

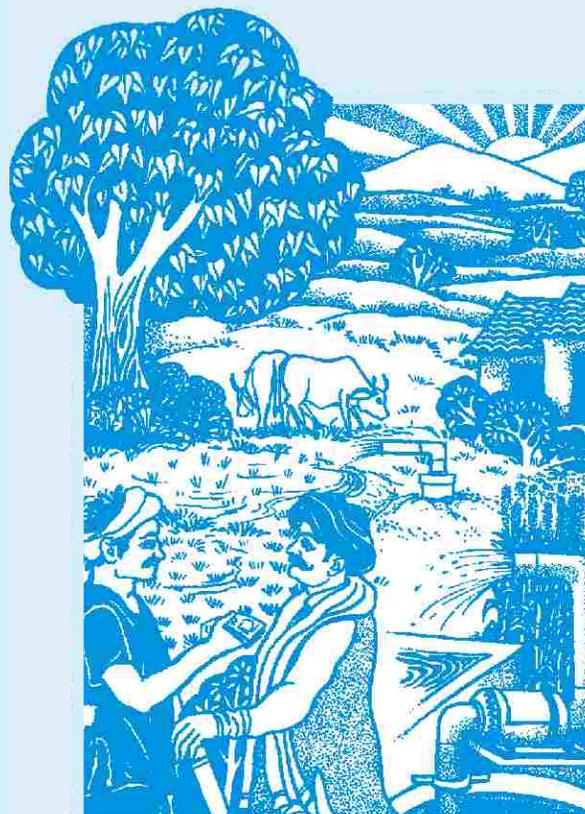
Water Policy Research

Highlight

**The Spread and Extent of
Irrigation Rental Market
in India, 1976-77 to 1997-98:
What Does the National Sample
Survey Data Reveal?**

Aditi Mukherji

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This paper is based on three rounds of NSSO data, viz. 31st, 48th and 54th rounds. This is the first paper of its kind that presents a macro level spatio-temporal analysis of pump rental markets in India.

Results show that there has been an enormous increase in area irrigated through pump rental markets, from less than estimated 1 mha in 1976-77 to estimated 20 mha in 1997-98. Thus, the spread of water market and its scale of operation are huge and deserve more attention.

The paper breaks certain myths. For example, the general impression that water markets in eastern India were underdeveloped stands negated. The NSSO data shows that even in 1976-77, eastern Indian states showed the highest prevalence of water market and it continues to do so even now.

The paper also suggests that ownership of pumps has become less scale biased with the overall ownership pattern shifting towards marginal, small and medium farmers, away from the large and very large farmers.

THE SPREAD AND EXTENT OF IRRIGATION RENTAL MARKET IN INDIA, 1976-77 TO 1997-98: WHAT DOES THE NATIONAL SAMPLE SURVEY DATA REVEAL?¹

RESEARCH HIGHLIGHT BASED ON A PAPER WITH THE SAME TITLE

INTRODUCTION

Expansion in irrigation facilities along with other inputs ushered in green revolution in India in the 1960s. At the same time evolved the ingenious institution of water market whereby owners of wells/tubewells and pumps either hired out their equipment to other farmers or sold water in return for pecuniary gain. Though water markets proliferated since the beginning of green revolution, it was only in the mid 1980s that this became a topic of research. Several studies followed, both in water scarce as well as in water abundant regions. While being theoretically sound and empirically rich, these studies were of limited spatial coverage and hence failed to generate a macro-picture of the spread and extent of the water market in India.

Indeed, data for doing such macro-level comparisons have been rare, with the exception of two rounds of National Sample Survey Organization (NSSO) data which give some estimate of the prevalence and spread of water market in various states of India. This paper uses these two databases for estimation of prevalence of pump rental markets (or hiring in of irrigation services)² at the state and regional levels during two time periods, viz. 1976-77 (NSSO 31st round) and 1997-98 (NSSO 54th round).

OBJECTIVE

The objective of this paper is to estimate the spatial spread of water markets in India over two periods of time viz. 1976-77 and 1997-98. In doing so, some other issues, such as total monetary value generated by water market, changing pattern of pump ownership among

various size classes of farmers and its equity implications will also be touched upon.

DATA AND METHODOLOGY

This paper uses data from three rounds of NSSO surveys-31st, 48th and 54th, each covering the years 1976-77, 1991-92 and 1997-98 respectively. While figures for total number of pumps (electric and diesel) along with size class of pump ownership³ can be calculated from all the three rounds, spatial spread of the pump rental market can be estimated only from the NSSO 31st and 54th rounds. However, like almost all other NSSO rounds, the 31st and the 54th are not directly comparable because of the way the survey was designed. Hence, for the sake of comparison a common unit had to be arrived at, the one I chose was *net area irrigated through hiring in of pump irrigation services*. The table below gives details of the data used, outputs derived along with assumptions made and limitations imposed by the very nature of the datasets.

RESULTS AND DISCUSSION

Spatial Spread of Pump Rental Market: 1976-77 to 1997-98

In 1976-77, for India as a whole, there were 6.5 million pumps, of which some 0.6 million pumps (10.4 percent) were rented. These rented pumps together irrigated 0.8 million hectares (mha) of the total 17 mha of lift irrigated land in that year. Thus, area irrigated through pump rental was still comparatively low. There were marked inter-region variations in the water markets; pump rental was most widespread in the eastern region where 38 percent of pumps were reported to be rented. Similarly, in terms of area, eastern India

¹This is based on an invited paper. Aditi Mukherji is a PhD student, Department of Geography, Cambridge University.

²Pump rental market, water market, irrigation services market and hiring in of irrigation services-all these four terms will be used interchangeably in the paper to mean the phenomenon whereby an owner of well/tubewell and pump (either electric or diesel) hires out or sells water to other farmers.

³Size class wise pattern of pump ownership data are not available in the published report of the 54th round. However, from the questionnaire appended at the end of the NSSO report, it is clear that this information was collected, though not reported.

Table 1: Data and Methodology

NSSO round (year)	Data available	Output derived and method of calculation	Assumptions and limitations
31 st round (1976-77)	<ul style="list-style-type: none"> a) Net area irrigated by various types of lift irrigation including electric and diesel pumps (million hectares) b) Total number of pumps including those owned singly, jointly and rented out (millions) c) Number of pumps (electric/diesel) and size class of ownership 	<ul style="list-style-type: none"> a) Area irrigated (million hectares) from rented pumps. First, average area irrigated per pump was calculated by dividing the total area irrigated by pumps with the total number of pumps in each state by multiplying total number of rented pumps with the average area irrigated per pump. b) Statewise number of pumps according to motive power and ownership status 	<p>Due to the aggregated nature of the data, average area irrigated per pump could not be separately calculated for electric or diesel pumps or for different types of pump ownership categories, though it has been separately calculated for each state. This might result in some over-estimation of area irrigated by rented pumps because rented pumps are also used for self - irrigation.</p>
48 th round (1991-92)	<ul style="list-style-type: none"> a) Percentage of households in various size classes owning either electric or diesel or other pumps b) Number of such estimated households 	<ul style="list-style-type: none"> c) Number of pumps owned separately according to motive power and for size class of owners. By converting percentage of households owning these assets into number of households given, the total number of households in each category is known 	<p>To arrive at the figure of total number of pumps, it was assumed that each household reporting owning pumps, owned only one pump each. This might result in underestimation of number of pumps, as several households may own more than one pump.</p>
54 th round (1997-98)	<ul style="list-style-type: none"> a) Percentage of households in each category operating irrigated land with hired services b) Estimated gross area under cultivation in these same households (million hectares) c) Net sown area and area cropped more than once for these households (ha) d) Number of cultivator households and percentage of those owning pumps among them 	<ul style="list-style-type: none"> a) Gross area irrigated by hiring irrigation services (million ha) given that both gross area cultivated by all households and the percentage of this gross area cultivated by hiring in irrigation services is known b) Cropping intensity (percent) for different size classes given that net sown area and area cropped more than once are known. c) Net area irrigated by hiring in irrigation services calculated by dividing gross area irrigated by cropping intensity in that size class d) Total number of pumps given that both total number of households and percentage of them owning pumps are known. 	<ul style="list-style-type: none"> a) Within a given size class, land is equally distributed. Thus, if the category of farmers of 0.5 to 1.0 ha own 1000 ha of land among themselves and of this 35 percent is irrigated by hired services, it is assumed that 350 ha is indeed irrigated by hired services. b) Due to the aggregated nature of data, cropping intensity could not be calculated for irrigated and unirrigated land separately and was assumed to be the same for both. This will result in over-estimation of land under hired irrigation because cropping intensity in irrigated land is likely to be higher than unirrigated land.

accounted for 38 percent of net area irrigated through pump rentals followed by central and western India where 10.5 percent was irrigated through the rental market.

As we come to 1997-98 these figures change drastically. While in 1976-77 only 4.9 percent of net lift irrigated area was irrigated through pump rentals, in 1997-98, of the 64.9 mha net irrigated area (including both lift and surface flow, unlike the 31st round when only lift irrigated area was reported), some 20.3 mha or 31 percent of the irrigated area was irrigated through pump rental markets. This is almost 20 times increase in area under hired irrigation services. However, regional patterns do not seem to have changed much. The eastern states still report highest amount of hired irrigation services where more than 60 percent of the rural households report hiring in of such services. This is followed by northern, western and southern states where 41 percent, 26 percent and 23 percent report hiring irrigation services. Table 2 presents the state and regional figures.

Agricultural Value of Output Generated Through Pump Rental Market

In this context it would be interesting to calculate the total value of agricultural output generated on land irrigated through the pump rental markets. Note that this is not same as the contribution of purchased irrigation water to total agricultural production, but an estimate of total value generated from land irrigated by purchased water and as such includes contribution of all other inputs such as fertilizer, land, labour and capital. This was calculated by simply multiplying area irrigated through pump rental market (ha) with average value of agricultural produce (Rs/ha) in each state. Table 3 presents the findings and shows that in 1990s, area irrigated through water market generated a whopping value of Rs 150 billion annually.

Number of Irrigation Pumps: 1976-77, 1991-92 and 1997-98

The only comparable figure across the three rounds of NSSO survey is the number of pumps. All these three rounds provide disaggregated data on the number of electric and diesel pumps, but only rounds 31st and 48th report data on land-size based ownership of pumps. Table 4 gives author's

estimates of total number of pumps in different states of India.

The table 4 reveals several interesting facts. First, electric and diesel pumps have been more or less equally distributed with the exception in 1991-92 when electric pumps outnumbered diesel pumps by a million and more. Indeed, this reflects the impact of government's concerted effort of rural electrification in the 1980s, which later lost steam in the 1990s after economic liberalization and increasing pressure on state coffers. Second, the eastern Indian states of West Bengal and Bihar have witnessed the largest percentage increase in the number of pumps. In Bihar, however the number of electric pumps declined between 1976-77 and 1991-92 supporting the argument that there has been 'rural de-electrification'⁴ in Bihar. Other high growth states are Kerala and Orissa, but then both these had very low base in 1976-77. Uttar Pradesh has maintained its lead as the state with most number of pumps since 1976-77. Now Uttar Pradesh farmers own 20 percent of all pumps in India.

Pump growth rates have, however, stagnated in Punjab and Haryana. In fact, Haryana saw a decline in number of pumps between 1991-92 and 1997-98. Among southern states, while the number of pumps increased by more than 200 percent (from 1976-77 to 1998-97) in Andhra Pradesh, Karnataka and Kerala, this increase has been rather modest in Tamil Nadu at only 45 percent during the same period. Indeed, Tamil Nadu has registered the smallest increase among

There is a clear but paradoxical east-west energy divide in India- while the water abundant eastern states are saddled with diesel pumps, the water scarce western and southern India are well endowed with electric pumps

all states, possibly because it already had a huge number of pumps (1.1 million) in 1976-77, the largest number then in India. The table above also clearly shows a clear but paradoxical east-west energy-divide in India, with the water abundant eastern states saddled with diesel pumps, while water scarce western and southern India are well

⁴Rural de-electrification refers to a situation where villages were originally electrified, but later due to lack of maintenance of electricity infrastructure, these villages were disconnected in a de facto sense, even if in government records they are still counted as electrified villages.

Table 2: Net Area Irrigated Through Irrigation Rental Market, Own Irrigation, Percentage of Pump Rented and Percentage of Households Hiring Irrigation Services⁵

S. No	State	1976-77 (NSSO 31 st round) 1976-77			1997-98 (NSSO 54 th round) 1997-98		
		Net area irrigated through hired irrigation services (mha)	Net area irrigated through own irrigation services (mha)	Percentage of pumps rented	Net area irrigated through hired irrigation services (mha)	Net area irrigated through own irrigation services (mha)	Percentage of households reporting hiring in irrigation services
A	B	C	D	E	F	G	H
1	Andhra Pradesh	0.03	0.74	7.41	1.41	3.73	33.76
2	Karnataka	0.02	0.36	6.57	0.54	3.42	16.56
3	Kerala	0.02	0.17	37.19	0.03	0.43	7.18
4	Tamil Nadu	0.02	1.03	2.41	0.41	1.69	24.64
5	Southern India	0.09	2.3	6.10	2.39	9.27	23.13
6	Bihar	0.16	1.34	31.19	3.40	3.01	68.56
7	Orissa	0.02	0.16	42.78	0.30	0.86	27.24
8	West Bengal	0.12	0.36	50.61	1.59	0.96	67.20
9	Eastern India	0.30	1.86	38.1	5.29	4.83	60.83
10	Haryana	0.04	0.83	4.74	0.58	1.69	38.52
11	Punjab	0.05	1.65	3.07	0.28	2.13	19.26
12	Uttar Pradesh	0.12	6.13	2.57	6.73	6.65	66.52
13	Northern India	0.21	8.61	3.1	7.59	10.47	40.83
14	Gujarat	0.02	0.93	2.35	NA	NA	NA
15	Rajasthan	0.05	1.49	7.99	1.48	5.46	27.79
16	Madhya Pradesh	0.09	0.62	24.26	1.91	6.48	29.55
17	Maharashtra	0.12	0.92	14.78	0.44	3.39	17.69
18	Western and Central India	0.28	3.96	12	3.83	15.33	25.66
19	All India	0.87	16.73	10.37	20.29	44.59	46.33

Source: Author's calculations based on NSSO 31st and 54th round data, NA = Not Available

endowed with electric pumps. This has serious implications on water and energy use as well as for crop economics.

Equity Issues: Who Owns Pumps and Who Buys Water?

Debate on water markets have focused on equity issues, the central concern being whether benefits of water market are equitably distributed among the water sellers and the water buyers. Opinions differ. However, from the NSSO data, there is no way to answer such questions. At best, two important equity related facts may be ascertained, viz. who owns pumps and who buys water.

Figure 1 shows the distribution of pumps among five categories of farmers in 1976-77 and 1991-92. This shows that the bulk of pumping asset is owned by two categories of farmers, viz. those who own land from 1 to 2 ha and those between 2 to 4 ha. These two categories owned 48 percent and 50 percent of the pumps in both the years. Most remarkable, however, is the shift in pattern of ownership in the below 1 ha category. Only 5.6 percent of farmers in this category owned pumps in 1976-77, but in 1991-92, some 10.7 percent did so. At the same time, pump ownership in the top two categories (4 to 10 ha and 10 ha and above) has come down from 35 percent to 25 percent.

⁵Data from the 31st and 54th rounds are not strictly comparable because of the very nature of the database. While, net irrigated area figure in the 31st round refers to only surface and groundwater lift irrigation (manual as well mechanized pumps), the figure for the 54th round refers to all types of irrigation, surface flow as well as surface and groundwater lift. However, since there is no evidence of trading in canal water in India, it may be safely assumed that hired irrigation services in the 54th round refer to lift or pump irrigation only. Hence columns C and F are more or less comparable, while columns D and G are not strictly comparable- column G includes all sources of irrigation including canal and tank flow. Again column E and H cannot be compared directly as the former refers to the number of pumps on hire and latter to the number of households hiring irrigation services. However, this is the closest that one can come to a comparison given the data limitations.

Table 3: Value of Agricultural Output Generated through Pump Rental Market, 1970s and 1990s (at 1990-93 Constant Prices)

State	Value of agricultural output generated through irrigation services market, 1970s (Rs. billion)	Value of agricultural output generated through irrigation services market, 1990s (Rs. billion)
Andhra Pradesh	0.15	13.27
Bihar	0.63	19.30
Gujarat	0.09	NA
Haryana	0.20	5.84
Karnataka	0.08	3.76
Kerala	0.31	0.50
Madhya Pradesh	0.26	9.11
Maharashtra	0.28	2.26
Orissa	0.07	1.81
Punjab	0.38	3.86
Rajasthan	0.10	5.51
Tamil Nadu	0.15	5.84
Uttar Pradesh	0.54	58.22
West Bengal	0.66	15.82
All India	3.72	149.90

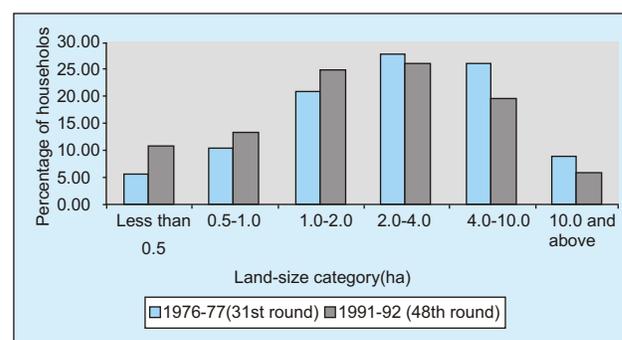
Source: Author's calculations based on NSSO 31st and 54th round data and Bhalla and Singh (2001)

The NSSO 54th round gives class size wise details of households who hire irrigation services and this reveals a very interesting pattern. Out of India's 82 million or so farming households, almost 25 million households reported hiring in irrigation services. Of these 25 million households, 18.5 million (almost 75 percent) farmers operate less than 1.0 ha land, in other words are small and marginal farmers (Table 5). There are inter-state variations, but on the whole this pattern of small and marginal farmers overwhelmingly being water buyers persists across states and regions.

CONCLUSIONS

This paper is based on three rounds of NSSO data, viz. 31st, 48th and 54th rounds. This is the first paper of its kind that presents a macro level spatio-temporal analysis of pump rental markets in India.

Figure 1: Pump Ownership among Various Categories of Farmers in India, 1976-77 and 1991-92



Source: NSSO 31st and 48th rounds

The results show that there has been an enormous increase in area irrigated through pump rental markets, from less than 1 mha in 1976-77 to 20 mha in 1997-98. Thus, the spread of the water market and its scale of operation are huge and deserve more attention. A very good case can be made for revision of categories used by the agricultural censuses for irrigation related statistics. The present categories of source wise irrigation should be modified to take into account whether or not the irrigation is hired from others. Such dis-aggregation will help in several ways. For example, very often, it is argued that agricultural electricity subsidies have bankrupted the state electricity boards and that the benefit of this subsidy goes only to the large and medium farmers who own electric pumps. This statement is fallacious because it does not take into account the fact that benefits of subsidized electricity are also passed on to water buyers. For every pump owner, there is at least one water buyer, if not more. This is evident from the fact that there are 21 million pump owners in India and another 24 million farmers who report hiring in of irrigation services (NSSO 54th round). This also calls for a further NSSO round, where more detailed information on irrigation services hiring, such as terms of transaction, cropping pattern and crop productivity of water buyers and sellers may be included.

Second, this paper also breaks certain myths about water markets. First, literature on water markets in the 1980s conveyed the impression that water markets in eastern India were underdeveloped. However, the NSSO data shows that even in 1976-77, eastern Indian states showed highest prevalence of water market and it continues to do so even now. The second myth is

Table 4: Number of Pumps, 1976-77, 1991-92 and 1997-98

State	Number of pumps (in millions)								
	1976-77			1991-92			1997-98		
	Electric	Diesel	Total	Electric	Diesel	Total	Electric	Diesel	Total
Andhra Pradesh	0.35	0.25	0.60	1.26	0.20	1.46	1.60	0.31	1.90
Bihar	0.18	0.19	0.37	0.11	0.59	0.70	0.19	1.37	1.56
Gujarat	0.10	0.40	0.49	0.39	0.48	0.87	0.65	0.73	1.38
Haryana	0.18	0.11	0.29	0.43	0.34	0.77	0.34	0.33	0.67
Karnataka	0.21	0.07	0.27	0.51	0.04	0.55	0.86	0.10	0.96
Kerala	0.04	0.06	0.10	0.31	0.03	0.34	0.50	0.08	0.57
Madhya Pradesh	0.15	0.19	0.34	0.87	0.24	1.11	1.51	0.61	2.12
Maharashtra	0.45	0.30	0.76	1.26	0.17	1.43	1.69	0.22	1.91
Orissa	0.00	0.02	0.02	0.03	0.04	0.07	0.04	0.10	0.13
Punjab	0.17	0.39	0.55	0.46	0.41	0.87	0.52	0.39	0.91
Rajasthan	0.25	0.17	0.42	0.62	0.70	1.32	1.01	1.21	2.21
Tamil Nadu	0.91	0.19	1.10	0.92	0.37	1.28	1.11	0.50	1.61
Uttar Pradesh	0.27	0.61	0.87	0.45	2.08	2.53	0.77	3.53	4.31
West Bengal	0.01	0.21	0.21	0.05	0.50	0.55	0.09	0.77	0.86
Total	3.26	3.15	6.41	7.68	6.23	13.91	10.89	10.40	21.29

Source: Authors calculations based on NSSO 31st, 48th and 54th round data

of recent origin. The general impression among scholars is that water markets are shrinking in parts of southern India because of depletion of groundwater. But the NSSO data shows that water markets are far from shrinking. If anything, they have expanded since 1976-77 when only 0.09 m ha was irrigated through pump hiring to 2.4 m ha in 1997-98.

Third, findings of this paper also corroborate some estimates which were made based on several assumptions. One such estimate is in relation to the total number of wells/tubewells and pumps in India. The NSSO 54th round shows that in 1997-98 alone, there were 24.7 households who reported owning wells and tubewells and 21.3

million households reported owning either electric or diesel pumps. According to the NSSO 31st round, on an average a household owned 1.12 pumps. Assuming that the same ratio holds (though there are chances that this ratio has increased since then), there would be almost 24 million pumps in India in 1997-98, a figure that would have certainly increased by now. The paper also suggests that ownership of pumps is becoming less and less scale biased with the overall ownership pattern shifting towards marginal, small and medium farmers, away from the large and very large farmers.

Thus, the NSSO's 31st, 48th and 54th rounds together generate a wealth of information on

India's burgeoning pump irrigation economy, the most important of which is the expansion of area under hired irrigation services during the last two decades. The findings drive home the point that the water market is no longer a localized, small scale phenomenon found in sporadic pockets here and there, but is an all pervasive feature in India's agricultural landscape. It demands more attention than hitherto given.

Table 5: Number and Percentage of Households Hiring Irrigation Services in India

Size-class category (ha)	Number of households hiring irrigation services (millions)	Percentage of households hiring irrigation services
Below 0.50	12.4	49.5
00.51 - 01.00	6.0	24.1
01.01 - 02.00	4.1	16.6
02.01 - 04.00	1.8	7.2
04.01 - 10.00	0.6	2.4
10.01 & above	0.1	0.2
All	24.9	100.0

Source: Author's calculation using NSSO 54th round data

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IWMI-Tata Water Policy Program

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