

There is a renewed interest in understanding whether investing in irrigation development has helped reduce rural poverty. Evidence from rural Gujarat seems to suggest that access to irrigation is a *sufficient* condition for poverty reduction though not a *necessary* one.

Investing in primary schooling infrastructure and enhancing gross agricultural output/rural person (gross FIRP) seem to offer the best bet for poverty reduction. FIRP is overwhelmingly influenced by land/man ratio and land use intensity; land use intensity, in turn is hugely influenced by irrigation density.

When it comes to spatial distribution of gains from irrigation, canal systems imply 'all for some', where as well irrigation means 'some for all'.

Water Policy Research

Highlight

Can Irrigation Eradicate Rural Poverty in Gujarat?

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Can Irrigation Eradicate Rural Poverty in Gujarat?¹

RESEARCH HIGHLIGHT BASED ON A PAPER TITLED:

“IRRIGATION DEVELOPMENT AND RURAL POVERTY IN GUJARAT, INDIA: A DISAGGREGATED ANALYSIS”

Since spread of irrigation is a major catalyst for agricultural growth, it is assumed that access to irrigation has a strong impact on poverty reduction. Irrigation is also a precondition to the adoption of the Green Revolution technology of high yielding seeds and chemical fertilizers. There are numerous studies that highlight the beneficial impact of irrigation on the small-holder economy and on crop yields, cropping patterns, cropping intensity, labour use, farm wage rates, and gross and net income from irrigated farming as compared to dry land farming. In recent times there has been a renewed interest in understanding the impact of irrigation development on rural poverty.

Gujarat presents the proof that the 'trickle down' effect of economic growth does not happen in a hurry.

Most empirical analyses of poverty using state-level data have combined time series and cross-section data to identify the factors playing a significant role in reducing poverty. Typically, these are pitched at too aggregate a level. In a few studies that use district level data; poverty estimates-based on the National Sample Survey's (NSS) expenditure surveys that samples around 40-80 rural households per district-themselves become unreliable.

Using Government of Gujarat's 1997 census of Below Poverty Line (BPL) households as well as the Village Amenity Survey of the same year, this paper explores the interplay between irrigation development and rural poverty in 177 predominantly rural *talukas*² (blocks) of Gujarat. Gujarat presents the proof that the 'trickle down' effect of economic growth does not happen in a hurry. According to the BPL census, one-third of households were below poverty line in the state; and more than half of the rural households were below the official poverty line in nearly 70 of the 177 rural *talukas* in 1997.

SOURCES OF RURAL POVERTY IN GUJARAT

Degree of urbanization, farm land availability and its productivity, farm income per rural person, distance from the Golden Corridor, and the number of primary classes per village are some significant determinants of the variations in the BPL ratio across Gujarat's 177 rural *talukas*

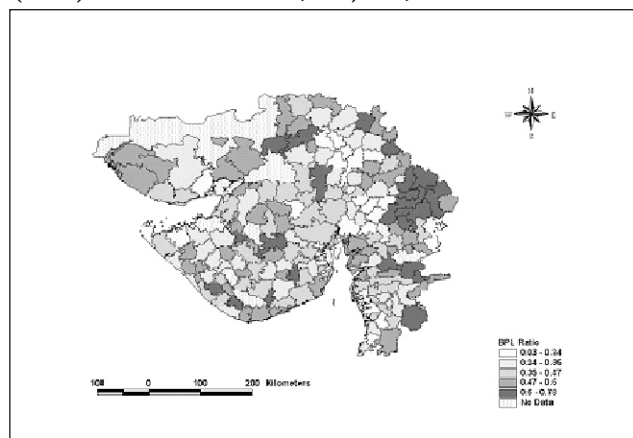
Of the total of 7.92 million households in Gujarat's countryside, 2.24 million were identified as BPL. We took these BPL households as a ratio of total rural households in each *taluka*, and asked

¹The research covered by this IWMI-Tata Research Highlight was carried out with generous support from Sir Ratan Tata Trust, Mumbai under IWMI-Tata Water Policy Programme. The research paper can be downloaded from the IWMI-Tata Website <http://www.iwmi.org/iwmi-tata>.

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²A *taluka* is an administrative territory below a district. In Gujarat, the *taluka* or a block, typically has 80-130 villages, a total population of 150-300,000 and 50-150,000 hectares of farm land.

Figure 1: Taluka-wise Below Poverty Line (BPL) Household Ratio, Gujarat, 1997



what factors might explain variations obtained in the BPL ratios. Figure 1 shows that poverty-dense *talukas* show no particular geographic pattern; they are all over the state defying neat analysis. Compared to a state like Bihar or Orissa, industrialized Gujarat also offers huge variations in the BPL ratio: in the poorest 10 *talukas*, three-fourth of all households are BPL; and in the best off 10 *talukas*, just around one-tenth are.

However, explaining these variations in the BPL ratio across *talukas* was not easy. In dozens of OLS models we estimated, the best OLS equation presented in table 1-in terms of the goodness of fit-still could just explain half of the variations in the BPL ratio across *talukas*. Irrigation development invariably entered all the models through its impact on gross farm income per rural person (FIRP) which had a small but statistically very significant coefficient. The elasticity value of -0.10 for gross farm income per rural person (Gross FIRP) indicates that a 10 percent increase in the average FIRP of the state can reduce the BPL ratio by 1 percent.

Rural electrification has relatively high poverty reduction elasticity; however, since most *talukas* are already electrified (as defined), the potential this variable offers for poverty reduction is very small (1.37 per cent reduction in BPL percent).

Urbanization and industrialization offer huge potential for poverty reduction; and over time, trickle-down from these will be the primary way

TABLE 1: Poverty-Reduction Elasticities

Policy Variable	B-Coefficient	t-Ratio	Elasticity*	Min. Value	Max. Value	Mean Value	Standard Deviation	Max. Impact: Percentage BPL Ratio by Raising the Mean Value to Sample Max Value
BPL Ratio (dependent variable)				3.3	78.09	43.19	16.08	
Intercept	85.75	17.49						
Percentage of Villages Electrified	-0.137	-2.5	0.29	21.3	100	90.06	16.63	-1.37%
Number of Primary Class-rooms/Village (number)	-1.996	-4.98	-0.197	1.96	17.53	5.83	2.55	-39.5%
Urban Population Ratio	-0.504	-8.27	-0.196	0	66.2	17.60	0.14	-54.1%
Distance from Golden Corridor	-3.04	-2.3	-0.143	1	3	1.53	0.74	-13.7%
Gross Farm Income/Rural Person (Rs)	-0.0017	-2.5	-0.10	660	8478	2511	1498.15	-23.8%

*Elasticity = per cent reduction in BPL ratio caused by 1 per cent increase in the value of the policy variable. Elasticity is estimated using simple means of dependent and each dependent variable in the formula B-coefficient * mean of policy variable/ mean BPL ratio.

out of poverty for most rural poor households. Farm land available per capita gets selected as a poverty reducer; but the problem is the practicality of increasing it, since there isn't any more land available to expand farming.

For targeted interventions, then, investing in primary schooling infrastructure and enhancing gross agricultural output/rural person (Gross FIRP) seem to offer the best bet for poverty reduction. In the case of primary education infrastructure, the direction of causality is open to question; it is equally possible to hypothesize that primary education infrastructure tends to get better as a *taluka* climbs the ladder of economic development and enjoys reduced levels of the BPL ratio.

In the case of FIRP too, it is possible to hypothesize thus; however, a priori it seems less likely that high land productivity and FIRP are the result rather than the cause of low BPL ratio. In particular, although at -0.1, the BPL reduction elasticity of FIRP is small, the gap between the average and maximum value of FIRP in the state is large (23.8 percent); and the proportion of BPL households in the state can be reduced by a quarter by raising the state's average FIRP to the level of the maximum achieved. FIRP is overwhelmingly influenced by the land/man ratio (LMR) and land use intensity (LUI); and LUI, in turn is hugely influenced by irrigation density (that is, percent of net sown area that is irrigated).

IRRIGATION ACCESS: SUFFICIENT BUT NOT NECESSARY FOR POVERTY REDUCTION

All evidence from rural Gujarat seems to suggest that access to irrigation is a *sufficient* condition for poverty reduction though not a *necessary* one. Some of the most rapidly growing hinterlands in Gujarat which are reducing their BPL ratio rapidly have little or no irrigation. Several *talukas* in North Gujarat and Kachchh have relatively low BPL ratio but little irrigation. In contrast, it is also true that some *talukas* with high irrigation have a high BPL ratio.

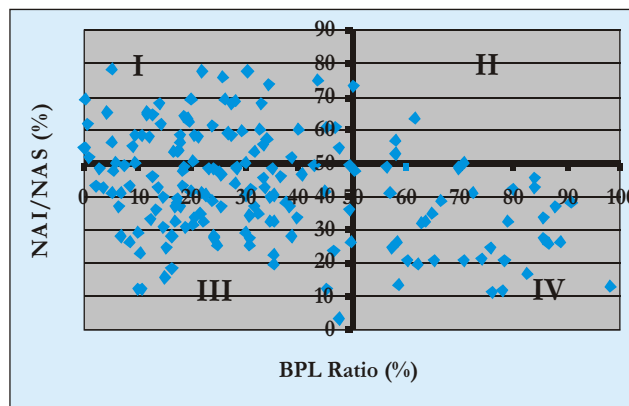
Figure 2 depicts that over 50 of the 177 rural *talukas* of Gujarat have more than 50 per cent of

their net sown area under irrigation; of these only 3 have a BPL ratio higher than 50 percent (quarter II). The figure also shows that *talukas* with high irrigation ratio commonly have low BPL ratio (quarter I); and it is equally common for *talukas* with low irrigation ratio to have high BPL ratio (quarter IV). But a much larger number of *talukas* have lower irrigation ratio as well as low BPL ratio (quarter III); which suggests that irrigation is not the only route to reducing rural poverty.

DIFFERENTIAL IMPACT OF CANAL AND GROUNDWATER IRRIGATION

Our model shows that an additional hectare brought under canal irrigation has a larger impact on FIRP and rural poverty compared to groundwater irrigation.

Figure 2: Irrigation Development and Rural Poverty Ratio in 177 Rural *Talukas* of Gujarat



This productivity differential gets amplified when we compare land productivity in *talukas* with the largest canal irrigation density with those that have the highest groundwater irrigation density.

At the level of the State, groundwater irrigation has a different scale and pattern of spread and therefore different impact on rural poverty compared to canal irrigation as shown in Figures 3 and 4. The bulk of Gujarat's canal irrigation is concentrated in a small number of *talukas* where its impact on land productivity, land use intensity, and FIRP is very high; however, groundwater irrigated area is far more dispersed. Besides, the total area as well as number of people benefiting from groundwater irrigation is many times larger than that from canal irrigation. While 0.59 million

ha (5.85 percent) of net sown area in Gujarat is under canal irrigation, the comparable figure for groundwater irrigation is 2.32 million ha (25.7 percent). Over 95 per cent of Gujarat's canal irrigation is concentrated in one-fifth of its *talukas* where its impact on land productivity, land use intensity, and FIRP is very high; however, groundwater irrigated area is far more dispersed (Figures 3 and 4).

In the post-Narmada scenario, too, groundwater is likely to dominate irrigated agriculture, with net sown area under canal irrigation rising to 2.37 million ha (24.55 percent) while that under groundwater irrigation likely exceeding 4.5 million ha (46.5 percent).

Figure 3: Land Productivity Under Canal Irrigation

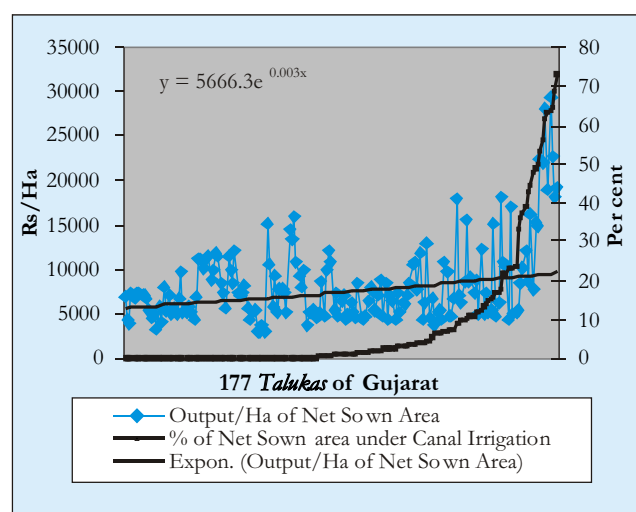
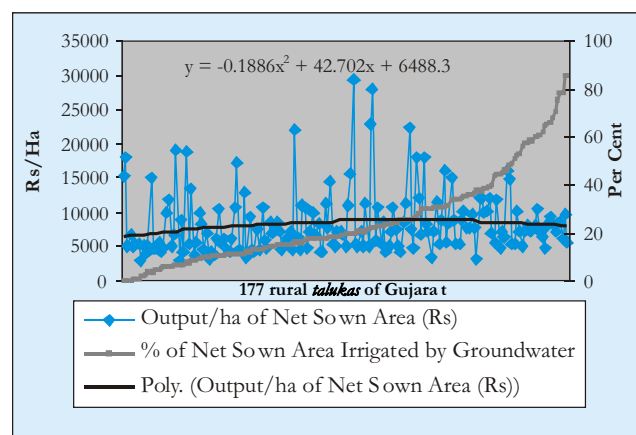


Figure 4: Land Productivity and Groundwater Irrigation



The canal irrigation proposed under Narmada project will raise the state's average FIRP by around Rs. 562 per person; but increased groundwater irrigation will contribute another Rs. 3410 to the state's average FIRP.

If all Narmada planning assumptions hold, the total increase of Rs. 3972 in the state's FIRP will help reduce the overall BPL ratio for rural Gujarat by 6.75 percent. In the case of canal irrigation, average output/net sown hectare increases steadily as the canal irrigation density increases in a *taluka*; however, in the case of groundwater, average land productivity rises up to a point and then plateaus off or even declines somewhat as the density of groundwater irrigation increases.

IRRIGATION DEVELOPMENT AND POPULATION PRESSURE ON FARM LAND

The key result of our empirical investigation is that whatever helps to raise the value of gross FIRP helps reduce the proportion of BPL households in that *taluka*. The Gujarat evidence suggests an inverse relationship between rural poverty and land productivity measured as value of output per net sown hectare. Our model also suggests that, the major route through which irrigation affects farm income and rural poverty is through increased land use intensity.

Irrigation benefits within command areas may approach a zero-sum game over long run because areas with intensive irrigation development act as magnets that attract poverty from their surround.

These gains of irrigation in terms of increased land use intensity are transient because over time population gets spatially redistributed in response to higher overall productivity of irrigated agriculture. In dry-land areas where the 'carrying capacity' of farm lands is low, land-man ratios tend to be higher; in contrast, in irrigated areas where carrying capacity of farm lands are higher, land-man ratios decline.

This is evident in Figure 5; at least some portion of irrigation benefits to farm households in

irrigation commands are nullified because they are shared amongst a larger number of heads.

Figure 5: Inverse Relation between Land Use Intensity and Farm Land Availability per Rural Person

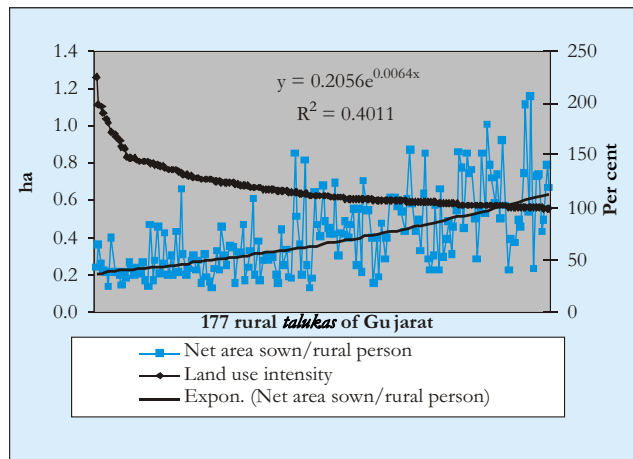
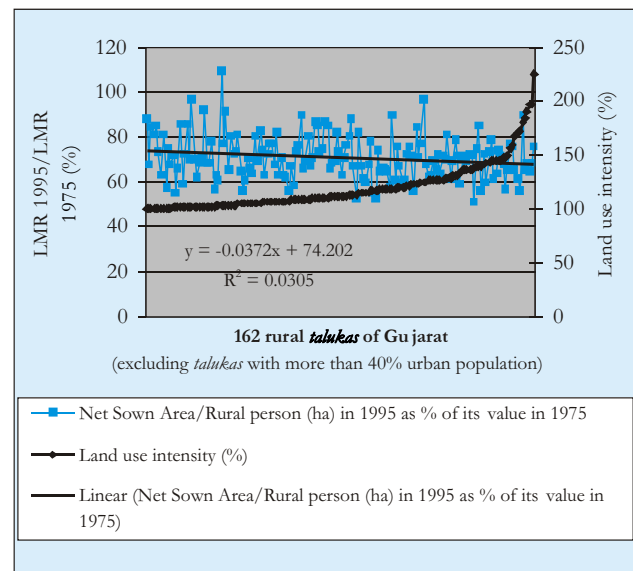


Figure 6: Decline in LMR with Rise in Land Use Intensity



It is possible that *talukas* we find having high irrigation density and land productivity were highly populated in the first place. But our contention is that there is a demographic process that has favored gradual increase in population pressure on high productivity lands and eased it in low productivity lands.

Figure 6 suggests that during the 20 years between 1975 and 1995, population pressure on irrigated lands has increased faster than on dry land *talukas*.

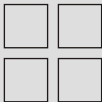
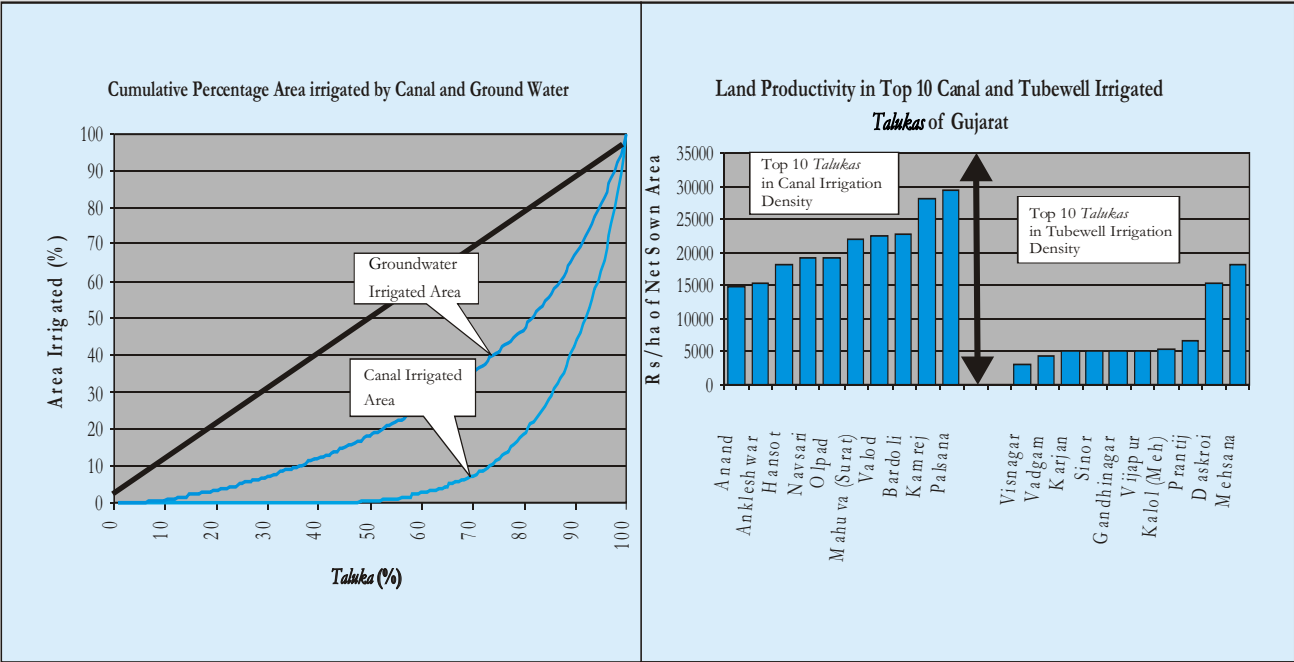
The analysis shows, among other things, that:

- Out of 10 highest BPL ratio *talukas* of Gujarat, eight *talukas* are dominated by tribal population with low irrigation density. Thus tribal *talukas* of Gujarat offer the largest opportunity for poverty reduction through irrigation.
- The proportion of urban to total population, farm land available per capita, index of farm land productivity, farm income per rural person, distance from the golden corridor, and the number of primary classes per village enter as significant determinants of the BPL ratio
- Some of the most important rural poverty reducers-such as urbanization and industrialization-have little relevance for design of rapid poverty-targeting interventions; electrification has large impact but most rural Gujarat is electrified as defined, leaving little incremental scope for using it for poverty reduction
- From the viewpoint of design of poverty reduction program, two variables hold appeal: investment in primary schooling infrastructure and improving gross farm income per rural person through increasing land productivity
- There is some evidence to suggest that irrigation benefits within command areas may approach a zero-sum game over long run and that irrigation impact studies focused at farm or command area level may understate the long term livelihood impacts of irrigation development. This is because areas with intensive irrigation development act as magnets that attract poverty from their surround
- Over a period of time, changing structure of rural population results in population-pressure rising faster (or declining at a slower rate) on intensively irrigated areas compared to dry land areas. The *taluka* level evidence from Gujarat does suggest a mild but definite tendency in the land/man ratio to rise in tandem with land use intensity.

INTENSIVE CANAL IRRIGATION: ALL FOR SOME; GROUNDWATER IRRIGATION: SOME FOR ALL.

Talukas in water-abundant central and south Gujarat, where the bulk of the net sown area is in the head reaches of Mahi-Kadana and Ukai-Kakrapar canal commands, irrigation's contribution to wealth creation is substantial, with gross output/ha ranging from Rs 15000-30,000. Agricultural prosperity here is dependent on water intensive crops such as sugarcane. In comparison, groundwater irrigated areas generate far less wealth.

However, only 5 percent of Gujarat's net sown area is served by canals. The rest of the state depends on either pure rainfed farming or some supplemental groundwater irrigation. When it comes to spatial distribution of gains from irrigation, canal systems imply 'all for some', whereas well irrigation means 'some for all'.



IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water-management approaches and current practices. These practices are assessed and synthesised for maximum policy impact in the series on Water Policy Research Highlights and IWMI-Tata Comments.

The policy program's website promotes the exchange of knowledge on water-resources management, within the research community and between researchers and policy makers in India.

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