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INTRODUCTION

India

In the next 40 years, an estimated increase in world population from 7 to 9 billion people will call for at least a 70% increase in food production[1]. This increase will have to take place in the face of rapidly diminishing natural resources – specifically water – as a result of global climate change and inefficient farming techniques.

Beginning in the mid-1950s, U.S.-sponsored agricultural research sparked the Green Revolution in South Asia, in the form of improved seed varieties combined with an increase in area under irrigation. These breakthroughs in agricultural technology and practices resulted in the most dramatic increase in agricultural yields and production in human history, allowing nations like India and Bangladesh to become nearly self-sufficient in food.[2]

Since then, farmers have shifted from basic food production to growing crops for more profit. This is using more water, taxing the old supply-driven irrigation system. This rate of exploitation is unsustainable for the future–Indian surveyors have divided the country into 5,723 geographic blocks, and more than 1,000 are considered either overexploited or critical, meaning more water is drawn on average from the ground than is replenished by rain.[3]

Gujarat

The region of focus, Gujarat, is the 5th richest state in India[4], and has one of the highest investments in irrigation infrastructure[5]. This has led it to vibrant and productive agricultural sector. However, Farmers in Gujarat have been farming in a far less sustainable way since the Green Revolution. Today the state faces acute water problems; "in such places (heavy agriculture states like Gujarat) aquifers are being depleted (mined) at a rate of 9-20 feet per year, with higher rates locally. Farm water use efficiencies are typically very low (5%–15%) given the subsidized provision of energy and water."[6]

The long-term effects of this have been observed in Gujarat, where farmers struggle to earn a livelihood amid a falling water table and soaring production costs. The farmers' current response to the water shortage has only exacerbated the problem, as they have to bore increasingly deep tube wells in order to continue supporting agriculture.

Existing Literature

Infrastructure Development:

Infrastructure is not an automatic solution; it depends on rainfall, can often adversely

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[1] Food and Agriculture Organization's Paper: *How to Feed the World in 2050.* Statistics. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

[2] GoodNewsIndia. "The Green Revolution in India." *The Green Revolution in India.* GoodNewsIndia, Nov. 2002. Web. 05 Aug. 2012. <http://www.goodnewsindia.com/Pages/content/milestones/greenRev.html>.

[3] - Somini Sengupta. "India Digs Deeper, but Wells Are Drying Up." *New York Times*, September 30, 2006. http://www.nytimes.com/2006/09/30/world/asia/30water2.html?pagewanted=all

[4] Gdp. (2012) India's top 20 states by GDP - Rediff.com Business. Retrieved August 15, 2012, from www.rediff.com/business/slide-show/slide-show-1-indias-top-20-states-by-gdp/20110722.htm

[5] (2012) Business Portal of India : Infrastructure : National Level Infrastructure : State Level Infrastructure. Retrieved August 15, 2012, from business.gov.in/infrastructure/state_level.php

[6] Leadership Group on Water Security in Asia. *Asia's Next Challenge: Securing the Region's Water Future*. Rept. Asia Society, 2009. PDF file.

impact communities, and is challenging to implement successfully.

An evaluation of dam construction in India found that downstream from a dam, cultivation of water-intensive crops increased.[7] In light of this, increased infrastructure may not be the most sustainable way to ensure the viability of agriculture in Gujarat, as it can dramatically affect communities both upstream and downstream from the proposed construction. The India Infrastructure report goes on, writing, "If overexploited areas in the upstream are supplemented with recharge structures, it may affect water availability (even for priority use, such as drinking) in the downstream projects."

The Narmada Canal System ostensibly serves the parts of Northern Gujarat that were surveyed. However, according to Rediff News, the system has been plagued with corruption when it comes to the construction of corollary canals, which would provide water to communities removed from the central canal.[8] The Indian Infrastructure report continues, "A bottom-up or decentralized regulation involving civic society and local communities and with a very limited role of the government could save transaction costs and get rid of political and bureaucratic corruption."

Check dams, in theory, are opportunities to harness more water from precipitation, and to recharge depleted aquifers. The India Infrastructure Report, published by the Government of India, "Besides arresting the depletion of water tables small decentralized water harvesting structures can capture more water and are a major alternative to conventional river basin water resource development." [9]However, the success of check dams is dependant on rain; there needs to be a healthy monsoon in order for them to fill up, and be effective at replenishing groundwater reserves, as exemplified by the 10 million rupee project (funded by a Non-Resident Indian) that has become a derelict ruin in Chadasna because there was never enough rain to fill it.

Infrastructure projects, and expansions, run the risk of being undercut by a lack of rain. The Narmada Canal system has dried up in certain places; preventing it from effectively supplying villages with much needed water for drinking and irrigation. [10]

Drip Irrigation:

Success of drip irrigation is dependant upon subsidies, awareness, access, and existing infrastructure.

The International Water management Institute has found, that there is a "slight difference in the poverty outreach of micro- irrigation technologies between Gujarat and Maharashtra due to differences in the support system: there are many NGOs operating in Gujarat."[11] In addition, "In Gujarat, the current micro-irrigation adopters are somewhat evenly distributed among the middle, rich and very rich groups." [12] However, "when the poverty outreach of micro-irrigation technologies was assessed it was revealed that the largest group of adopters were farmers that fall into the wealthier categories on one poverty

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7 DAMS. Esther Duflo and Rohini Pande. Harvard Kennedy School.

[8] Corruption has damaged Narmada canal system' - Rediff.com India News. Retrieved August 15, 2012, from www.rediff.com/news/report/corruption-has-damaged-narmada-canal-system/20110419.htm

[9] *INDIA INFRASTRUCTURE REPORT 2011 Water: Policy and Performance for Sustainable Development*. Rept. New Delhi: Oxford University Press, n.d. Print.

[10] Patel, Nitin. (2012) Slow work on Narmada dam might aggravate Gujarat water scarcity - Economic Times. Retrieved August 19, 2012, from articles.economictimes.indiatimes.com/2012-07-23/news/32804860_1_narmada-dam-water-scarcity-deficient-rains

[11] **.** International Water Management Institute (IWMI). 2006. ***Promoting micro-irrigation technologies that reduce poverty.*** Colombo, Sri Lanka: International Water Management Institute (IWMI).. 6p. (IWMI Water Policy Briefing 023) [doi]

[12] ibis

index.[13] It is still more expensive for small farmers to install drip irrigation; **"**Large cultivators may avail of a 35% subsidy for drip systems, and 40% for pipelines. There are also centrally administered programs that give subsidies to farmers for micro-irrigation technologies, but the rate is set at 25% for all farmers irrespective of their socioeconomic standing. Although these opportunities are available, actually procuring a system using one of these subsidies is a long and painful process. Farmers are often reluctant to engage state or central government subsidies for this reason."[14]

The technologies need to be accessible and affordable to the potential users. *Awareness or knowledge does not guarantee actual adoption unless the technologies are made accessible to the farmers through institutional support systems such as credit provisions and subsidies.*[15] Even when they are convinced about the returns, poor farmers might not be in a position to incur the huge capital costs due to poor access to credit facilities."[16]

Crop Changing

Crop changing is challenging as it depends on the trader buying crops.

Farmers of the scale surveyed are "small farmers," who, according to the National Resources Institute of India cannot directly bring vegetables and fruits to the mandis, which are unites of collection controlled by the Agricultural Produce Marketing Committee (APMC). Instead, small farmers need to sell their produce to a village commission agent who then sells it wholesale to the mandi. [17] The same report goes on to criticize the system, saying that mandis are "inefficient" and are and outmoded form of trade that is detrimental to both the farmer and trader. This system prevents the price determination of crops from being transparent, and makes it challenging for small-scale farmers to alter what they plant.

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[13] ibis
[14] **ibis**
[15] **ibis**
[16] **ibis**
[17] National Resources Institute. *The Rural Non-Farm Economy in India: Some Policy Issues*. N.p.: n.p., 2003. *National Resources Institute*. Web. 15 Aug. 2012. <http://www.nri.org/projects/rnfe/pub/papers/2752.pdf>.

CWC project in Gujarat

In response to the water crisis in Gujarat, the Columbia Water Center is studying and designing approaches to agriculture and water management in collaboration with the local electric utility, UGVCL. The effort is centered in Northern Gujarat to encourage farmers to use less water, and by extension, less electricity.

Farmers receive electricity at a subsidized rate, and use their allocated phase three power to draw water from their bore wells (tube wells). Farmers receive 8 hours of power for agriculture a day for a fixed price, which they consume in its entirety, as the cost is the same irrespective of the usage. Most farmers irrigate their fields by the flooding method instead of more efficient ways like drip irrigation.

The objective of the scheme is to help slow and reverse groundwater depletion. At the moment, farmers pay a bi-monthly flat rate to UGVCL based on the horsepower of their motor. Fees range from 3,000 to 15,000, and for most farmers, are non-refundable regardless of how much they eventually use. CWC/UGVCL implemented a scheme in April 2011 that seeks to incentivize water saving by offering farmers Rs. 2.50 for every kilowatt they save per hour. This translates, for example, to a Rs 100 gain, if a farmer with a 40 KW (kilowatt) pump chooses to not operate his pump for an hour. Theoretically, this should result in farmers investing in techniques like drip irrigation, and varying their crops, in order to use less electricity and thus draw less water to receive the monetary compensation offered by UGVCL/CWC.

The scheme's goal is to have farmers modify their planting and irrigation habits in order to save additional water. They are encouraged to do so by:

- Installing and Using drip irrigation systems
- Changing their crops
- Using tensiometers

To probe perceptions about the scheme, and seek suggestions for improvement get the farmers honest and unguarded opinions, a person ostensibly un-affiliated with the Columbia Water Center was sent to interview farmers both affiliated, and unaffiliated with the CWC/UGVCL scheme.

FIELD RESEARCH

Objective: To get the farmers honest and unguarded views on the Columbia Water Center/UGVCL scheme and to collect their ideas on how to improve the scheme. Questions were developed to assess:

- Farmers' perception of:
    - The gravity of the water problem
    - Water availability in the future
    - Outlook for farming in the short and long term
    - Feasibility of farming for future generations
- Farmers' responses to the increased difficulty of procuring water, and their:
    - Knowledge of any program to help them
    - View of how their fellow villagers and those in other villages are coping
- Farmers' assessment of what would improve the situation
    - Their ideal scheme
    - Actions they think would remedy or improve the water problem

Methodology

- *Geographical area and number of participants:* The study region covers a total geographical area of 180 sq. km. It forms a part of two districts: Mehsana and Gandhinagar, and three talukas (counties), Vijapur, Visnagar (in Mehsana district) and Mansa (in Gandhinagar district)
- Over 150 people were interviewed from July 5th through the 22nd. Approximately 25 of the farmers were part of the scheme (approximately because in a number of cases, the farmer interviewed was a stakeholder and not a tube well owner and was unaware of the intricacies of his billing.)
- Interviews were conducted in Gujarati, but noted in English.
- The field researcher was provided a list of the scheme participants in terms of the wells and their owners as well as a list of the control groups that was not participating.
- The field researcher was to avoid showing any "official" connection to the scheme in order to avoid any biases in responses. In order to ensure that the farmers were providing their unguarded and honest views, farmers were not told of a connection to the Columbia Water Center, or of any connection to the scheme put into place by UGVCL/CWC.
- Conversations were kept deliberately informal, and were conducted under the pretense of having a school project inquiring about the water situation and the drought.

Questioning patterns differed between villages, but followed the general outline of:

- The interviews would begin with the sar paanch of the village, and then he would recommend, or I'd ask to meet certain people that he had mentioned, or people that were actively using water saving techniques, and I would visit their farms, and speak with them. I also met with dairy collection officers, *Aangan Wadi* (town day-care center) teachers, and town accountants to understand how the water situation was affecting ancillary industries.
- Questions typically followed the thematic pattern delineated below, but were phrased in conversational Gujarati and in a casual tone:
    - Depth of tube wells
    - Prior tube well depth/amount
    - Fate of those without a well
    - Price of water/hour
    - Method of Billing
    - Means of conservation
    - Crop choice
    - Drip Irrigation
    - Irrigation techniques
    - Possible solutions
    - Government help
    - Program requirements
    - Ideal Program
    - Program flaws
    - Future vocation of children
    - Alternate sources of income
- This outline of questions was supplemented by requests for clarification and quantification

Observations

Perception of Current Situation

Village	Approximate Average Tube well Depth
Bilodra	~1000 feet deep
Vihar	~800 feet deep
Bapupura	~961 feet deep
Charada	~ 800 feet deep
Chadasna	~ 1000 feet deep
Kolawada	~ 800 feet deep
Fatehpura	~ 800 feet deep
Ubkhal	~ 1000 feet deep
Asnapura	~ 1000 feet deep
Gerita	~ 750 feet deep

Water levels have continued to fall in Northern Gujarat:

- As the aquifers descend, tube wells must follow suit, and the tube well owning farmers surveyed are noticing that their wells are only lasting for 2-5 years, as opposed to decades like they did in the 1970s
- The water at lower levels is known to be of a lesser quality, containing more fluoride, and being more salinated, resulting in pipes corroding sooner.
- Nearly all Farmers in the region receive phase three agricultural power at a subsidized rate. The majority of farmers pay a bi-monthly flat rate fee to UGVCL, and this fee varies based on the horsepower of the motor they are using. As they are forced to get water from deeper, they must increase the power of the motors they are using. Bore wells cost more than the average farmer can afford, so most farmers are part of a consortium that shares use of one tube well, which means that they receive power on a basis proportional to how much they invested in the building of the well.
- Tube wells are expensive to build; they cost around 1 million rupees, (18,500 USD). Each additional foot adds to the cost in terms of digging as well as additional piping. (Rs 650 rupees per additional foot of digging)
- The impacts of this are twofold
    - Production costs are increasing making it less lucrative to farm, to the point where for some farmers; it is cheaper to buy food than to grow it.
    - Tube wells need to be built with more partners in order for the division of cost to be feasible, thus, the individual farmers who cannot afford to invest a lot of capital receive less water than they need.
- In the area known as the “dark zone”, wells were dug 700-800 feet deep a few years ago, now, they are 800-1000 feet deep.
- *High level of awareness:* Though all farmers surveyed openly acknowledge the water crisis, and are well aware of the fact that they are contributing to falling water tables by boring tube wells, they continue to attempt to draw as much water as is possible within their energy constraints.
- *Not enough power/ water to save:* Eight hours of power is not perceived as enough by the majority of farmers. As a result of the dearth of water that is available to them, farmers do not maximize their yields, and they strongly feel that they should be getting more hours of power, in order for them to draw out more water and fully avail themselves of farming their land.

Means of Addressing the Problem

- Many farmers allow fields to lay fallow, or are planting for only 2 seasons
    - Building deeper tube wells
    - Selling water to other farmers as opposed to using it in ones own farming
    - Bilodra, 15% of land is left uncultivated
    - Chadasna, 70% of land is uncultivated.
    - Fatehpura, a village that has embraced the UGVCL/CWC scheme, 10% of land is left uncultivated during the summer
- Attempts at self financed infrastructure projects
    - Chadasna, with a donation of 10 million Rupees from a Non Resident Indian, built a huge dam to collect rainwater, and distribute it to people's farms. This construction occurred a decade ago, and since then, there has never been enough rain to fill the dam.
- Establishing supplementary sources of incomes
    - Reliance on dairy industry as opposed to agriculture[18]
        - Dairy industry is less water intensive, and provides a more regular income[19]
    - Women working outside the home as teachers
    - Men migrating to work in industrialized areas

Effectiveness of the Scheme

- The water saving scheme faces major barriers to success:
    - Perception that the current amount of water available is not enough
    - Civic duty/Social pressure to sell to those without tube wells as opposed to "saving"
    - Lack of capital/incentive to invest in water saving techniques like drip irrigation and other challenges to doing so

In every village, there are people who don't have a tube well and must buy water (by buying power) from their neighbors. In most villages, the rate that those without power are willing to pay is greater than the incentive offered by CWC/UGVCL. Even in villages where the rate is the same, like Fatehpura, most farmers will first sell to their neighbors out of a sense of civic duty, as Praveen Choudhary, a stakeholder in the Govabhai J. Chaudhari tube well said. The social pressure of selling to one's neighbors is greater than the monetary incentive offered by the UGVCL/CWC scheme. Furthermore, the potential of being socially ostracized if one puts profits over neighbors' needs is a key factor in nearly every farmer's decision calculus.

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[18] Mandhanna, Niharika. "Sluggish Monsoon Threatens India's Growth." *The New York Times* [New York] 10 Aug. 2012: n. pag. Web. 15 Aug. 2012. <http://india.blogs.nytimes.com/2012/08/10/sluggish-monsoon-threatens-indias-growth/>.

[19] Singh, O. P. *WATER PRODUCTIVITY OF MILK PRODUCTION IN NORTH GUJARAT, WESTERN INDIA*. N.p.: n.p., n.d. *International Water Management Institute*. Web. 16 Aug. 2012. <http://rwes.dpri.kyoto-u.ac.jp/~tanaka/APHW/APHW2004/proceedings/SUW/56-SUW-A281/56-SUW-A281.pdf>.

Town	Cost to buy water
Bilodra	140 rs/hour
Vihar	100 rs/hour
Bapupura	120 rs/hour
Charada	150 rs/hour
Chadasna	200 rs/hour
Kolawada	150 rs/hour
Fatehpura	100 rs/hour
Ubkhal	100 rs/hour
Patelpura	400 rs/hour
Asnapura	100 rs/hour
Gerita	180-200 rs/hour

Model Town: Only in Fatehpura did a majority of farmers agree that they could plan to save enough water to sell it first to their neighbors and then get rewarded by CWC/UGVCL. The success of Fatehpura is attributable to multiple factors:

- The homogeneity of the community
    - All belong to the same faith (Radhasoami)
    - Meet twice a week for religious/social discussions
- External education support from the Aatma project
    - The Aatma project is an agricultural education program that is being piloted in villages around Gujarat, and Fatehpura is a village where it's being tested
- High education level
    - Fatehpura's high school is Nirma rated, certifying it as one of the most progressive public school systems in Gujarat.

Drip Irrigation Usage:

- Use of drip irrigation and tensiometers in Fatehpura: farmers surveyed spoke highly of drip irrigation, and enthusiastically about how it had helped them initially, but complained about the challenges of maintenance.
- In Asnapura: according to Ranaji Thakor, the sar paanch of the village, 75% of the village's farmers installed drip irrigation, but later the maintenance was too time consuming, and fewer people continued using it.
- *In other villages, farmers who were not using drip had excuses for not doing so:*
    - It is expensive to install for a small plot of land
    - Drip systems need to be removed to plow the land
    - Government subsidies and the CWC/UGVCL scheme don't provide enough of an incentive to do so, or don't apply to the tribe/caste of the farmer
    - Wild boars and pigs often overrun and destroy drip irrigation systems, because the government doesn't do an adequate job of keeping wild animals in check.
        - Rats nibble at the drip irrigation tubes
- What savings have occurred through the scheme for farmers have been primarily because they 'saved water' because it rained, and they didn't need to use their tube well to draw water, or the motor needed repair, and they had no way of drawing water.

For example, a farmer in Fatehpura received back his entire UGVCL bill during the monsoon, because he never needed to power up his tube well.

- Many Farmers have already been adapting themselves to the changes in the amount of water and power available to them prior to the scheme being introduced. They were coping by:
    - Investing in cows to develop a dairy business
    - Farming a smaller portion of their land
    - Planting less water intensive crops such as castor, potatoes, guar gum, and ground nut, which are still in demand by traders
    - Exploring alternate sources of income

Crop Changes:

No farmers admitted to having altered what they plant specificallbecause of the scheme. The crops currently being planted by farmers are already low in water usage[20]:

- Castor
    - 500 mm water required
    - ~5 irrigations
    - Increasingly common
- Potatoes
    - During the monsoon
    - 500-700 mm water required
- Cotton
    - During the monsoon
    - 700-1300 mm water required
- Guar gum[21]
    - Requires only 3-4 irrigations
    - 203-380 mm water required
    - Increasingly common
- Wheat
    - 450-650 mm water required
- Groundnut
    - 500-700 mm water required
- Fodder

"Ideal Solution"

To 15% of farmers, the 'ideal solution' would be a scheme similar to the one proposed by CWC/UGVCL, but one whose compensations per kilowatt were higher.

The more common answer was that government infrastructure, in the form of canals, check dams, recharge canals, would provide them with more water. Every farmer's ideal solution included receiving more rainfall, which they felt was beyond their control.

Many Farmers view the 8 hours of power they receive as too little, though they are all aware that aquifers have gone down in the last two decades. Manoj ji Chawla of Bilodra talked about how although farmers are growing low water-intensity crops like castor, they still don't have enough water to grow those properly, since their power is restricted.

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[20] "Irrigation Water Requirement of Crops." *Civil Engineering*. N.p., n.d. Web. 15 Aug. 2012. <http://www.aboutcivil.org/water-requirements-of-crops.html>.

[21] *Report on Guar Seed*. Rept. Ahmedabad: NATIONAL MULTI?COMMODITY EXCHANGE OF INDIA, n.d. Print.

Fate of future generations

Village	Will children remain in farms?
Bilodra	No
Vihar	No
Bapupura	No
Charada	No
Chadasna	No
Kolawada	No
Fatehpura	No
Ubkhal	No
Asnapura	No
Gerita	No
Patelpura	No

Farmers unanimously want their children to leave the village for higher education, and to become professionals. Every person interviewed said their children would not farm, because they do not expect farming to be a viable occupation, as they are very aware of the decreasing availability of water. The ultimate goal for future generations, and for those still young enough, is to migrate to cities such as Ahmadabad and Mumbai, or abroad. As many families have either migrated abroad and left their homes empty, or work in industrialized areas, the population of every village except Gerita is decreasing.

- In Ubkhal, of 200 homes, 140 households have moved away to Ahmadabad, and other neighboring towns.
- Fatehpura's population has dropped from 4,000 to 1,175 because of an exodus
- Men in Bilodra join the police force and army in large numbers
- In Bilodra, 15% of the land is left uncultivated because men have left
-

Village	Percent Migrated in the last 15 years
Charada	58%
Kolawada	70-80%
Fatehpura	70%
Ubkhal	70%

- **Disparity of resources:** Just 20 or so kilometers away from the dark zone is the Narmada Canal, and farmers close to it can access its water. Every thirty meters on the canal are motors, pumping water from the canal into the surrounding farms. Hearing about these kinds of antics, farmers in the dark zone are resentful of their constricuted supply of power and water. This leads to an attitude of maximizing all available resources, since they find it unfair that they are forced to bear the brunt of conservation.

- **Merchants set prices**: In Bilodra, the Sar Panch (village head), Ishvar Singh Thakur, explained that commodity merchants from the larger cities set the price that crops command. As power and thus farming prices soar, it is less feasible to earn a living through only agriculture.

- **Decision Making:** Tube wells often have multiple stake holders, who have each invested a certain percentage into the construction. Since the prices of building a well has gone up, they now have 15-20 stake holders, making it difficult to reach a consensus on billing.

- **Wealth is illusory**: As the sar paanch of Fatepura, Narayanbhai Choudhary, said, all the wealth and greenery is an illusion, built by tube wells, and one that is precarious.

  - Material wealth in villages (fridges, TVs, concrete homes) is derived from the dairy industry. Each village has a milk collection center, and a number of farmers have abandoned crop farming in favor of dairy farming. In this case, those farmers use the tube-well water to grow grass to feed cows.
  - Anecdotally, farmers growing fodder for the dairy industry complain that they don't have enough water to do so. The dearth of water affects not only crop farming, but also ancillary industries like the dairy industry, thus highlighting the dependence on water.

- **Holding on to land in the hope of appreciation**: Many are maintaining their farms in order to sell them later. A man from Ahmadabad who was building a tube well in Bapupura noted that many, including him, have inherited land, and are trying to keep it relatively green and fertile as they wait for land prices to rise because of approaching industrialization.

- **Other utilities**: Power at home is available 24 hours a day and is paid for based on metered usage. Water is available for an hour in the morning and an hour in the evening. A low annuity is demanded of all households in order to pay for town lighting as well as the town water supply. Filtered drinking water is available for purchase at a monthly rate ranging from 50-70 Rupees for 10 Liters a day. Water filtration plants are subsidized by the government, and maintained by the township.

- **Shifting Responsibility**: Farmers tended to blame their current situation on *sarkar,* the government. They view the solution to their water problems as infrastructure, funded by the government, and more hours of power, funded by the government. Many farmers expect canals and dams to be the panacea to their woes, and they complain that they are denied access to the Narmada dam, and that the government is deaf to their cries for help. This seems largely true.

- **Disillusionment**: Most people are disillusioned within this region, and regard schemes in general with cynicism and suspicion. They are aware of the un-sustainability of their current agricultural practices, but continue anyways, citing as their reason the need to eat and to provide for their family. When asked if they thought their children would succeed them as farmers, every person responded with a resounding no. Farmers are encouraging their children to pursue higher education, and each proudly talk about how their child was succeeding academically, and told us stories of how other villagers had prospered by studying, working in industries or as professionals, and migrating overseas for work. A sizable cohort of farmers realize that land is gaining valuable as Gujarat is increasingly industrialized, and many who were interviewed said that they were cultivating the land in order to have it retain its value in the future.

ANALYSIS

Certain question phrases were negatively framed, and implied a preconceived view of the water situation. This may have led farmers to provide me with a bleaker picture of the situation in their village. Improved versions of these questions would be more neutral.

- "How many tube wells have you had already?"
  - Phrasing the question as "have you had past tube wells?" would have prompted an answer about past depth, without the assumption of a deteriorating situation.
- How do you take advantage of the program?"
  - There is an implication that the question is asking how they take advantage of the scheme without actually reducing water usage
  - The word scheme was deliberately not used
  - A more effective phrasing would have been, "What does the scheme require you to do?" which would have been more specific to what farmers were doing, or not doing to avail themselves of the scheme.

A few phrasings assumed certain conditions and cohorts existed, which could have prompted farmers to agree even if their experience differed.

- "What happens to people who can't afford to buy a stake in a tube well?"
  - This was asked without a prior question asking whether there are any people who pay for water, which could have skewed the results. A more effective phrasing could have been, "Do you know anyone who doesn't have a tube well?"

Questions that were too broad allowed for a great deal of speculative answers, rather than responses based on true experiences.

- "How do you use less water?"
  - This question led to expressions of the sentiment that the government is not doing enough to help farmers. An alternate phrasing would have been, "What are you doing to cope with less water?"
- "How can this problem be fixed?"
  - The phrasing of the question allowed respondents to bypass any personal responsibility, and solely discuss the role the government has to play.
  - A more effective phrasing would have been "What are you doing to make the problem less severe?" which would have led to responses that were more focused on what could be done at the village level.

Conversely, questions that limited farmers to certain responses may have limited the information gathered, and led to responses being re-enforcements of existing knowledge, rather than new information.

- "Do you use drip irrigation?"
  - This could have been phrased, "How do you irrigate," which would have elicited answers that discussed more than drip irrigation.

In some cases, the scope of the question allowed responses to supplement their answer in a way that provided important data that wasn't necessarily relevant to the question at hand, but provided important information.

- "Do you think your children will farm?"

- The responses to this incorporated views about the viability of farming, the perceived future of water, and of rising expectations, and goals for children.

The constraint of having to hide any association from the CWC project presented a challenge, but also allowed me to gain, what I hope is, more accurate, and honest information. It was difficult to identify which farmers were legitimately associated with the scheme, since names of people interviewed didn't always correlate with the data given; this was, in many cases, because those interviewed were not tube well owners, but people who had paid a percentage to be a partial owner.

CONCLUSION

1. There is a high level of awareness about the gravity of the water problem across villages, and widespread knowledge that farmers are exacerbating the situation. Outlooks about water availability in the future are bleak, with farmers predominantly taking a short-term approach to maximize their water usage while it is still available. This attitude is apparent in the unanimously held view that future generations will not continue farming for a livelihood.

2. In response to the increased difficulty of procuring enough water, farmers have adapted by planting less of their land, abandoning agriculture in favor of dairy, taking up industrial jobs, and encouraging women to work outside the home. The Gujarat government's micro-finance initiatives directed towards women have given families the capital necessary to start small businesses.

3. The scheme, applied the same way, differs greatly in its effectiveness across villages. The scheme has been most successful at Fatehpura, which has a homogenous population, an education level that is relatively high and where the water situation has not yet reached the point where people are completely disillusioned. On the other end is Chadasna, where the intervention has come at a point where people are not looking to salvage agriculture.

4. The CWC/UGVCL scheme faces a variety of challenges: Knowledge of the CWC/UGVCL scheme is not widespread; only about 17% of farmers surveyed knew of it. This is linked to sample size, but nonetheless, it demonstrates the disconnect between well owners and those who own a share of a well, or do not own one at all. A common response to why water isn't being conserved, is that any extra water is sold to those who don't have tube wells, even if they don't pay the same rate as CWC/UGVCL, because the social pressure of doing so outweighs the monetary incentive offered by the scheme. If the compensation was increased this would affect the decision calculus of farmers, but it would also put those without access to a tube well at risk of being left behind.

5. CWC/UGVCL's scheme depends on a host of external factors, such as subsidies for drip irrigation, prices set by traders for crops, and the price and pressure to sell water to those who don't own tube wells.