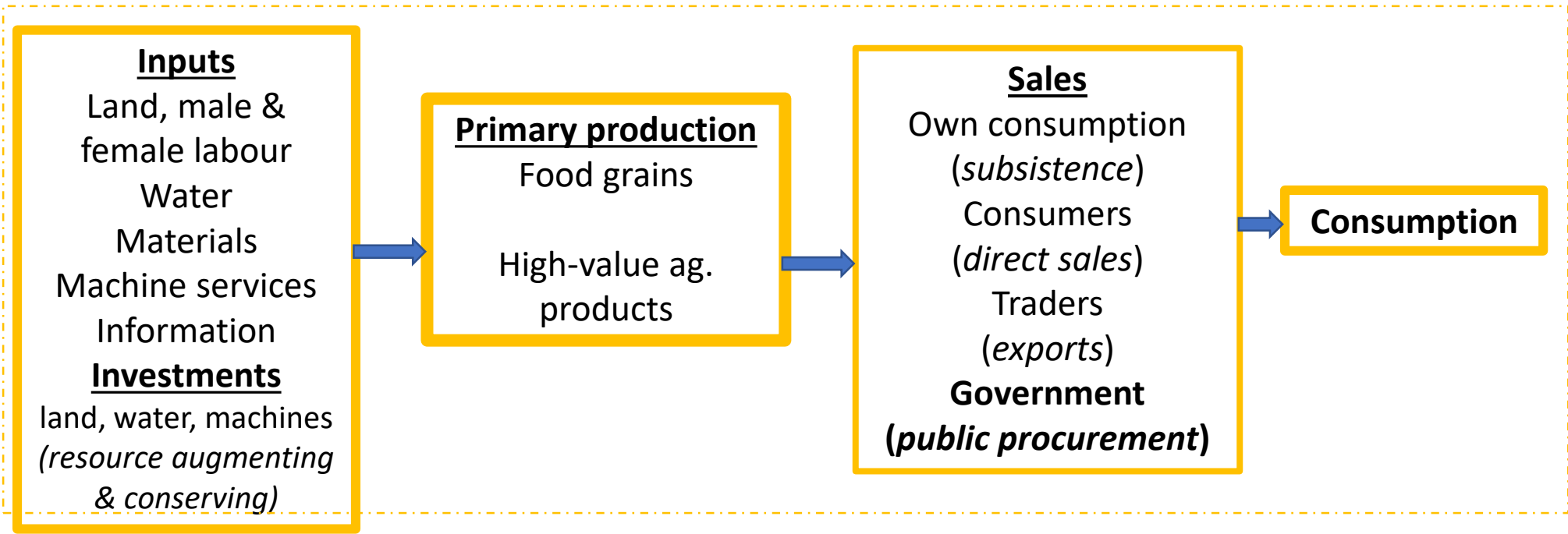
Informal Institutions: Rental markets in land, labour, machines

Consumer characteristics
(urbanization; income; awareness)

Economic transformation: Bihar & India

Soil

Aquifer



Environmental Outcomes

Social Outcomes

Economic Outcomes

Health & Nutrition Outcomes

Interactions between environmental drivers and food system activities

- The farm itself is the primary site of interaction
- Other sites: food processing, distribution, trade and consumption
- Activities throughout the value chain can influence the use of natural resources in food production
- Incentives and enabling factors for more efficient and sustainable use of natural resources in food production can arise from changes in all parts of the chain
 - E.g., energy pricing and availability
 - Food subsidies and marketing regime
 - Rental markets for machine services; pvt. Sector participation in supply of short-duration varieties
- Key interactions between different environmental drivers
 - E.g. water and energy; soil properties and water use

Setting the scene

- Low rates of urbanization
 - 88.82% households in Bihar
 - 97% households in Madhubani
- High rural population density
 - 1000-1500/sq. km.
- High population and employment pressure on land
 - 18.24% cultivators; 70.88% manual casual laborers
 - Manufacturing <10% of the GSDP
- Highest rates of migration after Jharkhand
 - 12% of rural households had a member staying away for work in kharif season (6% in the rest of India)*
- High incidence of poverty, low HDI ranks, low inter-generational mobility

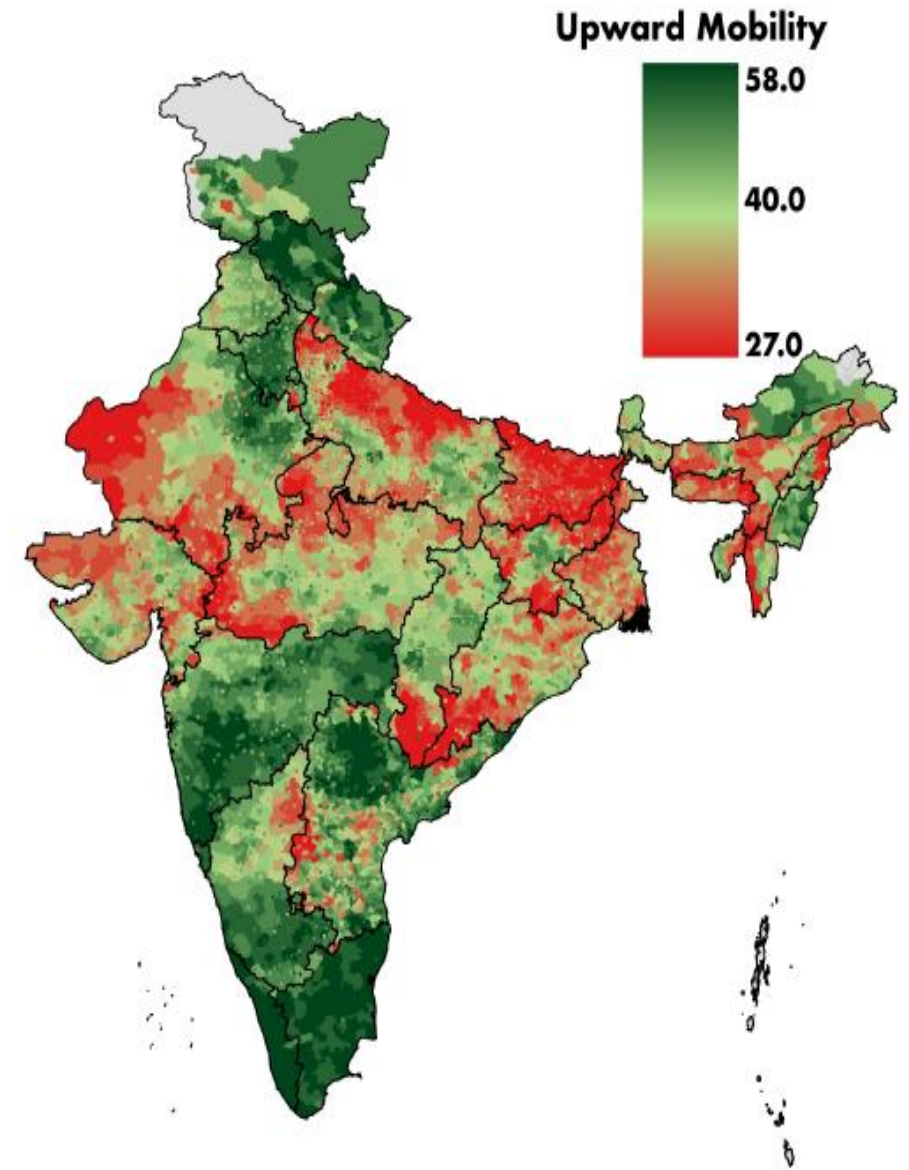
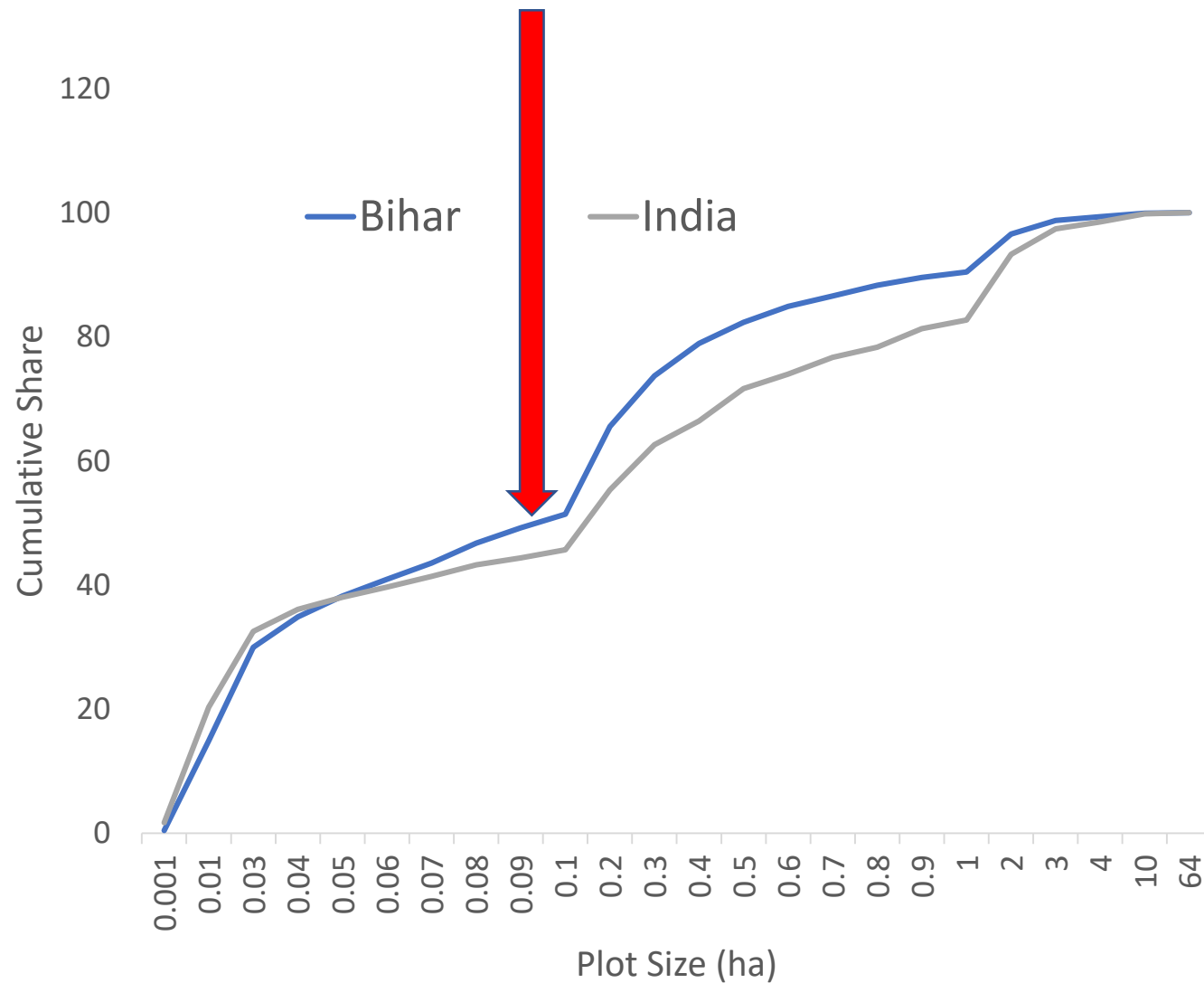


Figure 7 presents a map of the geographic distribution of upward mobility across Indian subdistricts and towns. Upward mobility (μ_0^{50}) is the average education rank attained by sons born to fathers who are in the bottom half of the father education distribution.

“Food is an essential connecting thread between people, prosperity, and planet”

- Food production employs nearly 2/3rds of rural women and men in Bihar
 - The only wage earning option for rural women in Bihar
- Food accounts for ~60% of the total monthly household consumption expenditure in the state
- Food production is
 - the dominant user of land (**60% area**) and the largest user of water in the state
 - ~ 8-9 BCM of Groundwater/year
 - a significant user of fossil energy*
 - A major source of GHG emissions
 - 21% of total emissions for India; likely to be higher in Bihar
 - and non-point contamination of soil and water
 - 9 districts in the state have high concentration of nitrates in groundwater

Stamp-Sized Plots



- **>50% of all farm plots were less than 0.1 ha in size and 2011**

- **1/3rd were smaller than 300 m²**

- **High incidence of landlessness**

- 44% rural HHs did not operate any land (32% in India).

- **And absentee land-ownership**

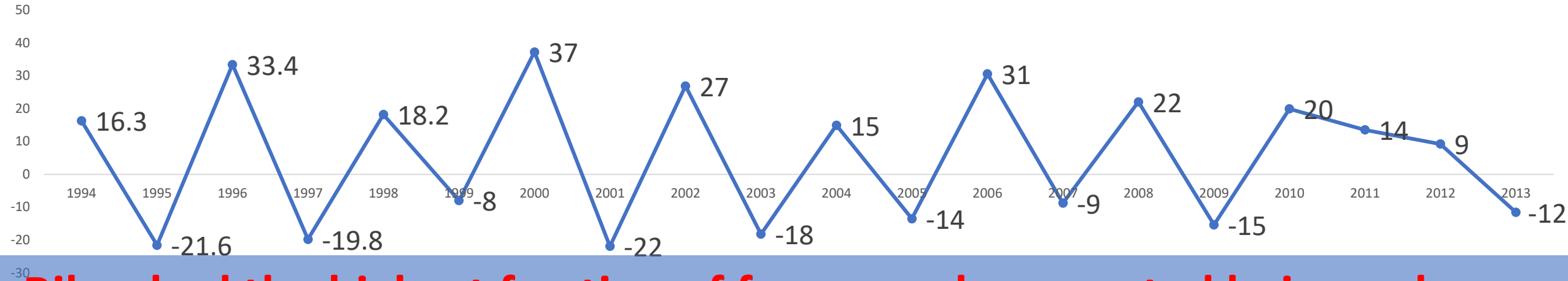
- 18% salaried HHs leased out land

- 17% urban HHs cultivated some land (<5% in West Bengal)

- **The extent of tenancy is underestimated**

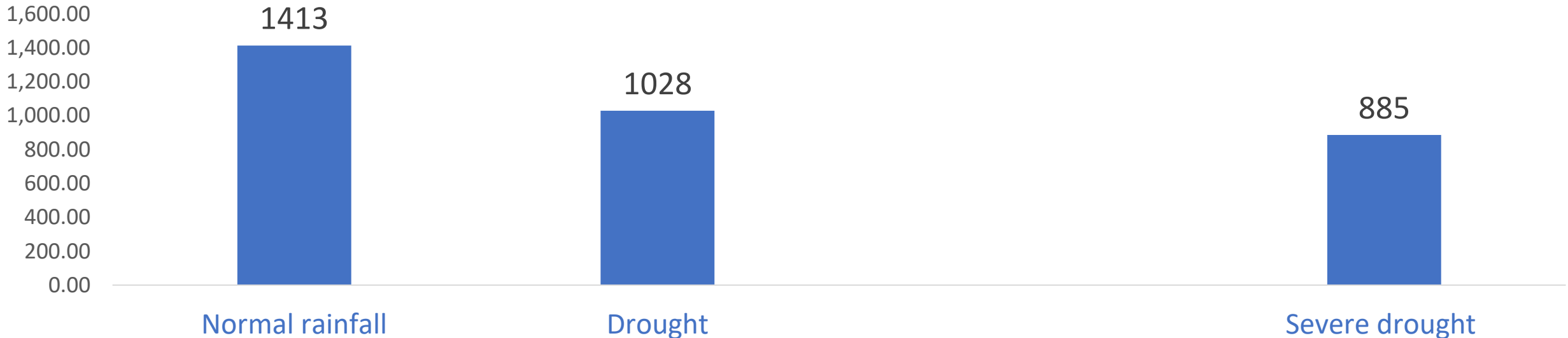
Agriculture is a high-risk, low-return enterprise in Bihar

Growth (%) in GSDPA

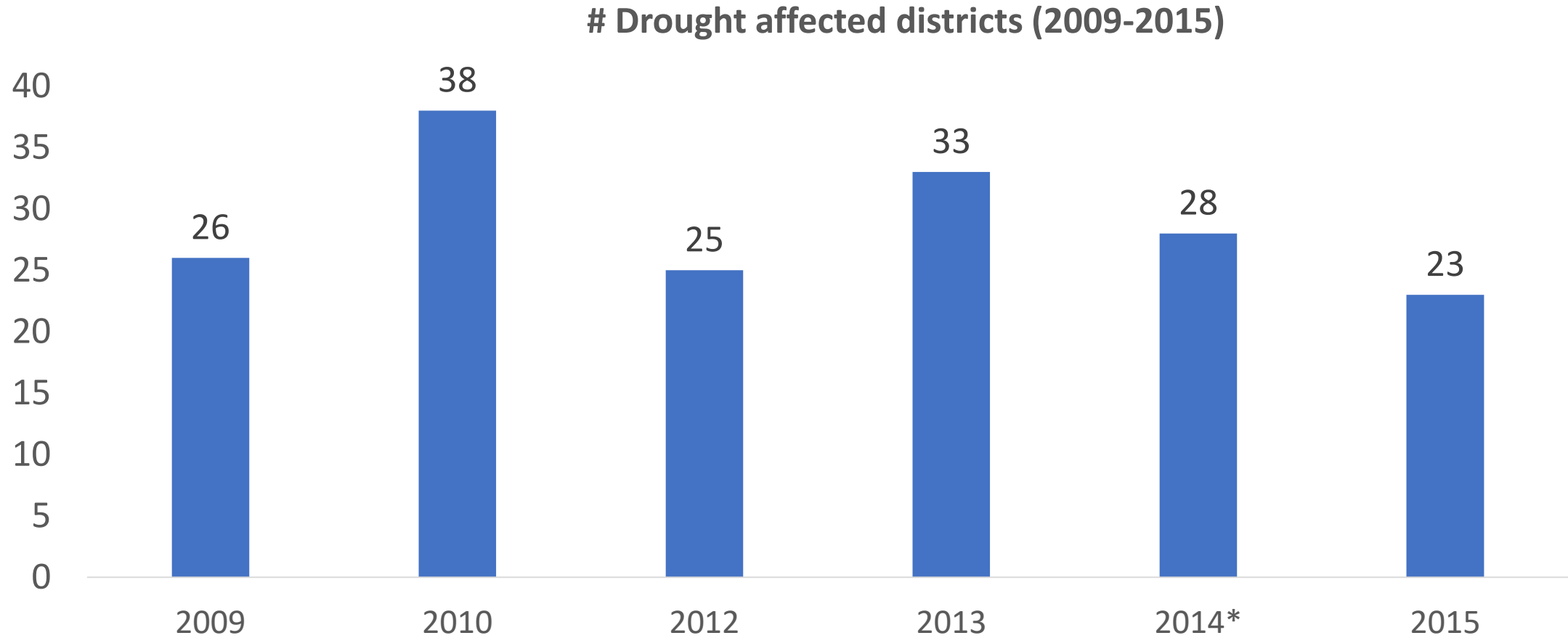


Bihar had the highest fraction of farmers who reported being unhappy with their current occupation

Average paddy yield (kg/ha)



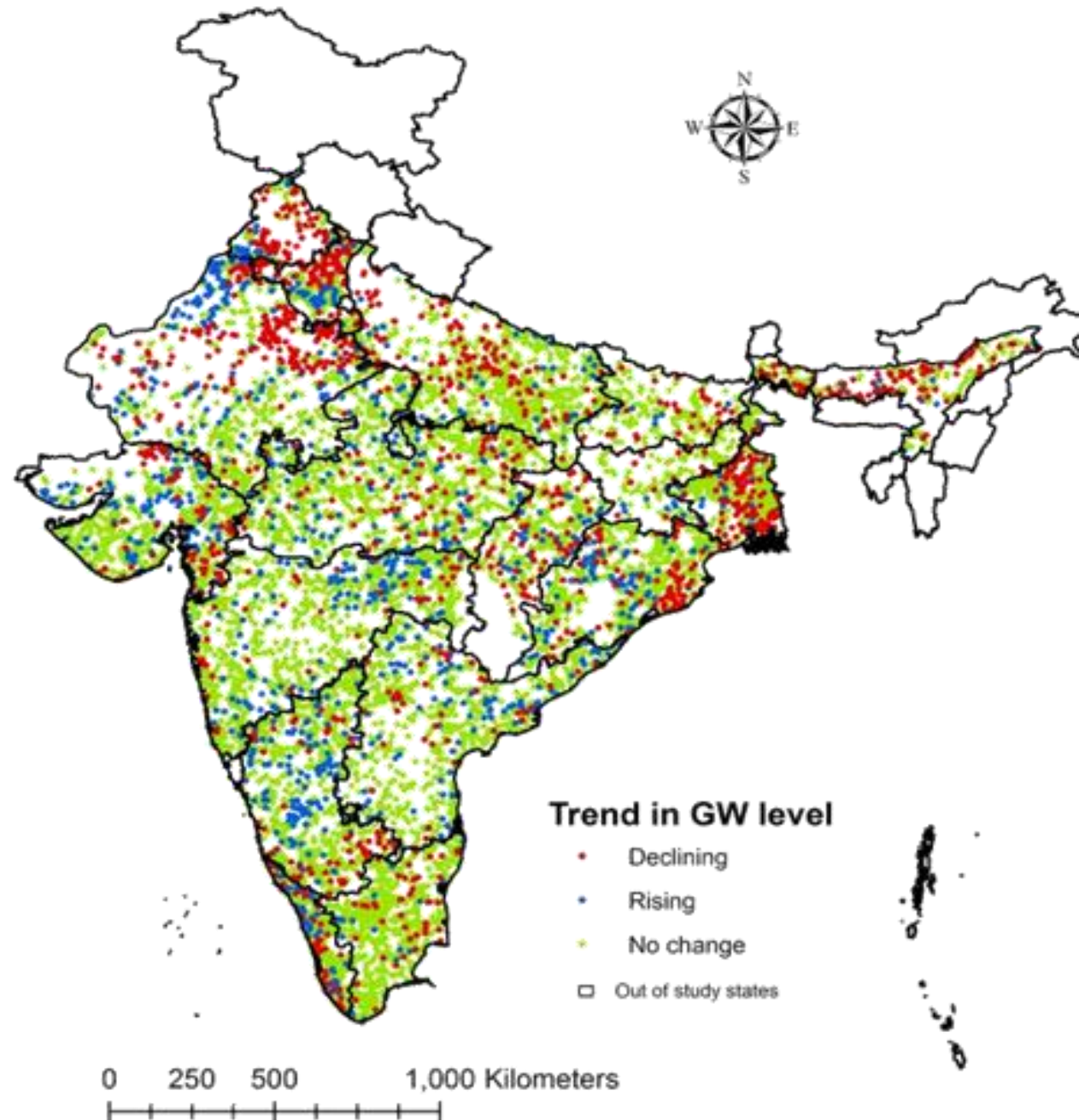
The worst flood affected state has been afflicted more by droughts in last 7 years



***Of the 38 districts in the state, 5 (Khagaria, Pashchim Champararn, Saharsa, Siwan and Seohar) have experienced droughts in all five years from 2009 to 2013; 14 experienced droughts in 4 out of these 5 years; another 14 saw 3 years of drought while the remaining 5 saw two years of drought

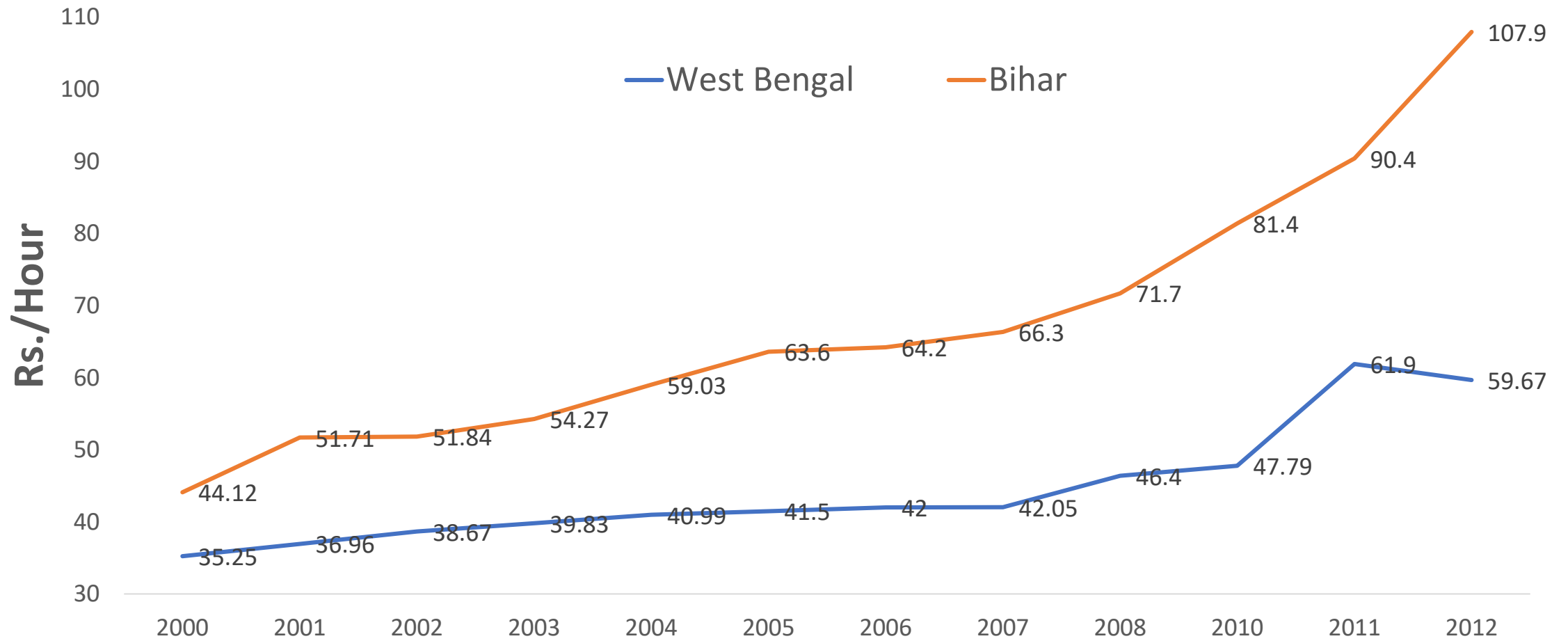
Shallow & stable aquifers

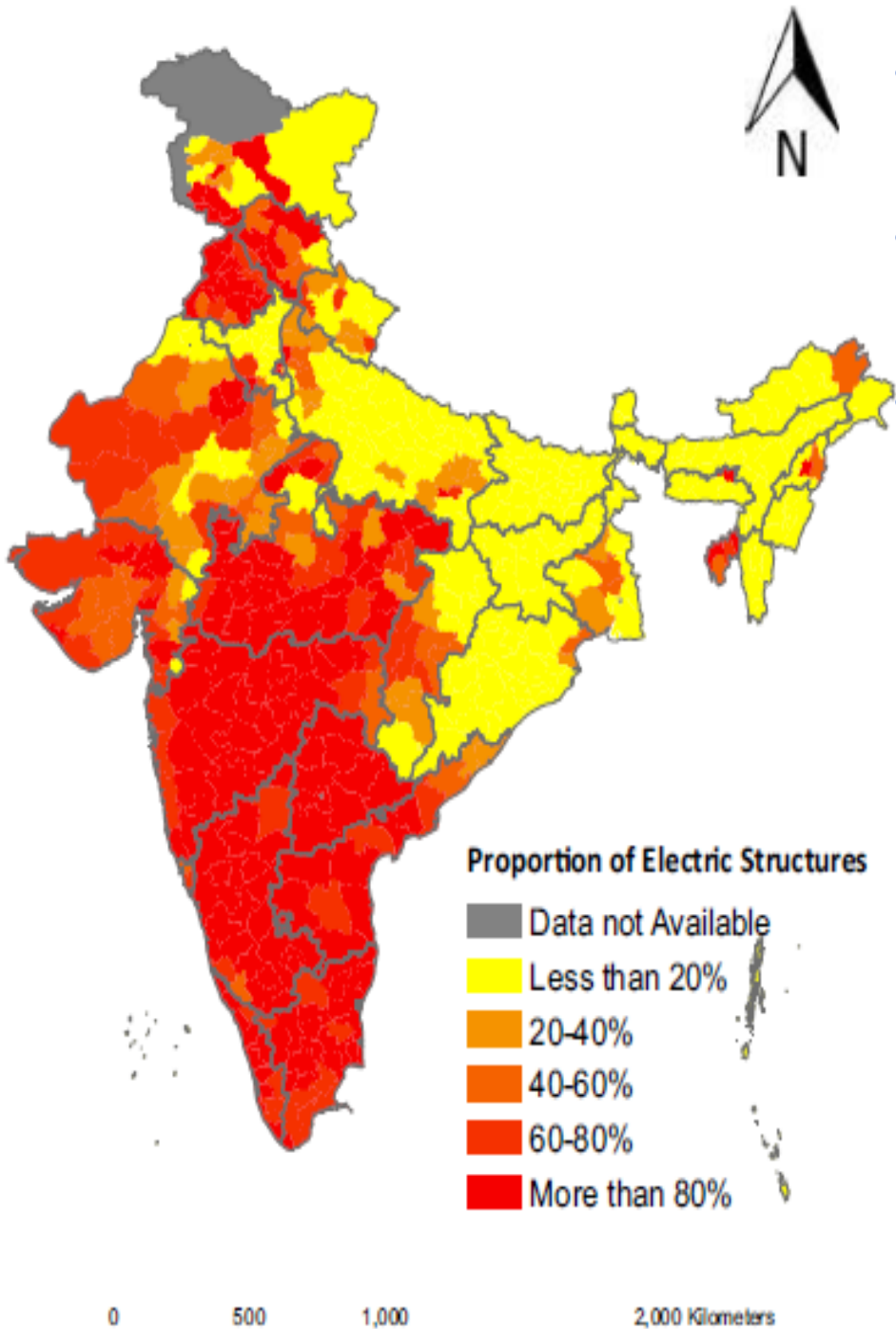
- 0.64 million pumps in Bihar for 16.2 million holdings and >30 million plots of farm land
- 7% irrigation pumps are submersibles in Bihar
 - 40% in the rest of India
- Only 2% of all wells in Bihar are deep tubewells
- **But pockets of decline in groundwater table**



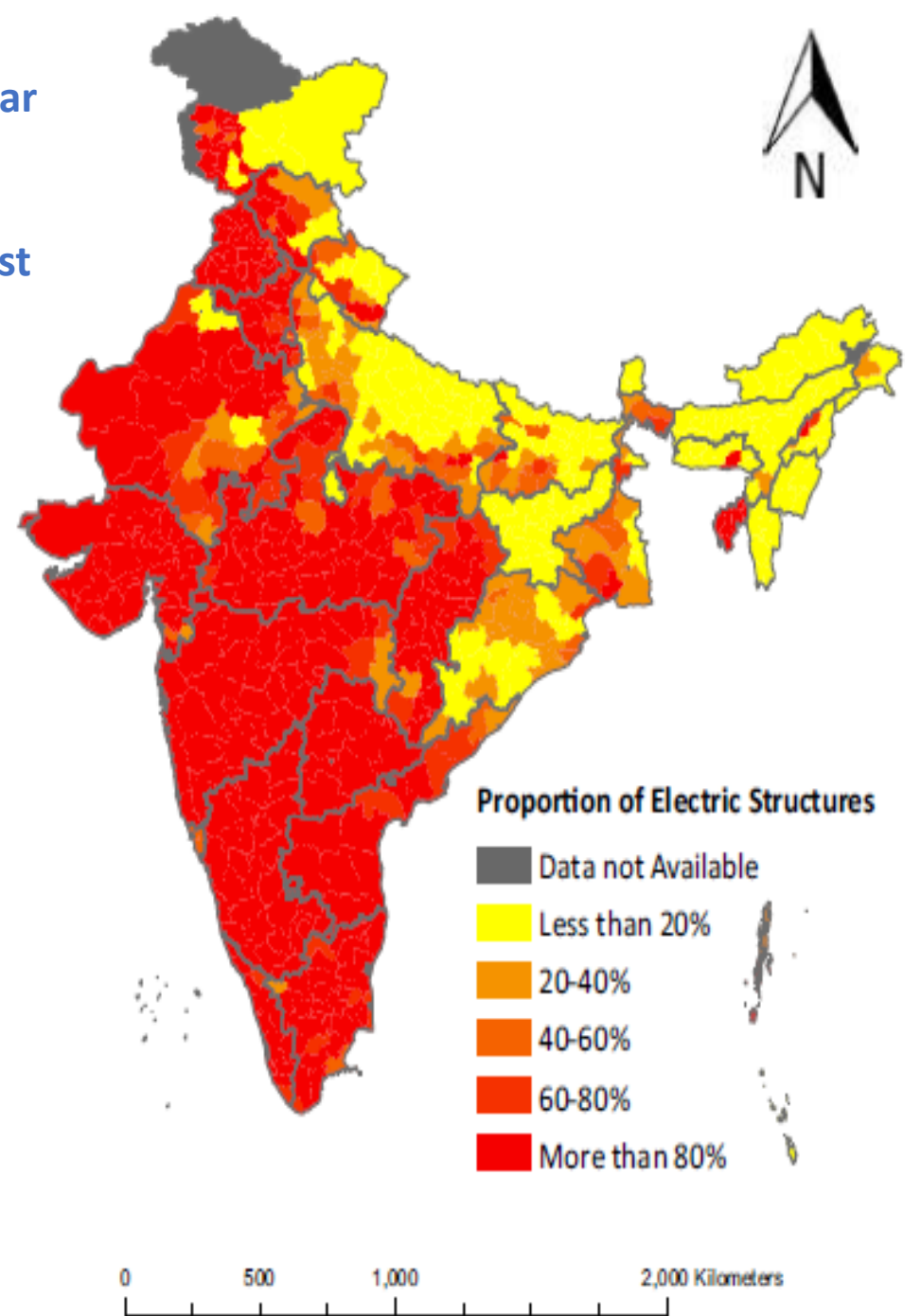
Irrigation is expensive

Rental Rate of Pump-sets in Bihar and West Bengal (2000-2012)

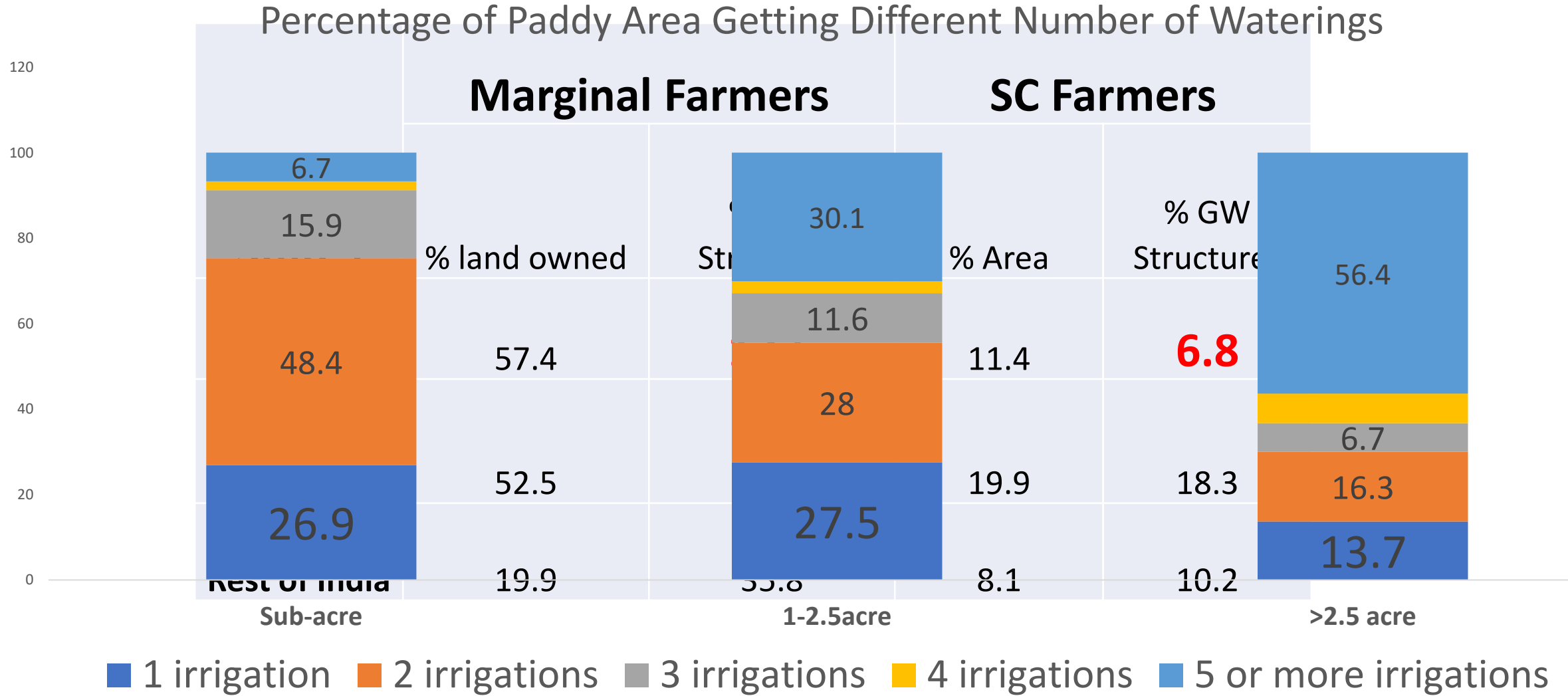




- 95% of pump-sets in Bihar are diesel powered
- Compared to 24% in West Bengal and
- 71% in the rest of India



Unequal access to groundwater and uncompetitive machine rental markets



High Cost of Irrigation; Under-irrigation

	Bihar	Punjab
Paddy yield (tons/ha)	2.56	5.9
% Farmers who irrigate paddy	40**	98
Hours of Irrigation/ha	2.94 & 13.50 *	263-270
Cost of Irrigation (Rs/hour)-own pump	0.7*(Diesel price/liter)	9.08 & 11.21
Cost of Irrigation (Rs/hour)-hired pump	120-150	54

- Farmers in Bihar do respond to moisture stress, but practice deficit irrigation; suffer yield and income loss**

Farmers in Bihar have limited interactions with the government in running their farm enterprise

Agricultural Activity or Facility	% Farmers who Benefit Directly from the Government	
	Bihar	Punjab
Electricity for groundwater irrigation	~5 %	92.89%
Technical advisory by government institutions	11.52	18.30
Institutional loans for agriculture	16.51	49.24
Awareness of MSP	43.57	87.90

IFPRI compared states of India on 9 indicators: Implementation of market reforms; market density; facilities & services in the wholesales agricultural markets; business process reforms; storage capacity; road density; power availability; financial access and crop diversity

Bihar ranks low on infrastructure; regulations; access to institutional finance, and crop diversity

High MSP + low procurement + high NFSA allocation: A toxic mix for farmers in Bihar

- 3.3 million tons of rice and 2.2 million tons of wheat to Bihar
 - 86% households to benefit from NFSA subsidy
 - **1.9 million ton** more subsidized rice + wheat compared to pre-NFSA period
- Public procurement is low
 - Rice : 1.2 million tons; Wheat: **nil**
- Home production = local consumption for rice; 1.2 million tons deficit in wheat

(Local production + NFSA imports) >> Domestic demand

- 4 million tons of cheap rice & wheat dumped from other states through the NFSA and more through the OMSS operation of the FCI
- Consumers will benefit(?), but agriculture will not
 - Smuggling to Bangladesh and Nepal could hurt farmers there too
- Increasing procurement will lower the incentives for much needed crop diversification

Key unknowns

- Interstate and international trade, trade barriers and competitiveness indices
- Occupational diversification in rural areas
- Interaction between farm and off-farm sectors of the economy
- Female labour force participation and feminization of agriculture
- Tenancy: the extents, terms of tenancy and their implications
- The impact of improvements in access to electricity
- Impact of the NFSA
- Impact of increase in public procurement of rice and wheat