

Groundwater Markets in China: Evolving Trends and Determining Factors

**Lijuan Zhang, Jinxia Wang and Jikun Huang
Center for Chinese Agricultural Policy (CCAP),
Chinese Academy of Sciences (CAS)**

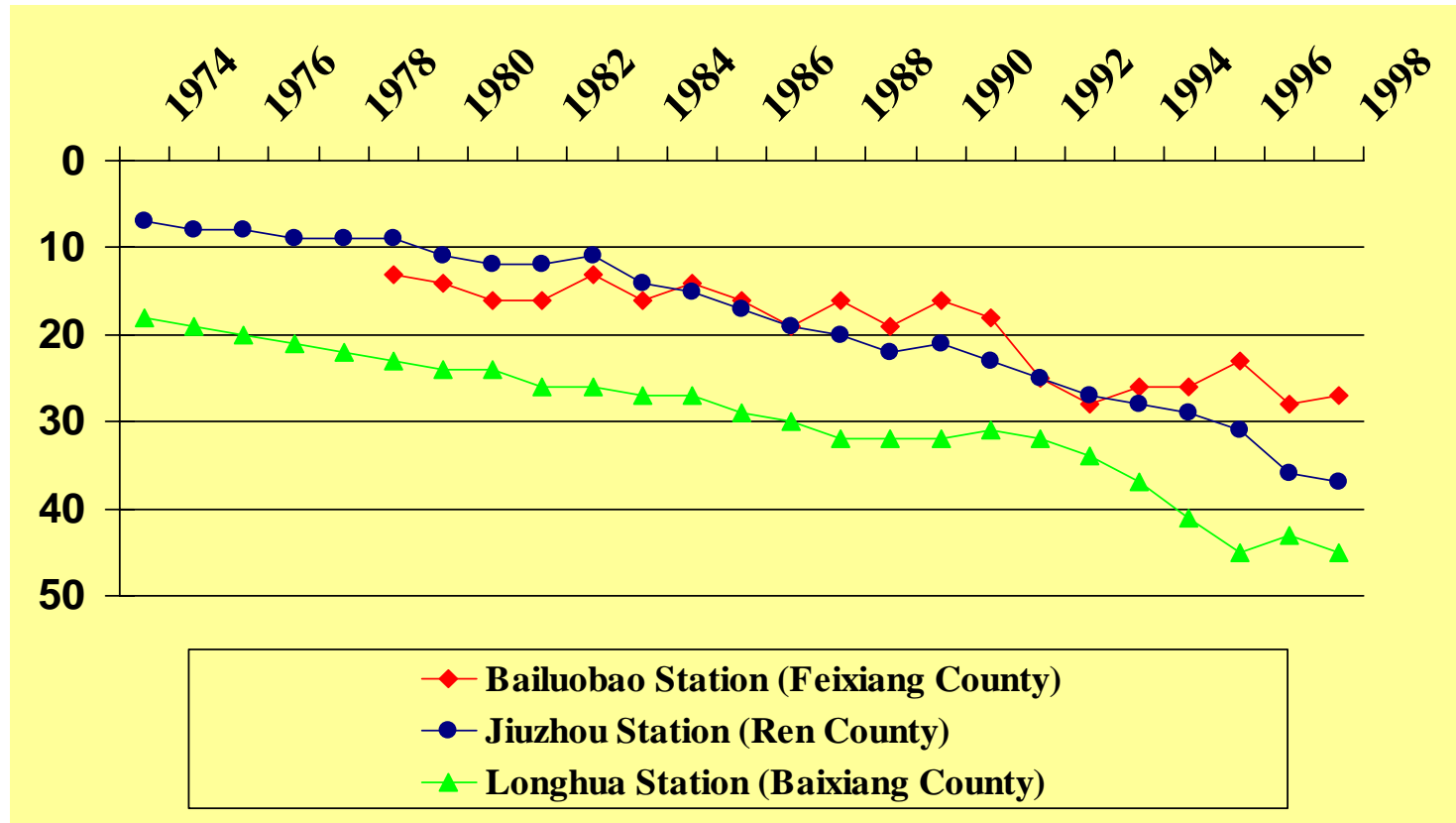
**Scott Rozelle
Department of Agricultural and Resource Economics,
University of California, Davis**

Motivation

- **Importance of groundwater irrigation**
 - 60% of irrigation water in North China from groundwater ... and growing!



Trend of Shallow Groundwater Table

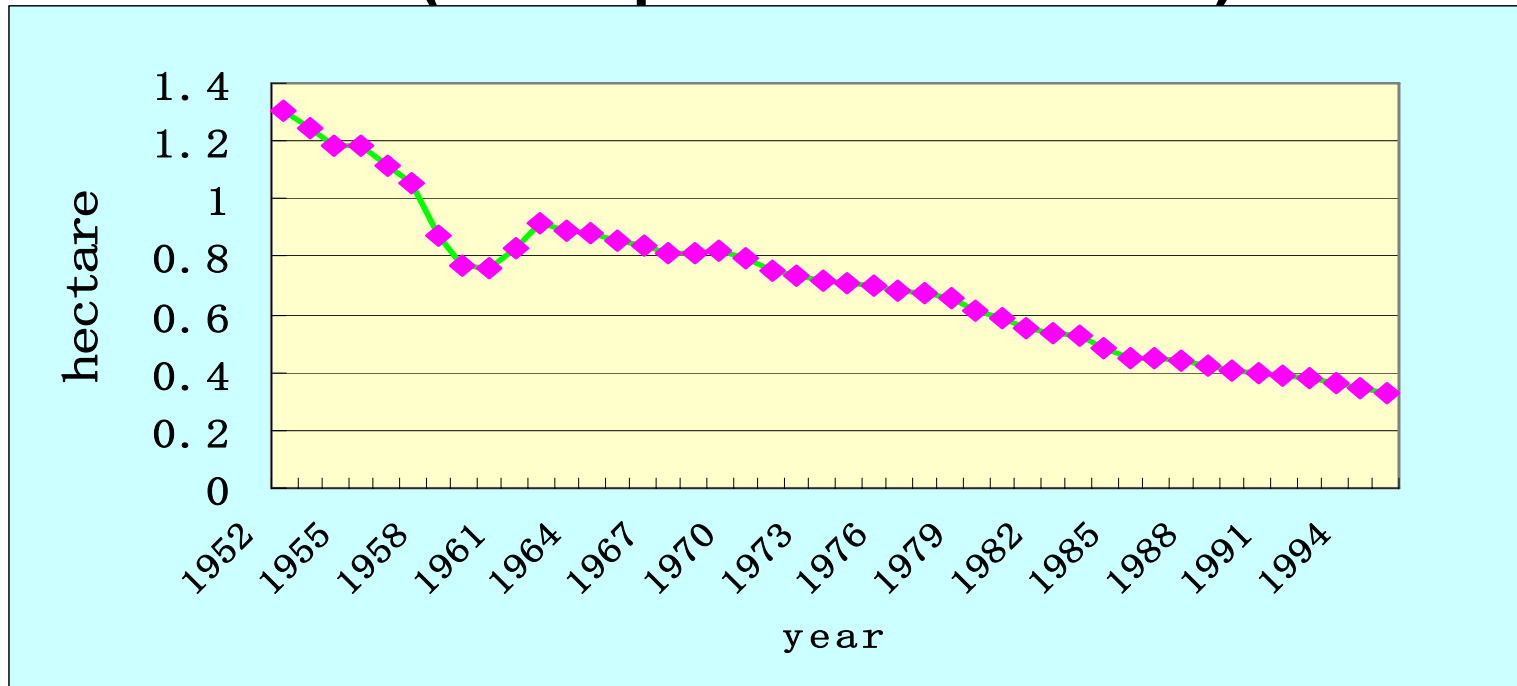


Decline of deep water table in the selected Counties in Hebei province (1980-98)

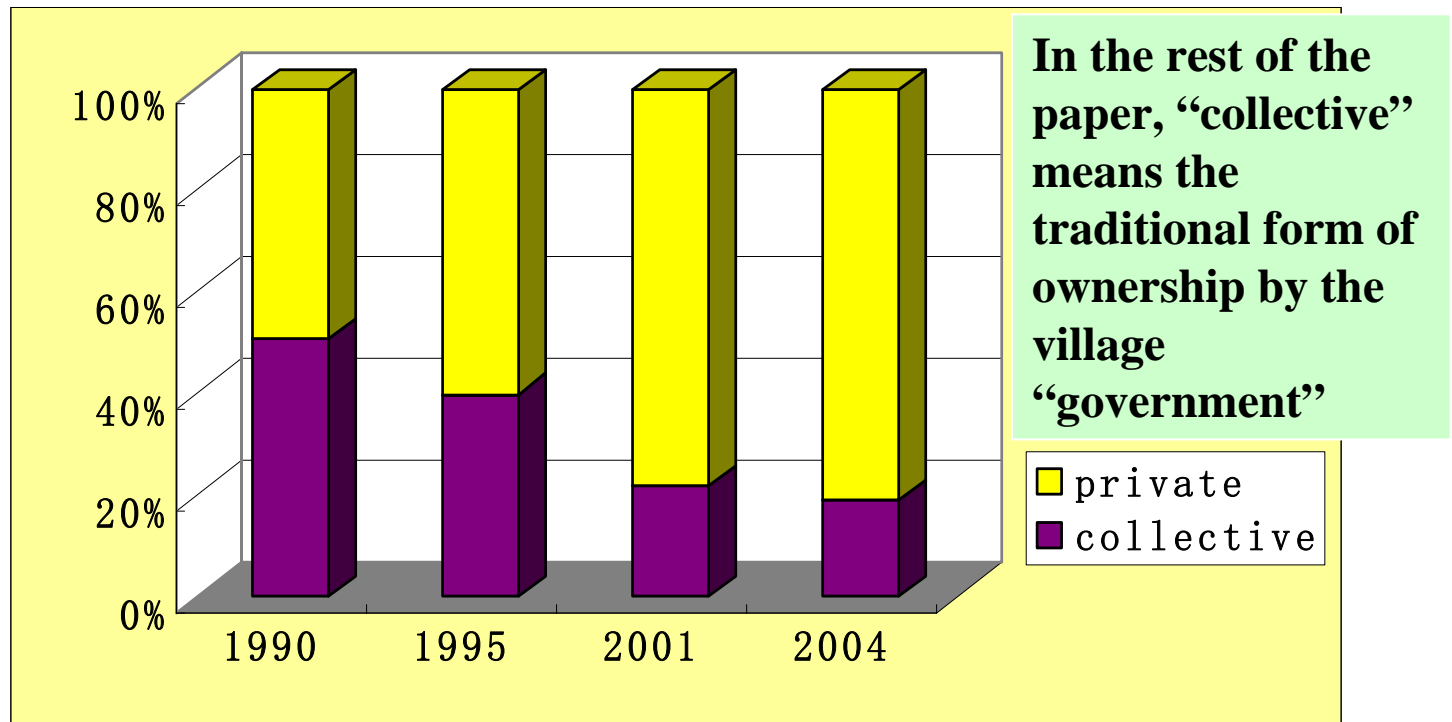
County/City	Fall Rate (m/year)
Longrao County	2.24
Pingxiang County	2.18
Xingtai City	1.97
Jiuzhou County	1.86
Wuyi County	2.18
Wuqiang County	2.20

Declining farming size

(Per capita cultivated land)



Shifts Towards Private Tubewell Ownership (Hebei and Henan)



Emerging issues:

So, to summarize: within an environment in the village in which there is:

- Increased costs of sinking tubewells
- Smaller farm sizes
- Changing of tubewell ownership ...

Key questions are:

- How do farmers get access to water?
- How do farmers irrigate their crops in areas with groundwater?

Access to Water

- Issue of access to groundwater is not new
- There are many ways to access GW (e.g., sinking wells by government projects; sinking wells by individuals themselves)
- One new issue is to what extent do GW markets help farmers get access

South Asian experience

- **There is a lot of GW market activity**
- **Help farmers to access groundwater for irrigation**
- **Improve tubewell utilization efficiency**
- **Increase incomes/reduce poverty**

[although most of this previous work on South Asia is descriptive]

Definition of Groundwater Markets

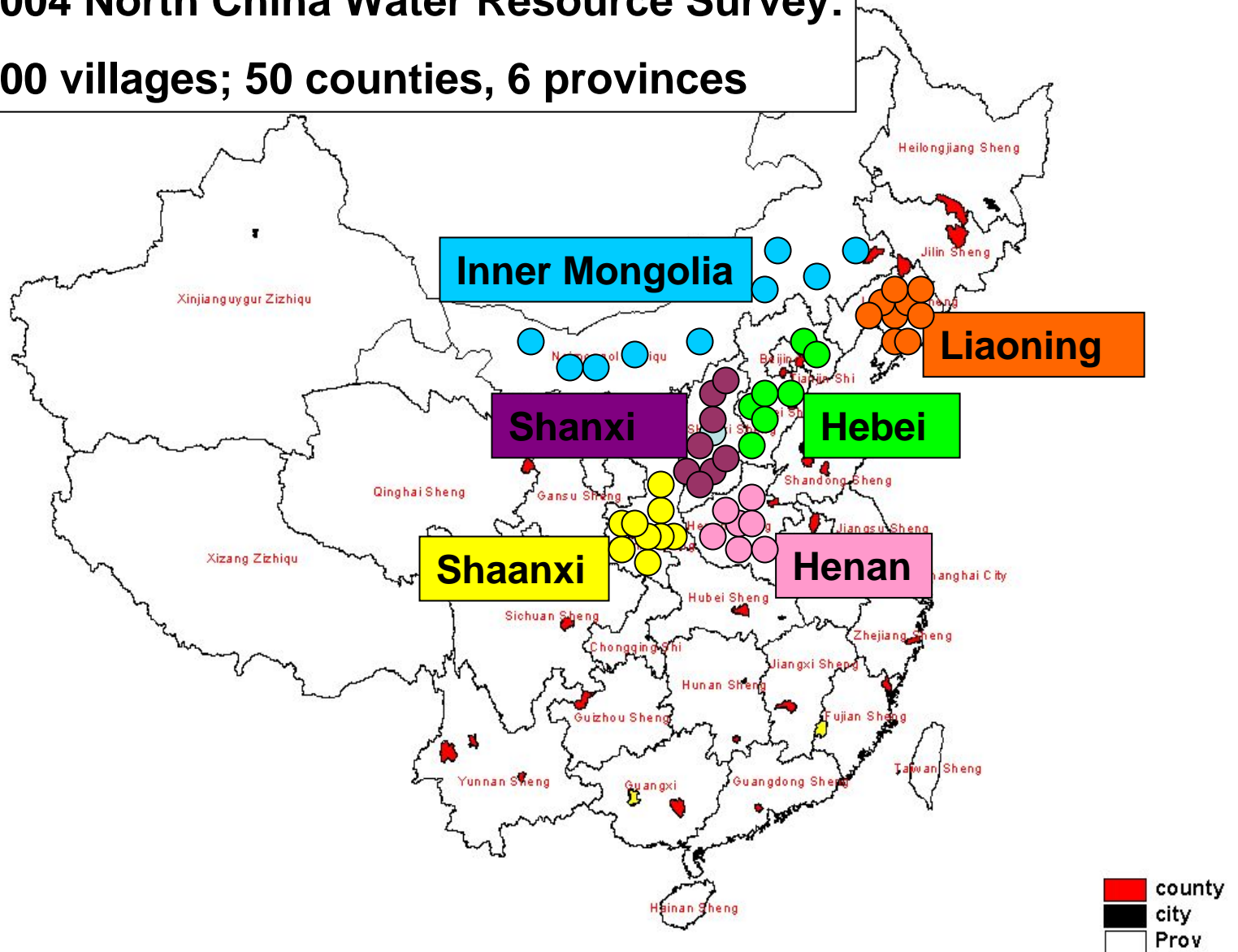
- **GW markets are localized, village level arrangements through which owners of tubewells sell pump irrigation services to other farmers of the village (in other words, they sell water to other farmers from their wells for use on crops).**
- **In our paper, we are only going to examine “private” water markets ... that is, we examine the nature of groundwater markets that are being driven by individuals and groups of individuals that sink wells ... we are assuming that when village leaders (the collective) provide water to villagers, this is being done under non-market conditions ...**

Research Questions in the Rest of the Presentation

Data sets

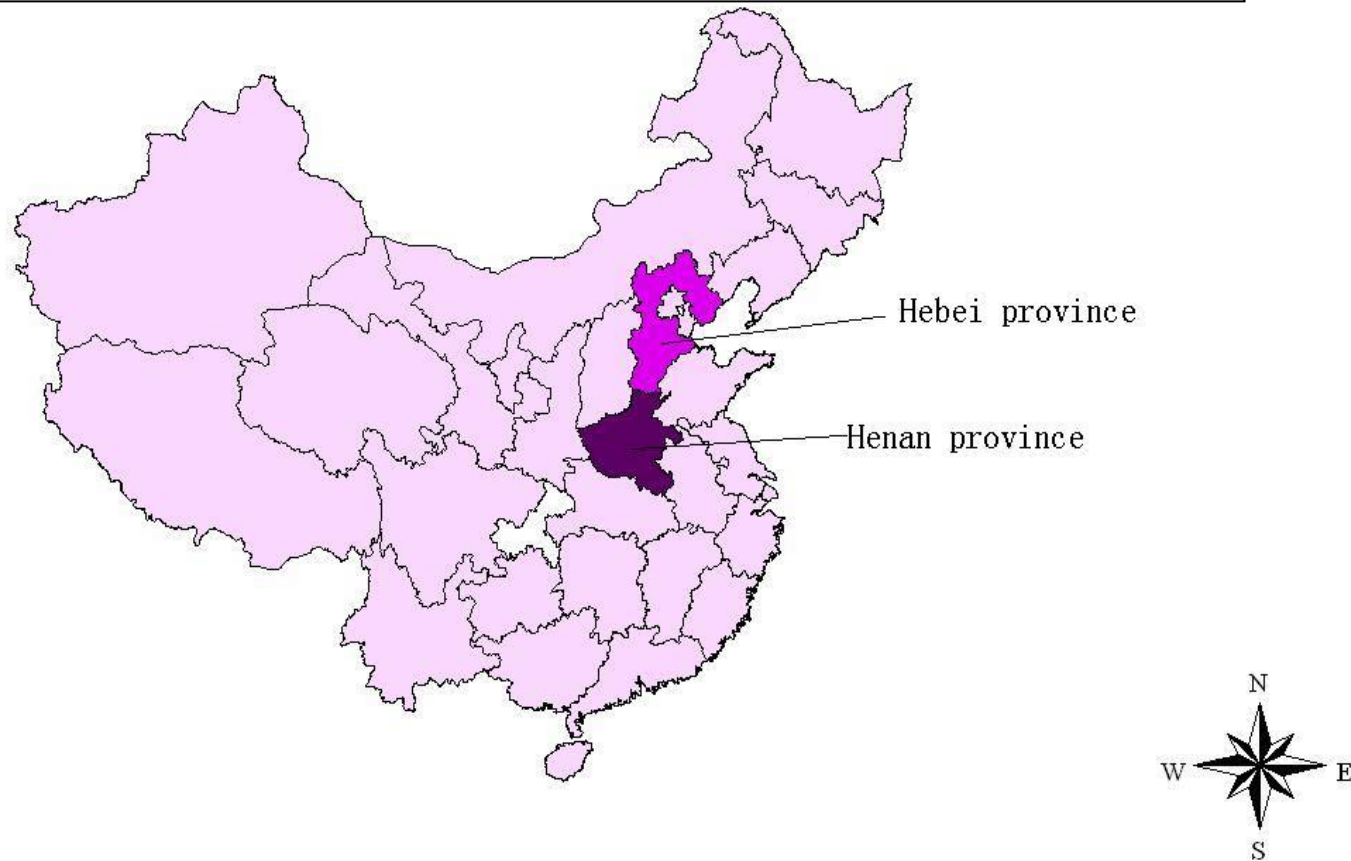
- **Data set 1**
 - National representative “North China Water Resource Survey” (NCWRS) ... 400 villages in 6 provinces in 2004
- **Data set 2**
 - Survey of 24 villages and 50 tubewell managers in 2001 in North China Plain (this is the basis of the analytical work)
- **Main Blocks of Surveys include:**
 -
 -
 -
 -

2004 North China Water Resource Survey: 400 villages; 50 counties, 6 provinces

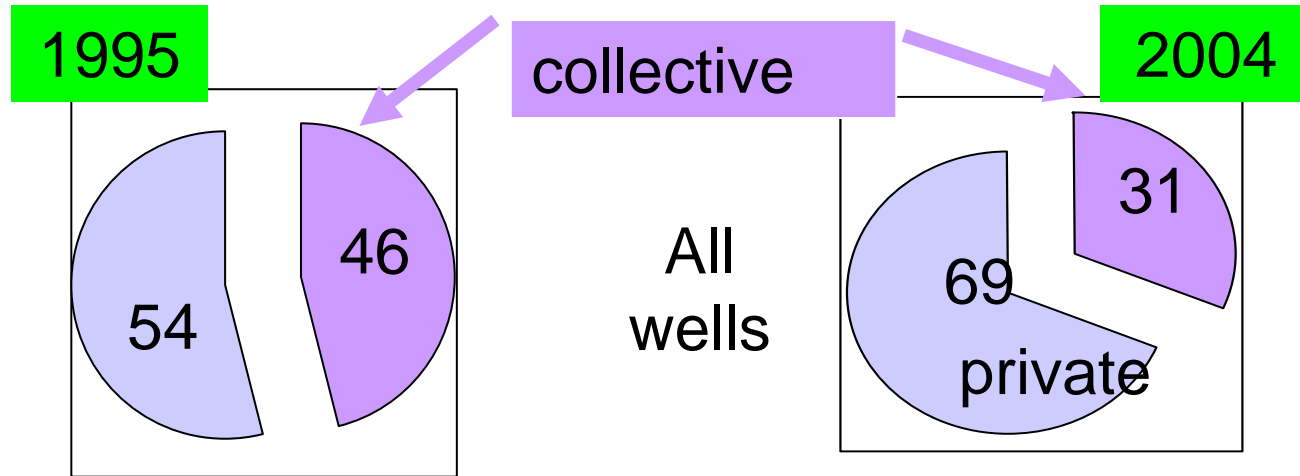


2001 North China Plain Survey:

24 villages, 50 tubewell owners, 2 provinces



Structure of China's GW tubewells

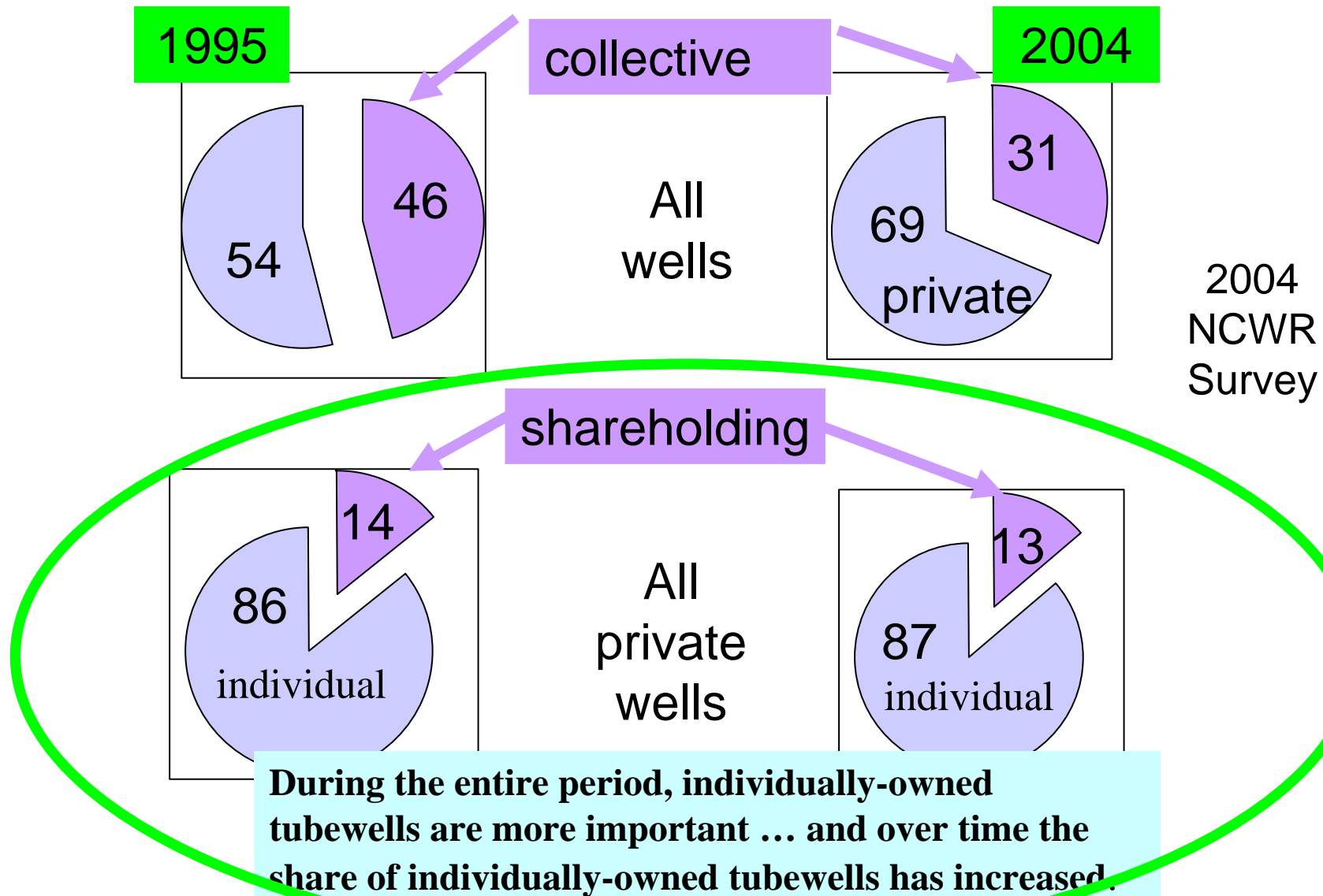


2004
NCWR
Survey

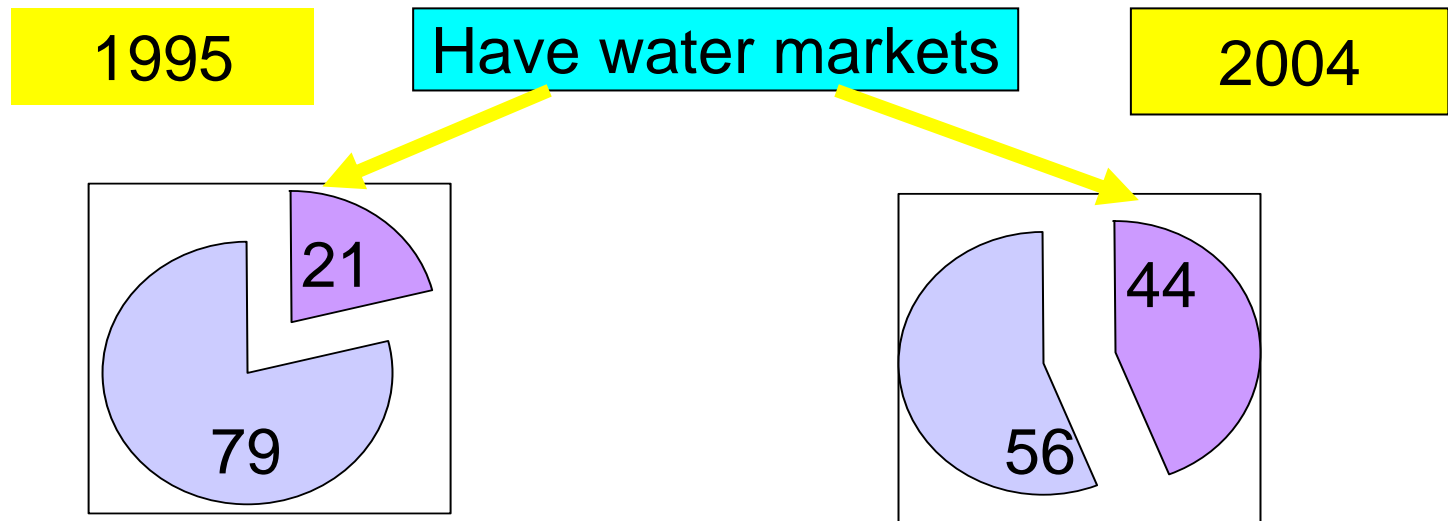
From 1995 to 2004, the percent of collective tubewell declined, and the percent of private tubewell increased.

China's GW economy is privatizing at a rapid pace!

Structure of China's GW tubewells



Growing importance of GW markets in villages in North China

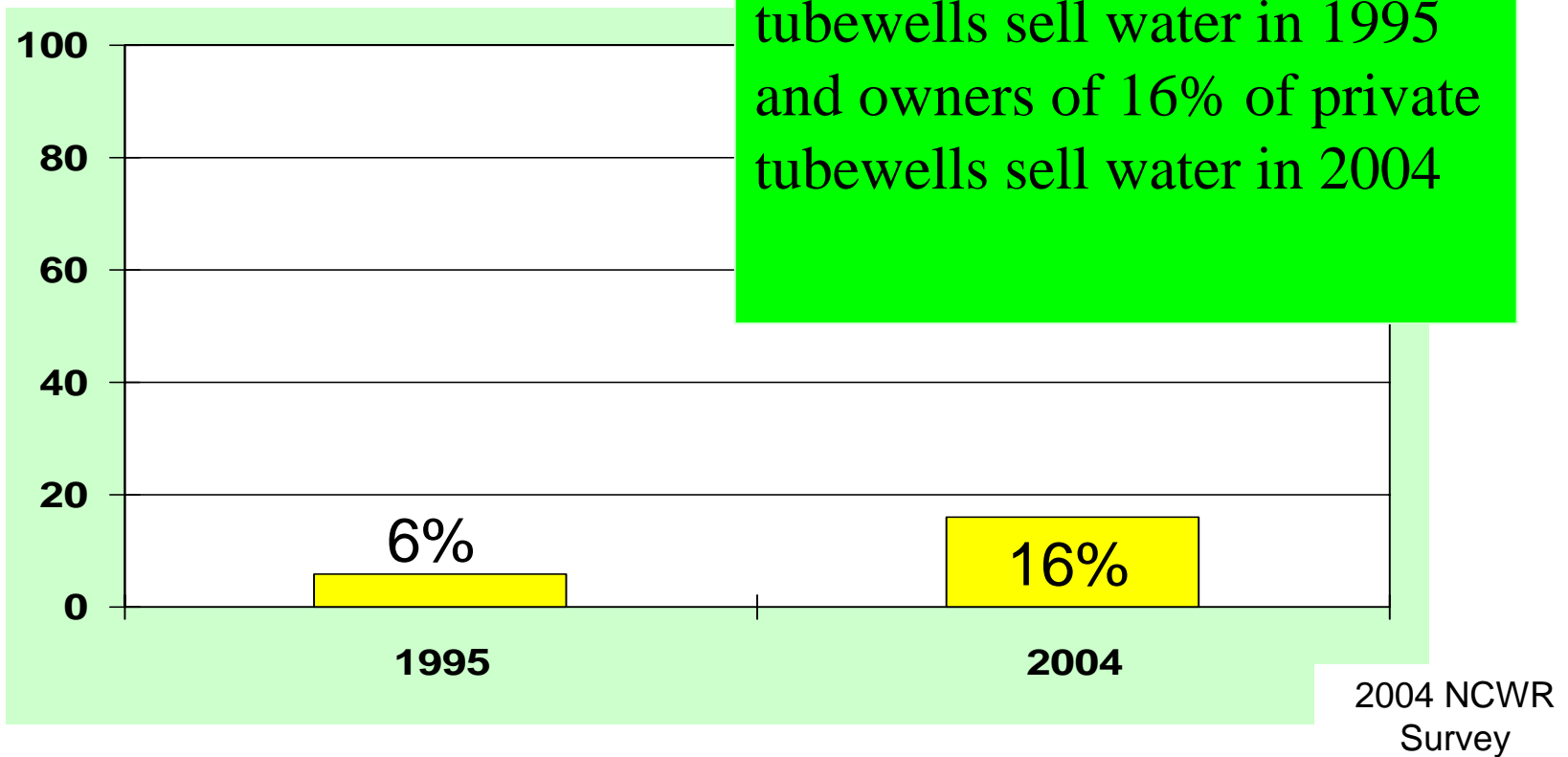


In 1995, in villages in which there were private wells, only 21% had water markets ...

By 2004, that number had risen to 44%

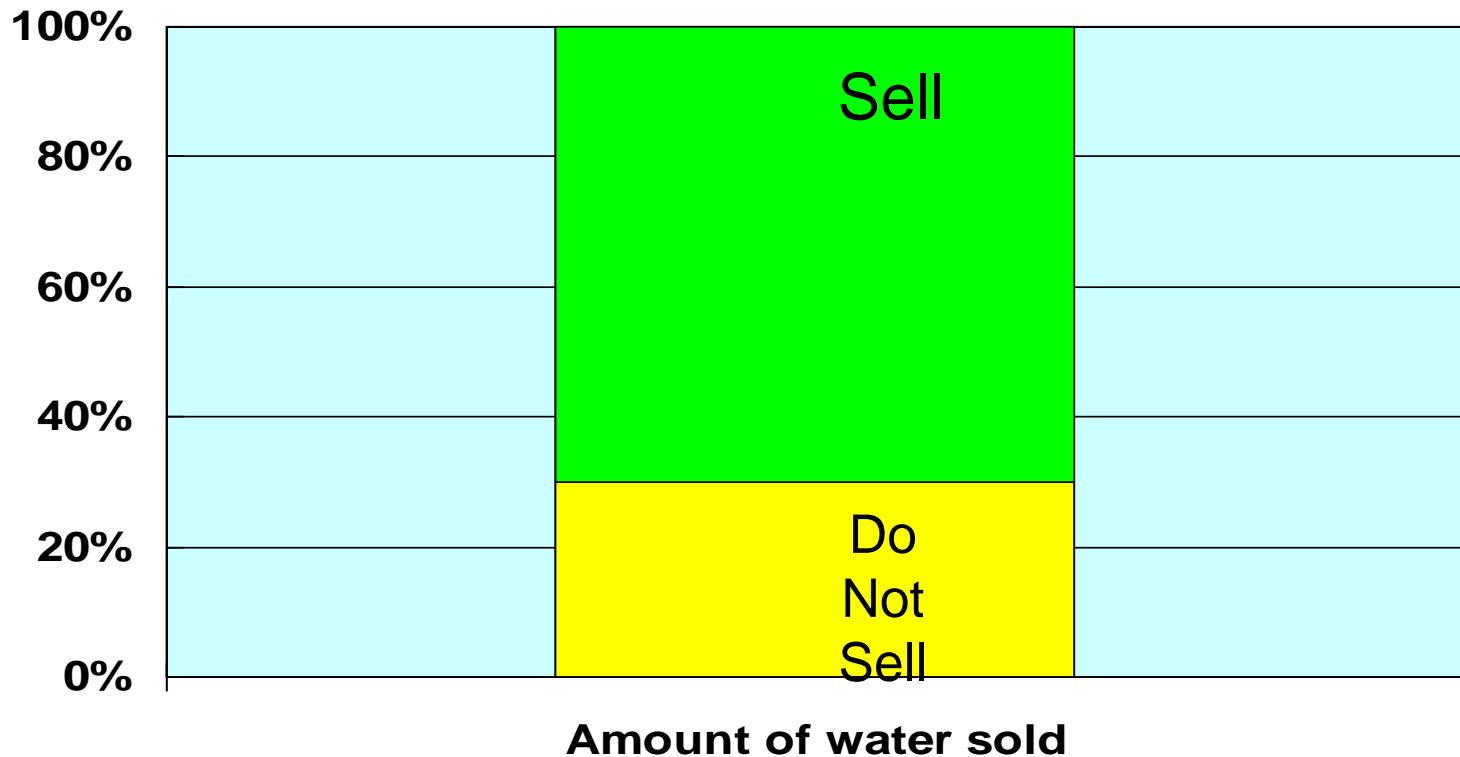
Of all the private tubewells , what is the share of wells that sell water?

Percent



2001 Sample: Magnitude of Water Sales (of wells that sell water)

Percent



Volume of water sold of the total volume of water pumped by wells that sell water

A Summary of the Emergence of GW markets in China

- They are emerging and doing so rapidly ...
 - Extrapolating to entire North China:
 - * Of 17 million tubewells, owners of 1.5 to 2 million tubewells sell water (*that is: there are more than 10 tubewell owners selling water in China for every 1 farmer in Australia*)
 - * These tubewell owners/ground water-sellers sell water in 64,000 communities in North China

Characteristics of these emerging groundwater markets

- According to Shah (1993), most markets in South Asia are:

Characteristics of groundwater markets in North China

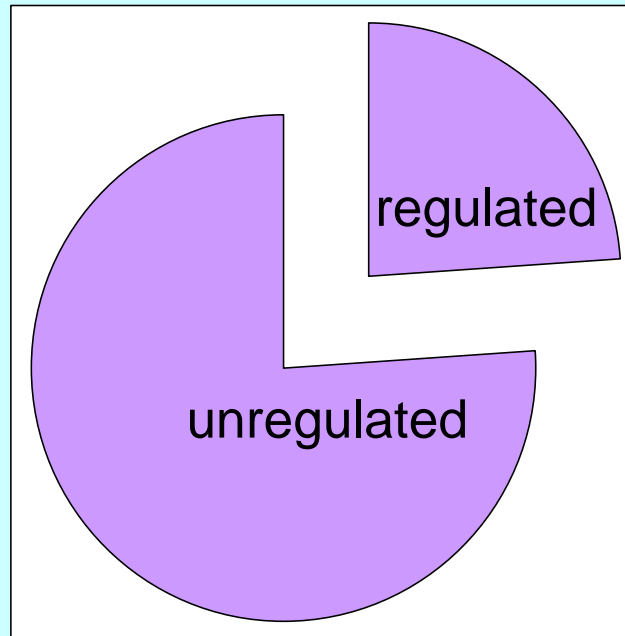
In South Asia

In China

Yes basically

Characteristics of groundwater markets in North China

Level of regulation



More than 75% of villages are in towns that do not regulate groundwater markets

Characteristics of groundwater markets in North China

In South Asia

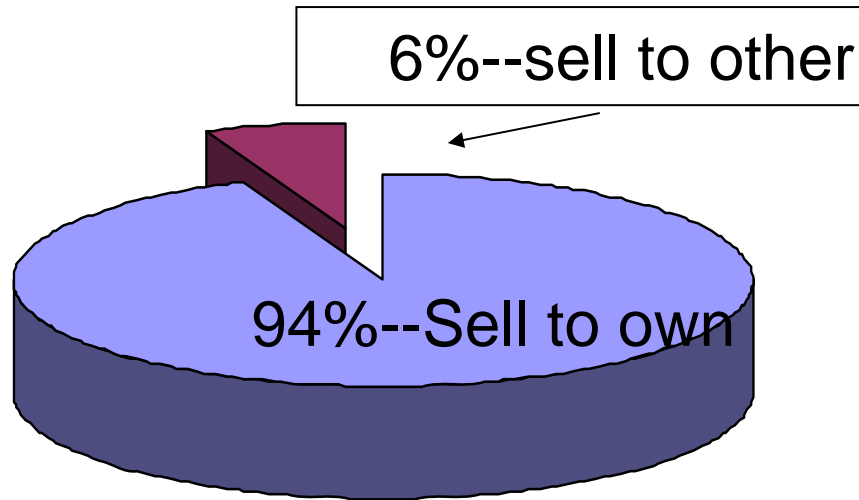
In China

Yes, basically

yes

Characteristics of groundwater markets in North China

Localized markets



94% of tubewell owners sell water to farmers in their own village;

Only 6% of tubewell owners sell water to farmers in other villages;

Characteristics of groundwater markets in North China

In South Asia

In China

Yes, basically

yes

Most households only buy from 1 well (not many options)

yes

Only between 5-10% of households buy from more than 1 well owner

24% of villages have household that both buy and sell water

Characteristics of groundwater markets in North China

In South Asia

In China

yes

yes

Most households only buy from 1 well (not many options)

yes

Between 5-10% of households buy from more than 1 well owner

24% of villages have household that both buy and sell water

Almost
yes

Summary of Characteristics of Groundwater markets

- They are in a large and growing number of villages in China
- Mostly being sold by individuals with private wells (up to 20 times more than shareholding wells)
- Share many characteristics of groundwater markets in rest of Asia

Given this information about GW markets in China, there are still two questions:

- **Why is it that GW markets exist in some villages and not in others?**
- **Why is it that some tubewell owners sell water and others do not?**



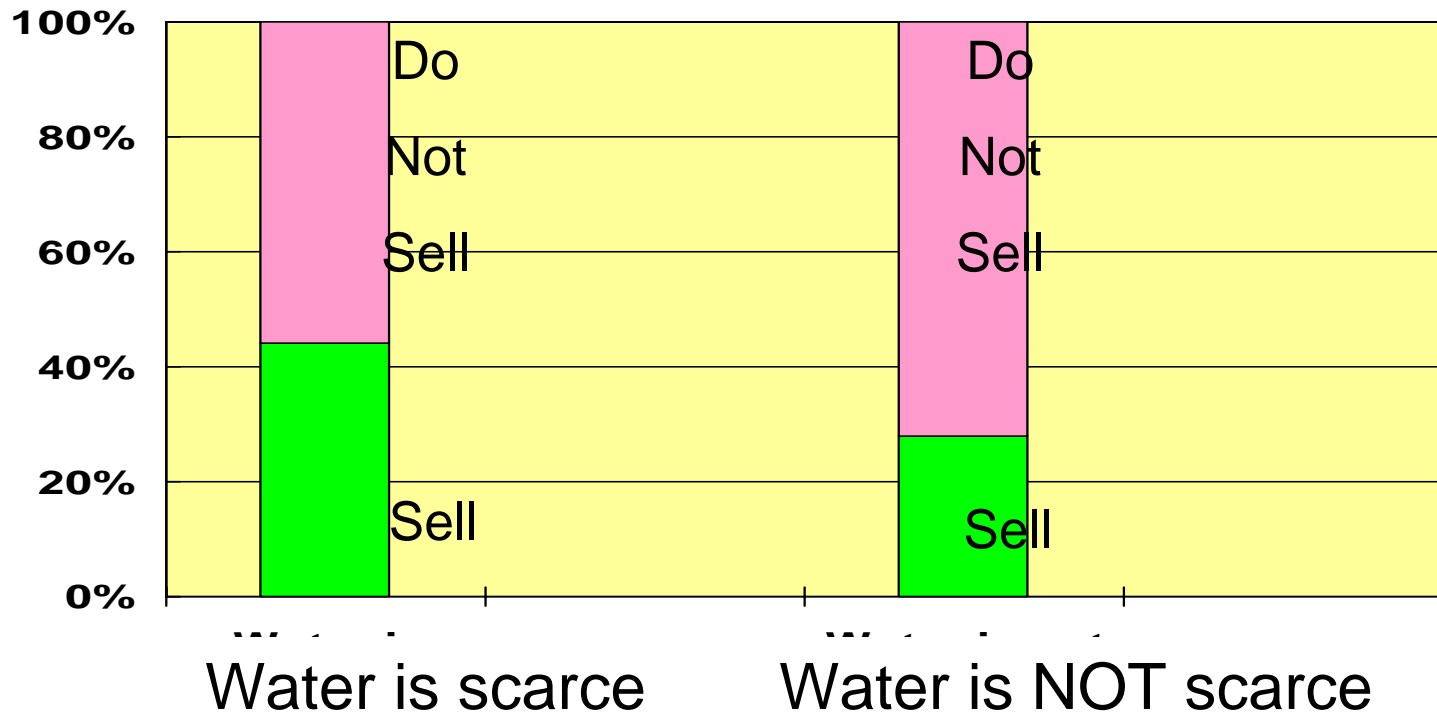
Determinants of groundwater markets

Plan:

1. Descriptive
 - a. Resource Scarcity Ownership
 - b. Ownership
2. Multivariate

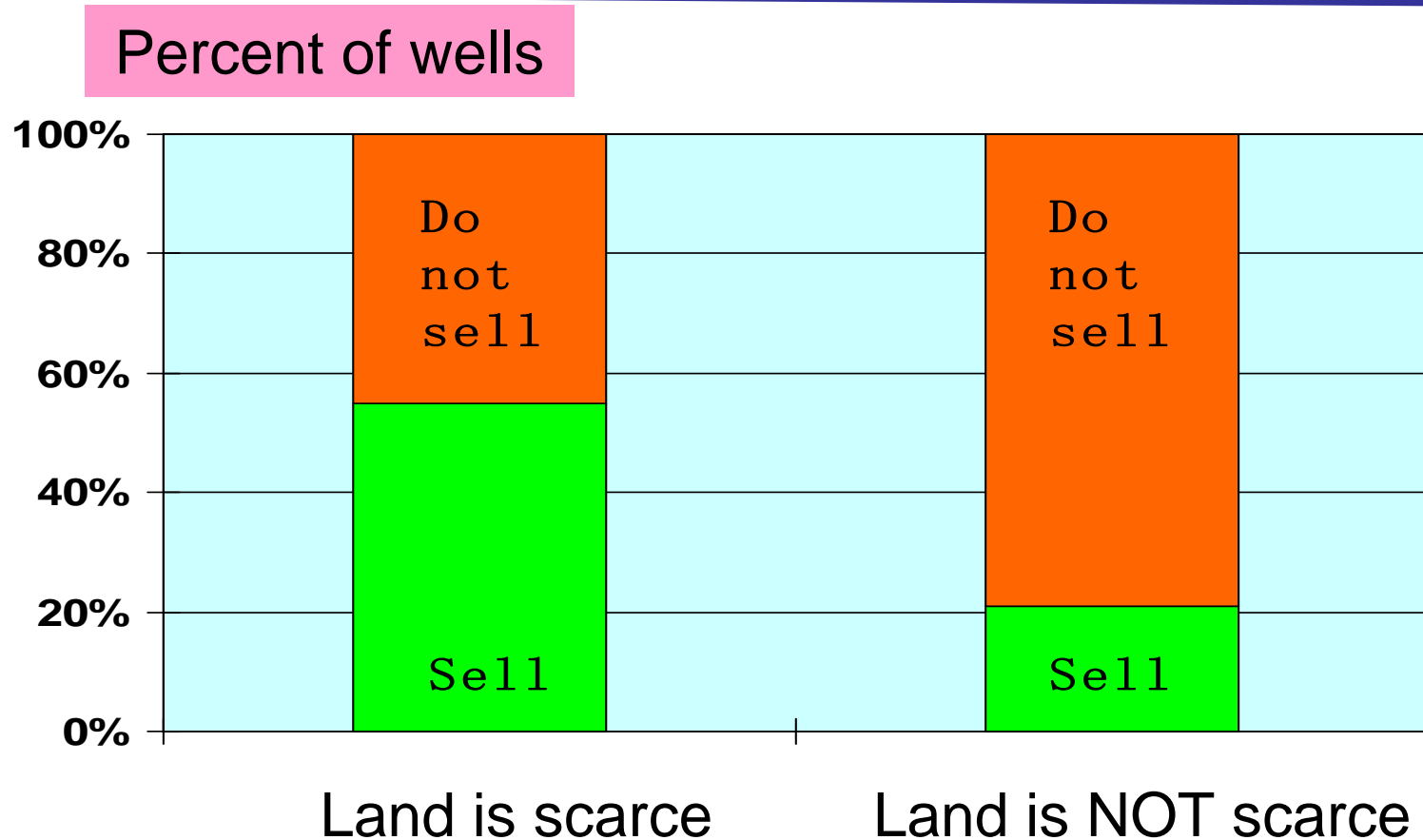
Resource scarcity and groundwater markets: Water

Percent of wells



We asked village leader: “Is water seriously scarce in your village?”

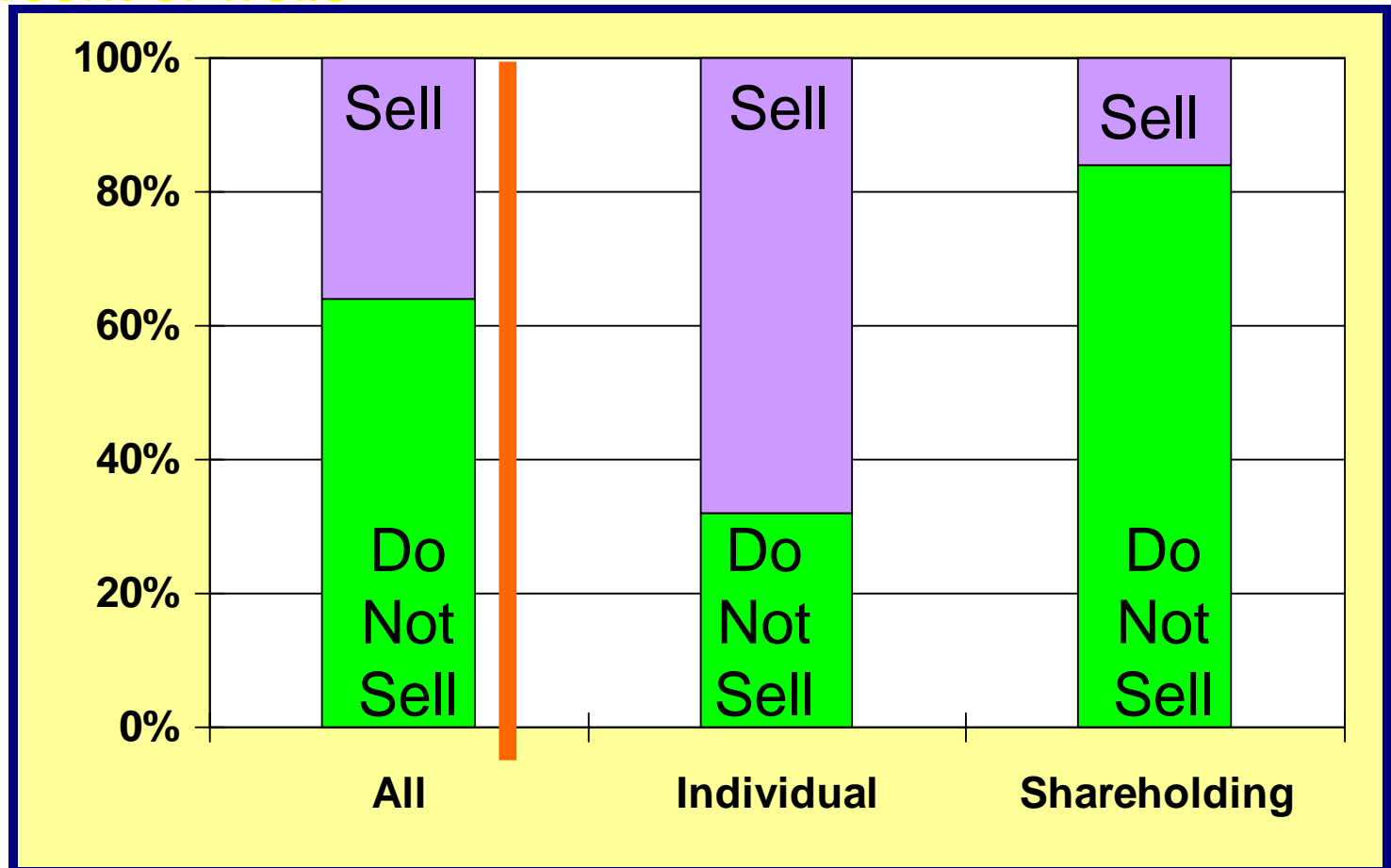
Resource scarcity and groundwater markets: Land



If per capita cultivated land is less than 0.1h, we assume that land is scarce in the village

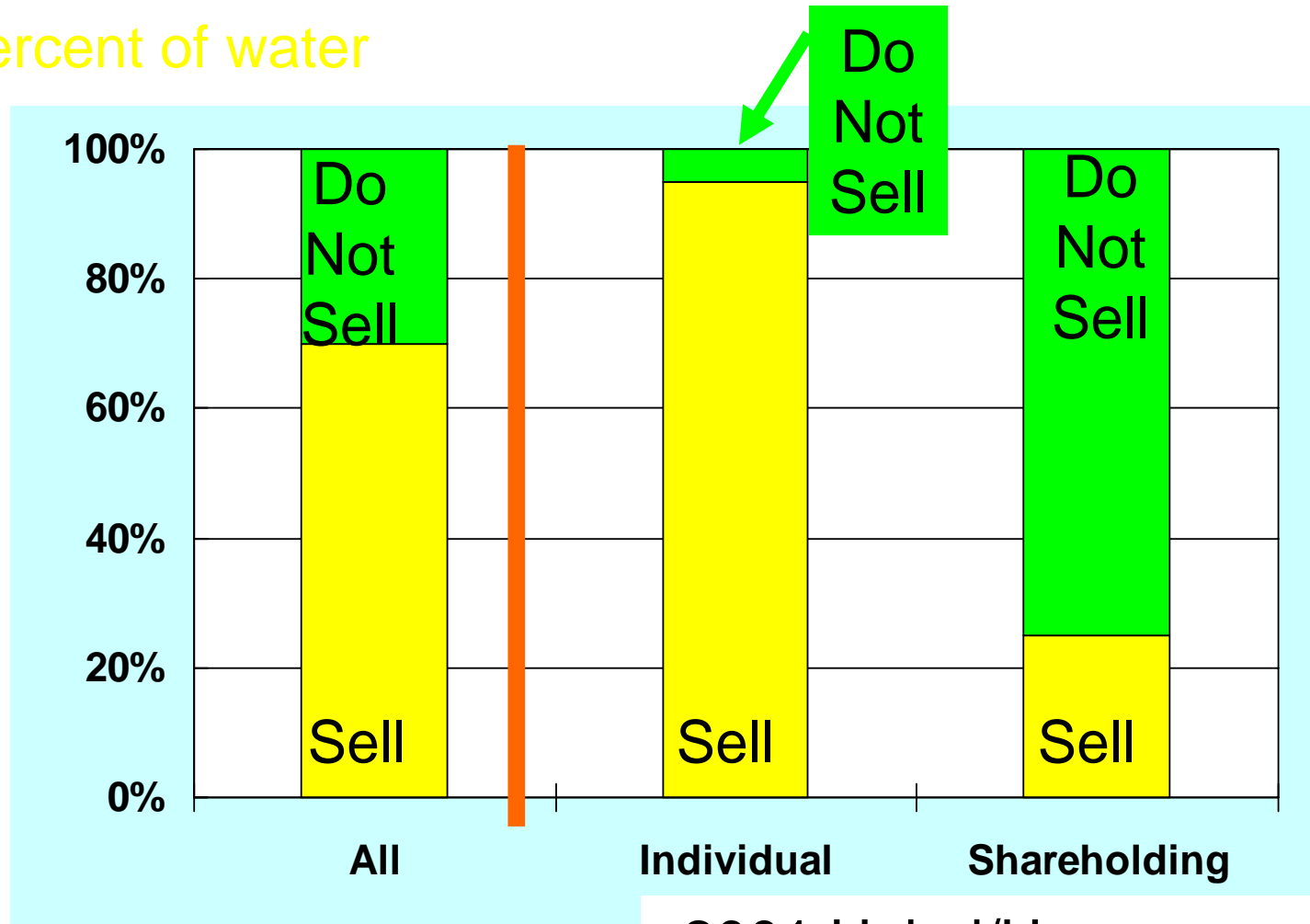
Share of “private” tubewells that sell water in 2001 Hebei and Henan Sample

Percent of wells



Of total volume of water pumped from tubewells (which sell water), what is share that is sold?

Percent of water



2001 Hebei/Henan sample

Econometric Results

Table 1 Econometric results of Determinants of groundwater markets

Dependent variable:	Explanatory variables:	Quantity share of selling water	
		OLS	Tobit
Share of water sold by tubewell owners	Economic variables:		
	Individual (dummy)	0.452 (5.47)***	0.477 (6.29)***
	Watertable (log)	0.166 (3.17)***	0.17 (3.55)***
	Per capita arable land	-5.867 (4.70)***	-6.412 (5.52)***
	Pipepercent	-0.001 -0.58	-0.001 -0.7
	Powertype	0.093 -0.66	0.149 -1.14
	Control variables:		
	Per capita income	0 (2.76)***	0 (3.39)***
	price	0.001 -0.11	0.001 -0.14
	Humancapital	-0.002 -0.93	-0.002 -1.28
	nonfarm	-0.985 (2.95)***	-1.058 (3.49)***
	roaddistance	0.067 (1.89)*	0.058 (1.78)*
	Province (dummy)	0.049 -0.34	0.038 -0.29
	Constant	0.467 (1.73)*	0.518 (2.12)**
Observations	50	50	
Df	38	38	
R-squared	0.76		
Adj R-squared	0.7		
F value	11.24		
Chi ²		73.97	
Log likelihood		5.61	

Note: Absolute value of t statistics in parentheses. * significant at 10%; **

OLS and Tobit ... N=50 observations

Determinants of groundwater market (The scarcity of water and land resources)

Explanatory factors	OLS		Tobit	
	Coefficient	t	Coefficient	t
Log of groundwater table	0.17	(3.17)***	0.17	(3.55)***
Per capita cultivated land	-5.87	(4.70)***	-6.41	(5.52)***

Determinants of groundwater market (The effect of ownership of tubewells)

Explanatory factors	OLS		Tobit	
	Coefficient	t statistics	Coefficient	t Statistics
Individual tubewell dummy variable	0.45	(5.47)***	0.48	(6.29)***
The results considering the endogeneity	2.68	(5.26)***	2.95	(6.31)***

Price elasticity

	OLS	
	Coefficient	t statistics
Price	-0.05	(1.63)
Price*log(watertable)	0.25	(1.43)
Price*private	0.06	(2.30)**
Price elasticity=-0.05+0.25*2.21+0.06*0.38=0.53		

Percentage increase in water sold in groundwater markets as the price of water increases (in percentage terms)

Conclusion

- Groundwater markets clearly have emerged as an important way that farmers in North China access groundwater, and they are evolving rapidly.
- Groundwater markets in the North China have similar characteristics as those in South Asia: Unregulated, localized, and fragmented ...
- Groundwater markets emerge most robustly in regions that are increasingly dominated by private well ownership, facing increasing water and land scarcities ...

Policy Implications

- Still too early to say, since we still need to understand the effect that GW markets have on efficiency, equity, poverty and water resources
- If like South Asia, GW markets should benefit farmers, and as such it is hoped that they should be expanded in the future ...
- Policies: difficult balance since they have been emerging rapidly in a fairly unregulated market (so do not want to over regulate) ...
- But, still may be a role for policy: any thing that will help privatization by individuals will also help (Wang et al., 2004, show that low interest rate loans and grants to help expand the share of private wells sunk by individuals ...) expand GW markets