Nature's Call: Can social mobilization promote toilet use and improve welfare? Results from a field experiment in Orissa, India

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ABSTRACT

A subset of the Millennium Development Goals reflect the world's collective hope and resolve to reverse a particularly pernicious, pervasive, and persistent set of problems in much of the developing world: high rates of diarrhea (the number one killer of small children), insufficient water and sanitation services, and seemingly unsafe, inadequate, and myopic behaviors. How can we change this? This paper uses a community field experiment in rural Orissa, India to gain insight into household-level decisions to build and use individual household latrines and to examine the welfare impacts of sanitation improvements. We outline a generalizable theory of health- and sanitation-related behavior change, highlighting a number of factors that may affect the perceived costs and benefits of adopting a new behavior, and explain how our experiment provided an exogenous shock to different components of households' utility functions. Our data show that the sanitation campaign had a substantial impact on latrine adoption and use. Using a difference-in-differences estimator, we find that the intervention increased latrine uptake by about 30%. This increase in latrine ownership, in turn, may have reduced child diarrhea and associated costs, although these results are less robust to different model specifications. We also investigate the role of social interactions in driving latrine adoption in the study area, and find some evidence that expected adoption by community members may have a significant and positive effect on a household's own adoption decision. Taken together, these results highlight the importance of understanding the motivators of household decisions in designing and implementing health and development interventions.

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I. Introduction

The prevention of diseases and provision of basic needs such as water and sanitation are important development goals in their own right, and there are also well-established links between health improvements and increased economic welfare (e.g., Strauss & Thomas 1998, Smith 1999, Gallup & Sachs 2001). The importance of these issues is reflected in the Millennium Development Goals (MDG) of reducing child mortality, combating infectious diseases and halving the number of people without access to basic water and sanitation services by 2015 (United Nations 2006). These MDGs also reflect the world's collective hope (and resolve) to reverse a particularly pernicious, pervasive, and persistent set of problems in much of the developing world, including a boisterous and emerging market economy such as India: high rates of diarrhea (the number one killer of small children), insufficient water and sanitation services, and seemingly unsafe, inadequate, and myopic behaviors. How can we change this?

This paper examines health-related behavior change and its impact on diarrheal diseases in the context of a field experiment in rural Orissa, India. The Government of India has adopted a nationwide Total Sanitation Campaign (TSC) which is intended to improve sanitation conditions throughout the country. However, sanitation coverage remains low – in India as a whole, less than 25% of the population has access to safe water and sanitation (DDWS 2004), and this number is even lower (less than 10%) in the state of Orissa (ODS, 1998-99) – the location of our study. These low levels of sanitation may contribute to poor health outcomes and high child mortality (Wang 2002, Murray & Lopez 1996), although these claims are not necessarily based on a long list of systematic and rigorous evaluations (Fewtrell et al., 2005; Poulos et al., 2006).

Several key knowledge gaps limit our understanding of these persistent sanitation and health challenges, thereby limiting current efforts to overcome them in Orissa and beyond. We present results from a randomized, community-level sanitation experiment to address these knowledge gaps. First, the study provides important information on the links between sanitation improvements, health outcomes and economic welfare. A recent meta-analysis by Fewtrell et al. (2005) identified only four studies conducted between 1970 and 2003 that examined the effect of sanitation interventions on health (diarrhea or cholera) outcomes in developing countries. Of these four studies, only one (Daniels et al. 1990) was considered to be of good quality by the meta-analysis team. While the Daniels et al. study did find that latrine installation significantly reduced diarrhea rates in the study area (rural Lesotho), Fewtrell et al. (2005) highlight the need for additional studies examining sanitation interventions in different contexts.

Second, the intervention we study employs a unique combination of social mobilization techniques aimed at generating demand for sanitation and motivating behavior change at the household level. While the need for these "participatory" and "community-based" approaches to development is now well accepted (e.g., Cairncross 2003), there is little rigorous measurement of the effectiveness of community-based approaches (Mansuri and

Rao, 2004). The design of this study allows us to evaluate the impact of one community-based intervention package on sanitation and health outcomes.

Third, the infectious nature of diarrheal diseases (and the associated externalities) suggests that households may not find it in their own self interest to engage in socially optimal prevention (and cure) if they believe they can "free ride" on the contributions of others (Beach et al., 2006). As Gersovitz and Hammer (2003) argue, prevention and infection externalities will be rife. Social interactions (e.g., social preferences, in general, as well as specific information and education) that are independent of the epidemiological channels can help blunt (or exacerbate) the negative externalities. Unfortunately, there are no known rigorous econometric estimates of the nature and extent of these externalities. We estimate these directly by using detailed data on knowledge, prevention, and infection that is collected at the household and community levels at different points in time.

Fourth, by employing one of the most rigorous impact evaluation methods (a randomized field experiment), we respond to recent calls for careful and systematic assessment of interventions for economic development (Duflo and Kremer, 2004). In the water and sanitation sector in particular, there have been no peer-reviewed rigorous scientific impact evaluation that utilize some mix of control groups, baselines, and covariates to establish the counterfactual scenario and permit the estimation of program impacts (McKenzie and Ray, 2005; Poulos et al., 2006). Thus, this expands the contexts for applying field experiments (Harrison and List, 2004).

Finally, we use the results of this study to shed light on the drivers of households' latrine adoption decisions. Notwithstanding significant global attention on household water and sanitation behaviors, there is astonishingly little formal conceptual modeling by economists of seemingly mundane, universal and routine (daily) behaviors. We outline a theory of health- and sanitation-related behavior change, highlighting a number of factors that may affect the perceived costs and benefits of adopting a new behavior. The model is relevant to a general class of choices made by households to reduce their exposure to environmental risks such as water contamination through microbial pathogens and air pollution (indoor and ambient), which are blamed for some of the most pernicious health problems - malaria, diarrhea, ARI - in the developing world (Smith, 1999). The infectious nature of these diseases (and the associated public good problem) creates the rationale for public policy analysis and the design and use of social incentives such as the social mobilization experiment in Bhadrak, Orissa. We explain how the intervention employed in this study incorporates aspects of this theory, and use the theory to analyze the impacts of this campaign.

The remainder of the paper is organized as follows.[2] The second section presents a simple model of latrine adoption decisions, which is used to explain potential barriers to latrine adoption. The third section describes the sanitation experiment in light of this theory, describing how it targets different barriers and provides an exogenous "shock" intended to increase latrine uptake. The fourth section briefly describes the location of the study in rural Bhadrak district, Orissa, and outlines the empirical study design. The fifth section presents the study's results. We analyze the intervention's impacts, and find large and statistically significant effects on latrine adoption and use. We also employ several different estimation strategies to analyze the impact of latrine use on child diarrhea rates, and find some evidence that these health outcomes improved as a result of the campaign. We also examine impacts on a variety of averting behaviors and associated costs. We find evidence of prevention externalities (community sanitation impact individual diarrhea outcomes) and of infection externalities (*i.e.*, community infection levels impact household sanitation choices and individual diarrhea outcomes). Impacts on sanitation-related knowledge and beliefs are also presented, as well as indicators of "social preferences" which may play an important role in households' latrine adoption decisions. We also investigate the role of social interactions in driving latrine adoption in the study area, and find some evidence that expected adoption by community members may have a significant and positive effect on a household's own adoption decision. A summary of key results and conclusions are presented in the sixth section.

II. The Simple Analytics of Demand for Toilets

The purpose of this study was to measure the impact of an intensive sanitation-promotion campaign, and to gain a better understanding of "what works" to encourage uptake of individual household latrines (IHLs). In order to address this question, it is helpful to outline a basic theory of latrine adoption. A simple economic explanation of households' decision to adopt latrines, or any other good, is that households will decide in favor of adoption when the perceived benefits of latrine use outweigh the perceived costs. Of course, in order for this explanation to have any practical meaning or predictive power, we need a better understanding of the "benefits" and "costs" that households consider.

The conceptual underpinnings of toilet demand are a special case of utility maximization theory—the household production model. This section presents a stylized model of toilet demand as the outcome of a process of utility maximization by households facing budget, time, and production constraints. Following Pattanayak et al. (2005), and Pattanayak and Whitehead (2006), we adapt the averting behavior models (also called defensive expenditure or coping costs models) described in Dickie and Gerking (1991). Furthermore, drawing on Udry's (2003) suggestion for iterating between theory and

[2] A companion paper (Pattanayak et al., 2006a) presents a richer description of the motivation for the overall study, the baseline findings, the intervention, and much of the background for this paper. This paper focuses on the early results of a randomized intensive information, education and communication campaign.

fieldwork in model formulation, we also draw on field observations and interviews with policymakers and village members in our study location to clarify this model. We treat the construction and use of IHLs as a type of averting activity that is conceptually equivalent to the self-insurance and self-protection idea in Ehlrich and Becker (1972). Thus, IHLs can be considered as one among a portfolio of utility yielding technologies (or input mixes), which also include construction and use of wells and rainwater harvesting schemes; safe handling and treatment of drinking water; handwashing; and medicines, doctor visits, and hospital care. To keep things simple, we focus on IHLs and not the entire vector of averting behaviors.

Constrained Utility Maximization[3]

Under this logic, households "produce" utility-yielding services such as health by combining their labor, money, capital, and environmental inputs. Consider the following stylized model that briefly summarizes the theory underlying coping costs. A typical household maximizes utility by allocating its time and income budgets to leisure (T1), health (S), and a composite consumption good (Z), for example, money. Health is measured by the number of days household members are sick. This utility is conditional on preference parameters (θ) that characterize the shape of the utility curve, usually proxied by socioeconomic data. Although we are using a stylized static model of a self-interested individual (or unitary household), θ can be conceived of as a place holder for common aspects of preferences such as discount rates (*i.e.*, inter-temporal tradeoffs), risk aversion, and other-regarding behaviors (e.g., altruism).

Utility is maximized subject to two constraints. First, the household faces a health production function that is twice-differentiable, continuous, and convex. Health (H) depends on environmental quality (Q) and the extent of coping (a). Q is a vector of water quality (i.e., free of biological and chemical contaminants that cause sickness) and quantity (i.e., daily access to a minimum volume of water) elements. Of course, in order for Q to enter the production function, households must be aware of the links between poor sanitation and health. Interviews with village members indicated that most people were aware of the links between open defecation and diseases like diarrhea, typhoid, and cholera, and in the baseline survey we conducted prior to the sanitation intervention, over 90% of household respondents cited open defecation as a cause of diarrhea.[4]Here we are using a rational expectations formulation of how risks are perceived and acted upon; that is, or economic agents accurately identify, estimate and forecast disease risks. However,

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[3] See Larson and Gnedenko (1998), McConnell and Rosado (2000), Larson and Rosen (2002) and Dasgupta (2004) for other examples of this type of micro-econometric modeling applied to environmental risks in developing countries.

[4] Several previous sanitation campaigns focused on educating households on this "germ theory," believing that this was a key barrier to latrine adoption. However, these campaigns often failed to motivate behavior change (Kar, 2003). In our study area it does not appear that this knowledge is an important barrier to latrine adoption.

this approach is not central to our analysis and, as will be revealed in the discussion of the data, we certainly have a wealth of information on knowledge and attitudes to develop alternative approaches to risk perceptions.

Q depends on public policies (G) such as the expansion of infrastructure networks and hygiene education campaigns. Q also obviously depends on the extent of averting behaviors in the community (A). For example, open defecation contributes to poor water quality, and flies may transmit openly available fecal matter to food and drinking water sources.[5] If the community water is not potable, reliable, or sufficient, then households must engage in a greater amount and possibly wider variety of averting behaviors - *a*. These averting goods and services depend on time (T2) and material (M) inputs. Water quality and therefore household use also depend on the household's technical know how (K), for example, about the optimal location and pit depth of IHLs and the design and materials used to aerate the structure, while sealing for water contamination. However, *a* is not a perfect substitute or complement for Q.

The resulting averting good, e.g., IHL, can also contribute directly to household utility, i.e., not through the health pathway. For example, women may benefit from the privacy, security and convenience afforded by an IHL, instead of having to wake up early in the morning, walk long distances, and always travel and defecate in the company of other women. For example, Jenkins & Curtis (2005) studied the motives for latrine construction in rural Benin, and found that "prestige" and "well-being" goals, such as identifying with the urban elite or increasing convenience and comfort, played a more important role than avoidance of fecal-oral disease transmission per se. Similarly, in interviews with village members in Bhadrak, "privacy," "dignity," and "convenience" were often mentioned as reasons for building or wanting to build latrines. Other people cited disadvantages of latrine use, such as bad odor or presence of flies and mosquitoes.[6] Many of these psychic benefits (or costs) of IHL use are socially defined and dependent on community customs, culture, and beliefs. We would expect peer reference groups to have a strong influence on households' desire for things like privacy, and the notion that using a latrine is more "dignified" than practicing open defecation is a social construct. To the extent that these factors play a role in households' adoption decisions, we would

[5] To the extent that health risks operate through these community-level pathways, the actions of any individual household will have only a small impact on expected health outcomes. In this case, averting behaviors act as a contribution toward a public good of "village cleanliness," with the associated problems of free-riding and collective action. Moreover, IHL use itself may be perceived to entail health risks, for example, if many of these are inappropriately located very close to wells.

[6] A few people we spoke with said that open defecation was a tradition, even something they enjoyed doing. In one village, a man told us that, "If it was good enough for the Maharajas, it's good enough for me." In another village, women said that going out together in the evenings for open defecation gave them a chance to spend time together and gossip. These statements suggest that there may be psychological costs associated with breaking with tradition and establishing a new practice.

expect these decisions to be characterized by social interactions (Manski 1993, Moffitt 2001, Brock & Durlauf 2001).

Second, households face a budget constraint: expenditures on consumption items (Z and T1) and household production inputs (T2 and M) must be no greater than the sum of exogenous and earned income (E). Earned income is limited by the total amount of time available to the household (T), which is spent on leisure (T1), coping (T2), or being sick (S). All prices are normalized by the price of Z. Without loss of generality, we assume that the time constraint and the health production constraint are binding and therefore use a full income constraint below. The Lagrangian for this problem (ℓ) is presented in Equation 1, where μ and λ are Lagrangian multipliers that represent the marginal utility of income and averting behavior.

$$\begin{aligned} L_{T_1,T_2,Z,M,\lambda,\mu} &= Max \;\; U[T_1, Z, S(a, Q\{G, A\}), a; \theta] \\ -\lambda[f(a, T_2, M; K)] + &\quad \mu[E + w(T - S - T_1 - T_2,) - p.M - Z] \end{aligned} \qquad (1)$$

The first-order conditions of this utility maximization are presented in Equations 2 to 8.

$$\begin{bmatrix} L_{T1} \\ L_Z \\ L_a \\ L_M \\ L_{T2} \\ L_\lambda \\ L_\mu \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} U_{T1} - \mu \cdot w \\ U_Z - \mu \\ U_a + U_S.S_a - \lambda \cdot f_a \\ -\lambda f_M - \mu \cdot p \\ -\lambda f_{T2} - \mu \cdot w \\ f(a, T_2, M) \\ E + w(T - S - T_1 - T_2,) - p.M - Z \end{bmatrix} \Rightarrow \begin{bmatrix} T_1 * (p, w, \theta, K, E, Q[G, A]) \\ Z * (p, w, \theta, K, E, Q[G, A]) \\ a * (p, w, \theta, K, E, Q[G, A]) \\ M * (p, w, \theta, K, E, Q[G, A]) \\ T_2 * (p, w, \theta, K, E, Q[G, A]) \\ \lambda * (p, w, \theta, K, E, Q[G, A]) \\ \mu * (p, w, \theta, K, E, Q[G, A]) \end{bmatrix} \ldots \begin{pmatrix} 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \end{pmatrix}$$

Simultaneous solution of the first-order conditions of this Lagrangian determines optimal consumption of S, Z, and T1 based on the optimal amount of a. In essence, time and money are allocated so that marginal opportunity costs are equal to marginal utility of consumption generated by these efforts.

T1, Z, M, T2, and the resulting levels of S and a can thus be described as a function of opportunity cost of time (w), price of averting inputs (p), preference proxies such as exogenous household characteristics (θ), technical know how (K), exogenous income (E), and government policies (G) and community averting behavior that determine environmental quality (A)—all exogenous to the household.

For three reasons, we follow Wolfe and Behrman (1982) in presenting a reduced-form characterization of optimal choices in Equations 2 through 8 (instead of a structural representation). First, the choice of functional form for a structural representation of all epidemiologic and economic functions would be arbitrary. Second, the resulting analytical expressions would be sufficiently complex that the signs of most partial derivatives would be indeterminate without very specific information not only about the functional forms but also about the magnitudes of all of the parameters. Finally, without good measures of pain and suffering, especially in monetary terms, we do not have the data to estimate the complete system. By relying on a reduced-form model, we are essentially following all the prior empirical studies on averting behaviors related to inadequate and contaminated water supply (see Pattanayak et al. [2005] for the full list of papers).

However, we are interested in a better understanding of the determinants of *a* (i.e., IHL) than is represented in equation 4. To better interpret this Marshallian equi-marginal condition, we can re-write it as equation 4a.

$$U_a + U_S . S_a = \lambda \cdot f_a \qquad (4a)$$

The left hand side represents the marginal benefits of constructing and using IHLs – these include psychic benefits (safety, privacy, convenience) and health effects. To get a clearer intuition for the costs, we can totally differentiate equation 7 to obtain 7a, which is essentially the marginal production of averting goods through more time and materials.

$$- f_a = f_{T2} . a_{T2} + f_M . a_M \qquad (7a)$$

Re-writing equations 5 and 6, as 5a and 6a

$$f_M = -\frac{\mu \cdot p}{\lambda}$$

$$f_{T2} = -\frac{\mu \cdot w}{\lambda} \qquad (5a, 6a)$$

and replacing fT2 and fM in 7a, and the replacing for fa in 4a, we get 4b.

$$\frac{U_a + U_S . S_a}{\mu} = w \cdot a_{T2} + p \cdot a_M \qquad (4b)$$

Now the marginal benefits are written in money terms (by normalizing by the marginal utility of money) and the marginal costs are the marginal productivity of time and materials in IHL construction and use in terms of their opportunity cost. Equation 4b represents the classical Marshallian interior solution: household will invest time and money in building and using IHLs up to the level that the costs are equal to the perceived psychic and health benefits of IHL.

Some Predictions

As Pattanayak et al. (2005) illustrate, this model can also be used to derive a micro-economic measure of the value of improved Q as the sum of four economic concepts - coping expenditures, cost of illness, opportunity costs of lost work days, and monetary value of pain and suffering. This derivation of the willingness-to-pay (WTP) for improving Q (e.g., reducing community microbial contamination) is based on a comparative static analysis of coping activities attributable to inadequate and poor quality water. Thus, it is relevant to a technology such as IHL, which can improve Q by diminishing household exposure to microbial contamination.

Prior to the sanitation intervention, latrine coverage was quite low in the 40 villages we study in rural Bhadrak. Overall, less than 10% of surveyed households had latrines. Based on the model outlined here, what can we say about the potential reasons for this initially low level of adoption? Moreover, what are the model's recommendations for increasing households' demand for latrines? Following Pattanayak et al. (2005), we can conduct comparative static analysis with equation 4b to understand how demand for IHL would respond to the constituents of the marginal benefits and costs, for example, by taking total derivatives of Equation 4b with respect to say K – an shift in technical know how through an exogenous training and information campaign of the kind discussed in this paper. Instead, perhaps an intuitive explanation of some key policy-amenable drivers is sufficient. Demand for IHL will expand if:

1. time and materials are subsidized
2. technical know how is enhanced to improve the quality of IHL
3. non-health aspects of IHLs such as dignity, privacy, and security are clarified and perceived
4. health benefits of IHL are well understood
5. social norms shift (in favor of IHLs)

This last prediction needs some further clarification. If households know about the potential benefits of latrine use and have the ability to adopt this technology, another important factor influencing household decisions will be the expected actions of other households. If households place a high value on village cleanliness, they face a typical public goods problem where the expected benefits of individual action may be quite low since each household has an incentive to free ride. *Social norms* may help to overcome the collective action problem (Sethi & Somanathan 1996) by establishing a set of common expectations about others' actions. However, persistent social norms that, for example, establish open defecation as the "accepted" practice may act as additional barriers to latrine adoption, especially where households have a strong preference toward conformism.

III. The Experiment: Community-Led Total Sanitation[7]

The experiment that was applied in our 20 study village in Bhadrak district represents an intensive (and randomly assigned) version of the Total Sanitation Campaign of the Government of India. The "intensification" of the TSC campaign draws many ideas from a model of "Community-led Total Sanitation" (CLTS) developed by Kamal Kar in Bangladesh (Kar 2003). Following a larger trend in development programs, the CLTS experiment relies on generating demand for improved sanitation through changing the

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[7] We use the terms *experiment* and *intervention* interchangeably throughout the text to imply the same activity – the community-led total sanitation campaign.

"software" of knowledge, attitudes and practices, rather than simply providing latrine "hardware." Because Bhadrak's local government in the water and sanitation mission is comprised of engineers with little experience in these "software" activities, Delhi-based Knowledge Links was brought in to draw on its experience with CLTS and provide technical assistance to the Bhadrak intervention.

According to Kar (2003), the CLTS approach focuses on "empowering local people to analyze the extent and risk of environmental pollution caused by open defecation." More crudely, one Knowledge Links staff member explained that the approach used in Bhadrak boiled down to "getting people to realize that they are eating each others' shit." Knowledge Links believes that creating this kind of visceral experience for people is essential for affecting lasting behavior change. They argue that having the knowledge is not enough to motivate lasting behavior change. Instead, the CLTS approach seeks to generate strong, emotional responses at the community and individual level, culminating in a community-wide resolve to end open defecation by a community-defined target date.

According to the KL Report, three main activities or CLTS "tools" were selected to form the core of the sanitation experiment in the study villages:

1. Calculation of fecal material
2. Walk of shame
3. Defecation mapping

These tools were invariably preceded by repeated small 'focus group' discussions. Additionally, depending on community interests, technology options and the costs of diarrheal illness were also discussed. Indeed, the nature of the community-based, interactive intervention dictated that the specific content of the campaign differed from village to village. However, a similar protocol was followed across the 20 intervention villages and the end goal -- self-analysis of the sanitation situation leading to community consensus to end open defecation -- was the same. Knowledge Links worked with district government and village water, sanitation, and health committees (VHWSCs), formed as part of the intervention process, to implement the CLTS activities. Village production centers (PCs) were also established to produce the materials needed for latrine construction. Local NGOs served as "implementing agencies" in each village, and were often in charge of carrying out latrine construction.

Typically, CLTS de-emphasizes subsidies, trying instead to motivate households to adopt latrines on their own, without any external support. However, subsidies were employed in the Bhadrak intervention. According to district-level government staff, the typical cost of construction for the type of latrine (off-pit) promoted under this campaign was Rs. 1500 (about US$30), of which households below the poverty line (BPL) were only required to pay Rs. 300 (about US$6). However, it is important to note that KL and the CLTS approach do not favor the use of subsidies. According to the KL Report, "The mention of subsidy under the CLTS approach is considered to be inimical to the very spirit of CLTS, which is intended to be totally community led, with outside people of agencies functioning only as community facilitators/catalysts." Thus, there is at least an apparent tension between the vision of CLTS brought in by Knowledge Links, and the tradition of providing subsidies under the Government of India's Total Sanitation Campaign.

In terms of the theory of latrine adoption outlined in the previous section, the CLTS intervention conducted in Bhadrak provides an exogenous source of variation affecting each of the broad factors we identified as potentially impacting demand for latrines. First, CLTS *subsidizes materials and labor* for latrine construction. These subsidies for households below the poverty line are intended to relax the budget constraint and increase uptake by poor households, although we can interpret Knowledge Links' concern about subsidies as a fear of creating an endowment effect. Second, the campaign provides *technical know-how* to guide household construction of IHL. The supply of both materials and expertise are increased through production centers and NGOs in the villages. Third, the campaign places much emphasis on the *non-health benefits of IHL use*, such as dignity and privacy for women. Fourth, the campaign targets households' knowledge of the *health risks* associated with open defecation. While this intervention does not focus on "germ theory" education per se, providing other kinds of knowledge—for example, awareness of the total amount of feces in the village—is an essential part of the campaign.

Finally, CLTS attempts to budge *social norms*: essentially, CLTS is an attempt to move communities from one social norm (open defecation) to another (universal latrine use). To promote this new norm, CLTS motivators focus on increasing the perceived benefits of latrine use by emphasizing privacy and dignity as important values, and inducing individuals to feel shame when they violate this new norm. Importantly, the intervention explicitly targets villages, rather than individual households, and the stated goal of CLTS is to generate a community-wide agreement to end open defecation. Bringing village members together, establishing this common goal, and promoting a new set of norms that reinforce this goal, may allow households to overcome their collective action problem. Furthermore, CLTS encourages villages to establish systems for punishing "free-riders." Punishments can involve monetary fines or social sanctions such as mocking or even throwing stones at those who continue to practice open defecation.

Thus, the focus of the CLTS intervention employed in Bhadrak addresses a broader set of barriers to latrine adoption than those considered by most previous campaigns, which tended to include more narrowly defined information campaigns as well as "supply-push" measures. The model outlined in the previous section emphasizes that while these knowledge and supply-side considerations may be necessary conditions for latrine adoption, they are not sufficient. In many cases, social norms and collective action problems present an additional set of barriers that must be addressed. It is this set of barriers that is squarely targeted by the CLTS intervention in Bhadrak.

IV. Study Location and Design

To explore the impacts of such a strategy on household behavior change, and ultimately health and other development outcomes, we collected community, household and individual data in two waves between August of 2005 (before the intervention) and September of 2006 (after the intervention).

Design of Sample of 40 villages from 2 blocks

Within Orissa, the coastal district of Bhadrak (see Figure 1) served as our study area for three reasons:

1. Bhadrak still had a sufficiently large number of blocks and villages where the Government of India's TSC interventions had not been implemented;
2. the use and maintenance of latrines in the area remained unsatisfactory despite adequate water availability; and
3. the Government of Orissa agreed that no special water, sanitation or hygiene programs would be implemented in 'control' villages during the study period.

Within Bhadrak, 40 study villages were selected in two adjacent blocks, Tihidi and Chandbali, using the following criteria.[8] First, we excluded those with less than 70 or more than 500 households to ensure that included villages would be similarly rural and would provide enough households with at least one child under the age of five, since the main health outcomes we are measuring is child diarrhea rates. Second, in order to minimize spillover effects, we grouped villages by panchayat[9] and selected one village per panchayat, and then spatially mapped all villages in the sampling frame and removed from the selection process contiguous villages. Third, we selected villages that were accessible via roadways and avoided areas where political issues could affect survey implementation. Finally, we randomly selected 20 of the 40 sample villages and assigned them to the "treatment" group, while the other 20 villages served as "controls." Figure 2 shows a map of the study area and the location of our treatment and control villages.

The study was designed to measure the impacts of an intensive sanitation-promotion intervention being piloted under the Government of India's Total Sanitation Campaign. This intervention is described in detail in section four. In order to assess the impact of this intervention on uptake of individual household latrines (IHL) and child diarrhea

[8] Sample size calculations indicated that 40 villages with 25 eligible households per village would provide sufficient statistical power (i.e. 80% or greater) to identify meaningful differences between treatment and control villages on one of the primary outcomes, prevalence of diarrhea among children younger than five years. We assumed a base rate of 25% and an anticipated program effect of 0.30. Moderate attrition was considered and a design effect (DEFF) of 2.0 was introduced to account for variance inflation

[9] Panchayats are groups of about 3-6 villages that are linked administratively and interact frequently

rates, we implemented a repeated measures cohort design. Baseline data were collected in all 40 villages in August of 2005. The intervention took place in the 20 treatment villages between January and May of 2006, and post-intervention data were collected in August and September of 2006. The study protocol was approved by an ethics review board, an external technical oversight group from leading public health agencies, and a local steering committee. Throughout the design stage of this study, the evaluation team worked closely with GoO as well as the sanitation campaign implementation team to ensure consistency and coherence across all aspects of the study, including integrity of the design and measurement.

Collection of community, household and individual data

Multiple data collection methods were used to provide information on: 1) outcomes of interest, IHL ownership and use and diarrhea rates among children under 5; 2) household- and village-level "covariates" potentially impacting these outcomes; and 3) content and perceptions of the sanitation intervention.

Our primary data collection instrument was a comprehensive *household survey* that was conducted in all 40 villages in 2005 and 2006. In August of 2005, a listing and mapping exercise identified the set of "eligible" households in each village (i.e., households with children under 5), and then survey enumerators randomly selected 28 households from the sampling frame generated by the mapping and listing process. At each household, enumerators were instructed to interview the primary care giver for children under 5 years whenever possible. This was done to ensure the most accurate information on child health and child sanitation and hygiene practices. The survey instrument included eight sections covering health-related knowledge, attitudes, and practices, family demographics, recent illnesses, water supply and hygiene practices, sanitation, socioeconomics, and social preferences. The 2005 baseline survey covered 1086 households (treatment = 534, control = 552), and 1050 of these (treatment =529, control =521) completed follow-up surveys in 2006.

Second, *community surveys* were administered to key informants in each of the 40 villages. These surveys collected information on village characteristics such as population, village size, land use, socioeconomics, village institutions, and water, sanitation, and health-related projects.

Third, *water quality* was tested in 50% of households surveyed, as well as for in-use water sources in each village. Household surveys, community surveys, and water quality sampling were all conducted by an international survey organization, TNS, with substantial local experience and presence. Approximately 30 local enumerators, supervisors, and water quality personnel, all of them with at least a bachelor's degree and fluent in the local language, were involved in carrying out the data collection.

Fourth, members of the study team conducted informal *interviews* with key stakeholders to gain additional perspective on what the sanitation campaign looked like and how it was perceived by various actors. Stakeholders included state- and district-level government officials in charge of implementing the sanitation scheme, as well as the Delhi-based consultants who led the "community-led total sanitation" (CLTS) intervention in the 20 villages, Knowledge Links. Interviews with village members were also conducted in 10 of the 40 study villages, including 7 treatment and 3 control villages. Finally, project documents such as Knowledge Links' final report on the sanitation intervention in Bhadrak were reviewed to gain additional perspectives on the intervention.

Descriptive Statistics

Table 1 presents descriptive statistics for a number of household and village characteristics in 2005 and 2006. In general, treatment and control villages are fairly similar, with few significant[10] differences in observable covariates prior to the sanitation intervention. Villages are fairly similar in size, both in terms of population and area, and in socioeconomic characteristics such as education levels, percent of the population categorized as below the poverty line (BPL), percent Hindu, and percent categorized as "scheduled caste" or "scheduled tribe." Household sizes are also similar across both groups. However, treatment villages do appear to be slightly "worse off" along a few dimensions, such as distance from all-weather roads and ownership of consumer durables like TVs and cell phones. Furthermore, when we turn to the main outcomes of interest, Table 2 shows that treatment villages had a lower rate of IHL ownership and higher child diarrhea rates compared to control villages prior to the intervention. Thus, through simple luck of the draw it appears that the baseline situation in treatment villages was slightly worse than in control villages according to a few key indicators prior to the intervention. This highlights the importance of collecting baseline data so that these pre-existing differences can be controlled for in estimating program impacts.

Following the intervention, there are no major changes in the covariates across treatment and control villages. However, Table 2 shows that there is a substantial increase in IHL ownership in the treatment villages, with no change in control villages. Figure 3 shows how the distribution of latrine ownership has changed in the treatment and control villages. In 2005, there were no villages either the treatment or control groups in which latrine ownership was greater than 50%. Indeed, in all 20 treatment villages, latrine ownership was below 20%. Figure 3 shows that, following the sanitation campaign, IHL ownership increased significantly in many treatment villages. In these villages, latrine ownership is now above 20% in 12 out of 20 villages, above 50% in 5 villages, and above 80% in 3 villages. Table 2 also shows that diarrhea rates fell substantially in both treatment and control villages among both children under five and children under three, and that there is no longer any significant difference in this health outcome across treatment and controls. Interestingly, we do not see improvements in household water quality in treatment households relative to controls. Nonetheless, these simple means

[10] Throughout this discussion, we refer to statistics as "significant" when they have a p-value less than 5%.

comparisons provide a preliminary indication that the treatment had an impact on IHL uptake and may have improved health outcomes, as well. These effects are examined in greater detail below.

V. Results: Impacts of the Sanitation Promotion Campaign

Our discussion of the CLTS intervention highlights its potential to succeed where other sanitation interventions have failed by focusing on a portfolio of 'adoption barriers'. By implementing this intervention in a randomized manner, the Bhadrak study introduced an exogenous shock to knowledge, costs, supply, and social factors in 20 villages, allowing us to rigorously measure the campaign's impacts. This section summarizes the campaign's results.

Impacts on of the Sanitation Campaign on Knowledge and Preferences

Before we assess the campaign's impact on IHL uptake and child health, it is interesting to ask what effect, if any, the campaign had on respondents' sanitation- and hygiene-related knowledge, attitudes, and practices (KAP). As the theoretical model suggests, these factors may be important. Examining responses to these questions may provide some insight into whether, for example, village members were even aware of the campaign. Table 3 summarizes key (KAP) indicators in 2005 and 2006. The 2006 survey included a question that asked whether respondents were aware of any "sanitation- and toilet use-related information campaigns, education messages, and information camps" that took place in their village since the beginning of 2006. Sixty-seven percent of respondents in treatment villages answered "yes," to this question, compared to about 10% of respondents in control villages, and this difference is highly significant. It is interesting to note, however, that over 30% of respondents in treatment villages were not aware of the sanitation campaign, while there were several respondents in control villages who did report similar activities taking place in their village. Nonetheless, it is clear that exposure to these sanitation messages was substantially higher in treatment villages.

What impact, if any, did these messages have on households' health-related KAP? Looking at respondents' knowledge of diarrhea symptoms and causes, we see that respondents in treatment and control villages were very similar in their responses in 2005. On average, respondents were able to identify 2.34 diarrhea symptoms[11] correctly, and 94% of respondents cited open defecation as a cause of diarrhea. This latter statistic, in particular, reinforces the assertion by Knowledge Links and others that knowledge of the "germ theory" linking open defecation and disease is not a fundamental barrier to latrine adoption in our study area. What is also interesting is that the stated belief in open defecation-diarrhea linkages actually decreases somewhat in both treatment and control villages following the intervention. However, this decrease is smaller in treatment

[11] Essentially, we count how many of 6 correct symptoms (*i.e.*, loose stool, blood/mucus in stool, abdominal pain, fever, vomiting, & loss of weight) were identified by households.

villages. Meanwhile, knowledge of diarrhea symptoms increases in both treatment and control villages, but this increase is greater in treatment villages. Thus, in 2006, respondents in treatment villages are both more knowledgeable about diarrhea symptoms and more likely to cite open defecation as a cause of diarrhea compared to respondents in control villages, and both of these differences are significant.

Another important question is whether, other than latrine adoption, the sanitation campaign affected behaviors that might also have an impact on child diarrhea rates. This question is interesting in and of itself, and will also be important when we discuss our estimation of the campaign's impacts on diarrhea rates. Reviewing the evidence in Table 3, there is some evidence to suggest that one key diarrhea-related behavior, treating households' drinking water in any way (e.g., boiling, filtering, chemical treatment), did increase somewhat following treatment. In 2005, about 4% fewer households in treatment villages treated their drinking water when compared with controls, and this difference was significant at the 10% level. Following treatment, water treatment increased slightly, from 9.4% to 12%, in treatment villages, while there was no change in control villages. Looking at another key hygiene behavior, reported handwashing increased for both mothers and children from 2005 to 2006, and this increase was observed in both treatment and control villages. In both years, reported handwashing is slightly higher in treatment villages compared to controls. For mothers, this difference is highly statistically significant in 2005, but the difference is smaller and no longer significant in 2006. For children, the difference between treatment and controls becomes somewhat larger in 2006, but is still not significant. Thus, the data do not indicate that the sanitation campaign had a substantial impact on handwashing behavior, which was not something emphasized in the campaign.

In addition to these KAP indicators, the 2006 survey also included a set of questions on social preferences. These seven questions were intended to gauge respondents' attitudes and values, which may be important drivers of latrine adoption. Table 4 summarizes responses to these questions, each of which had respondents choose between two alternative statements. The first question measured commitment to family versus community. The second question assessed attitudes toward tradition versus progress. The third question asked whether households tended to be "first adopters," or new technologies, or whether they tended to wait until others had adopted to try new things. The fourth question assessed whether respondents felt it was important to report people who broke community laws, or whether it was better to mind one's own business. The fifth question measured stated "willpower," while the sixth question was intended to gauge the importance respondents gave to conformism. Finally, the seventh question assessed whether respondents tended to solve problems directly, or "cope" with obstacles.

Random assignment of treatment ensures that, in expectation, responses to these questions would have been the same in treatment and control villages in the absence of the treatment. Therefore, households' actual responses give us an estimate of the campaign's impact on this set of social preferences. For questions 1 (community vs.

family), 2 (tradition vs. progress), 4 (punishing those who broke community laws), and 7 (problem solving vs. coping), responses are quite similar across treatment and control villages. However, we do see significant differences between treatment and control responses for the remaining questions. Households in treatment villages are less likely to be "early adopters," more likely to exercise willpower (e.g., eat sweet treats gradually) and more likely to conform to community norms (rather than do their own thing). In subsequent analyses, we use these variables to try and explain reasons for variation in latrine adoption.

Impacts on IHL Adoption

We estimated the impact of the sanitation campaign on latrine uptake using several different models. Given that treatment was randomly assigned, the comparison of village-level means provides the most simple treatment effect estimate. Random assignment assures us that treatment conditions are uncorrelated with potential outcomes in expectation. That is, $E[Y_1|D=1]=E[Y_1|D=0]$ and $E[Y_0|D=1]=E[Y_0|D=0]$, so that comparing realized outcomes for the treatment and control groups gives us:

$$E[Y_1|D=1]- E[Y_0|D=0]= E[Y_1-Y_0|D=1]= E[Y_1-Y_0] \qquad (9)$$

Since this holds in expectation, comparing observed outcomes for the treatment and control units in our study yield an unbiased estimate of the effect of the IEC campaign on IHL uptake. Based on the means comparison presented in Table 2, the estimated impact of the sanitation campaign on IHL adoption is the difference in means in 2006, or 19%.

However, since we know that treatment and control villages were somewhat different prior to the intervention, and that, in particular, IHL ownership was significantly lower in treatment villages in 2005 compared to controls, we can obtain more precise estimates by controlling for these differences in a number of different ways. Moreover, we are ultimately interested in understanding outcomes (IHL adoption and use and health outcomes) at the household level. By analyzing outcomes at the village level, we miss heterogeneity in household characteristics that may play a key role in determining sanitation and health outcomes. Thus, we conduct a number of analyses at the household level, controlling for various combinations of household- and village-level covariates. Table 5 presents results of various model specifications, where the dependent variable is household ownership of IHL: $Y_{ijt}=1$ if household i in village j owns a latrine in year t, and $Y_{ijt}=0$ otherwise. Since this outcome is binary, the models were estimated using probit regressions. Models 1-4 are variations of the model:

$$Y_{ijt} = E[Y_{ijt} \mid T_{it}, X_{ijt}] + u_{ij}$$
$$E[Y_{ijt} \mid T_{it}, X_{ijt}] = P(Y_{ijt} = 1 \mid T_{it}, X_{ijt}) = 1 - F(-\beta_1 T_{it} - \beta_2 X_{ijt}) \qquad (10)$$

$T_{it}=1$ if village i was in the treatment group in year t, X_{ijt} is a vector of village and household characteristics, and F is the standard normal cumulative density function. Standard errors are clustered at the village level. In models 1 and 2, the dependent variable is latrine ownership in 2006, and covariates include a number of village and household characteristics. Model 2 is a difference-in-differences model, where the right-hand variables are $T_i=1$ if the village was assigned to the treatment group, a if the village was assigned to the treatment group, a $Year_t$ variable that takes a value of 1 in 2006 (after the intervention), and the interaction term, $T_i *Year_t$, which will take a value of 1 for treatment villages in 2006. The coefficient on the interaction term gives the difference-in-differences (DID) estimate of the sanitation campaign's impacts. Model 3 uses the same DID setup, and also includes both socioeconomic controls. Model 4 is similar to model 3, except now we include village level fixed effects and estimate this as a linear model.

Not surprisingly, all of these models confirm that the sanitation campaign had a substantial and statistically significant impact on latrine adoption. Estimated impacts range from a 29% to a 36% increase in IHL ownership. These estimates also confirm that, because of the initially lower level of latrine ownership in treatment villages, the simple means comparison for 2006 underestimates the impact of the sanitation campaign on IHL adoption. These models also allow us to identify other variables that influence latrine adoption decisions.

In related analysis (not reported here), we also find some evidence that the indicators of social preferences that we measured have some impact on latrine uptake. Agreement with the statement that, "Improving our community is just as important as looking after my immediate family," is associated with an increase in latrine ownership, while, somewhat surprisingly, stating to be a "first-adopter" of new technologies is associated with a lower probability of latrine ownership. Finally, the effect of the social preference toward "embracing progress" is ambiguous. Using only 2006 data, those who claim to embrace progress are more likely to adopt latrines, while in the DID model, this statement is associated with lower levels of latrine ownership. The effects of the other social preference variables are not statistically significant.

It is important to note that the treatment effects estimates presented here are likely underestimates of the full impact of the sanitation campaign. Interviews with village members and observations in August of 2006, a couple of weeks before the survey was implemented, revealed that many people in the treatment villages had begun to construct latrines but had not yet finished. The sanitation campaign occurred in all 20 treatment villages between February and April of 2006. Village members in several villages told us that construction had been put on hold when the monsoons started in June, and that construction would resume only when the rains stopped. Results from the household survey confirm that, in addition to the 157 households (142 treatment, 15 control) who say that they built an IHL in the past year, 44 households, all of which are in treatment villages, claim that they have a partially constructed IHL. When asked about plans to build IHL in the future, there are an additional 43 treatment households and 2 control households who say they will build IHL within the next month, and another 53 treatment and 45 control households who are planning to build in the next year. Of course, it is quite possible that these stated plans will not translate into action, but the fact that we observed several partially constructed latrines during our visits to study villages suggests that the full impact of the campaign had not yet materialized as of the second round survey. Thus, the impacts we measure here give a lower bound on the effect of the sanitation campaign "treatment" on IHL adoption.[12]

Impacts on IHL Use

While it is important to measure latrine construction and ownership as key campaign impacts, it is ultimately *use* of these latrines that is the desired outcome. Table 6 presents some preliminary indicators of IHL use based on households' reported defecation practices. The variables reported in this table record the percent of household respondents who reported that men, women, and children "daily/usually" used a private latrine for defecation. Results are reported for the whole sample, as well as for only the households who had a latrine in each year. In the whole sample, for men, women, and children, reported use was lower in treatment villages in 2005 compared to controls. This is consistent with our finding that IHL coverage was initially higher in control villages. We also see that use has increased for all groups in treatment villages, and that reported use has actually declined in control villages.

Limiting the sample to only those households who had IHL in each year, we can examine whether households who adopted latrines after the campaign were more or less likely to actually use them. In 2005, only 53% of men in treatment villages were reported to use IHL given that their HH had one, compared to 73% of households in control villages. After the treatment, this trend is reversed, with 70% of men in treatment villages now using IHL. Meanwhile, use has actually declined slightly among men with IHL in control villages, to 64%. For women, use was initially slightly lower in treatment villages, and became somewhat higher after treatment. However, what is more notable is the overall decline in reported use among women. In 2005, 85% of women in treatment villages and 86% of women in control villages report using their IHL, while these numbers have declined to 69% and 63% in 2006. The decrease in use is repeated for children, who also have the lowest rates of reported use compared to men and women (average of 52% overall in 2005 and only 33% in 2006). Thus, these results suggest that many of the new latrines that have been constructed are not yet being uniformly used by women and children. However, the substantial number of new latrines that have been built has led to a significant increase in latrine use among men, women, and children overall.

[12] To get a better sense of the campaign's potential longer term impacts, we re-estimated the difference-in-differences model (Model 4) adding "future adopters" to the households that had constructed IHL by the 2006 survey. First, adding households that said they had *started building* an IHL at the time of the second survey led to an estimated treatment effect of 44%. Second, including household that said they were planning to build an IHL *within the next month* increased the treatment effect to 54%. Finally, including households that said they were planning to build *within the next year* led to an estimated effect of 56%.

Impacts on Child Diarrhea

The evidence we have presented to date indicates that the sanitation campaign had the intended impact on latrine construction and use in our study villages. In a single year, latrine ownership among households in treatment village increased from 6.4% to 32%, while the percentage of households in control villages owning IHL remained constant at about 13%. We also observed in Figure 3 that a handful of villages in the treatment group now have more than 50% of households owning IHL. The next question is whether or not these increases in latrine ownership have resulted in improved health outcomes, as we would expect from an epidemiological model that links open defecation to diseases like diarrhea. Answering this question is more difficult than measuring the effect of the IEC campaign more broadly because unlike the sanitation campaign treatment, IHL adoption itself is not randomly assigned. Ultimately, households choose whether or not to build and use IHL, and it is quite possible that some of the factors that influence this decision will also be correlated with diarrhea outcomes. For example, if households that adopt IHL are naturally more health- and sanitation-conscious, we might expect these households to have lower diarrhea rates even in the absence of the IHL "treatment." Thus, simply regressing diarrhea outcomes on IHL ownership will likely result in a biased estimate of the treatment effect in this case.

We can interpret this problem as a case of *partial compliance* (Duflo et al., forthcoming) with assignment to receive an IHL. In this framework, the sanitation campaign acts as a randomly assigned "encouragement" to adopt the IHL "treatment." However, not all household that are subject to the campaign actually build an IHL, and there may be households in the comparison group that decide to build IHL on their own. Nonetheless, we can use the random variation in the campaign, which influences the IHL adoption decision, to identify the impact IHL adoption on diarrhea outcomes. If we denote Y_{ij} as the individual or household level diarrhea outcome and Z_i as the sanitation campaign (Z_i =1 if village *i* received the campaign, and Z_i =0 otherwise), then random assignment implies that $E[Y_{ij}(0)| Z_i =1]=E[Y_{ij}(0)| Z_i =0]$ (where Y_{ij} is the individual or household level diarrhea outcome). We can thus measure the *Intention to Treat* effect as the realized outcome: $E[Y_{ij}| Z_i=1]-E[Y_{ij}| Z_i=0]$.

Furthermore, under two assumptions, the following Wald estimator will give us a valid estimate of the impact of IHL adoption (T) on diarrhea outcomes for a well-defined group of households (or individuals):

$$\beta_\omega = \frac{E[\, Y_{ij} \mid Z_i = 1\,] - E[\, Y_{ij} \mid Z_i = 0\,]}{E[\, T_{ij} \mid Z_i = 1\,] - E[\, T_{ij} \mid Z_i = 0\,]} \qquad (11)$$

The numerator is the difference in diarrhea outcomes between households (or individuals) in treatment villages and diarrhea outcomes in control villages—i.e., the ITT. The denominator is the difference in IHL uptake between households exposed to the campaign and those that were not exposed. Under the assumptions discussed below, this estimator (or, equivalently, an instrumental variables estimator) will give us the effect of

IHL adoption on diarrhea outcomes for the group of households that were induced by the campaign to adopt IHL. This is the local average treatment effect, or LATE (see Angrist & Imbens 1994).

The assumptions that are required to identify the LATE are:

1. Independence: (Y_{ij}^C, Y_{ij}^T, $T_i(1)$, $T_i(0)$) is independent of Z;
2. Monotonicity: Either $T_i(1) \geq T_i(0)$ for all i, or $T_i(1) \leq T_i(0)$ for all i.

The monotonicity assumption is fairly straightforward: it requires that households who are exposed to the sanitation campaign are (weakly) more likely to adopt a latrine than they would have been in the absence of the campaign. Given the large, positive, and statistically significant average effect of the campaign on IHL uptake that we found in the previous section, this assumption seems plausible. The independence assumption is somewhat more complex. This assumption essentially requires that the only way the instrument (the sanitation campaign) affects diarrhea outcomes is through its effect on IHL uptake. While there is no way to test this assumption directly, we ran two specification tests to examine whether the campaign had any effect on two behaviors that may also influence diarrhea outcomes: handwashing behavior (for both mothers and children under 5) and whether or not households treat their drinking water. Difference-in-differences estimates of the impact of the sanitation campaign on these two behaviors are presented in Table 7. Furthermore, we see no difference in disposal of garbage or waste water, or in safe handling and storage of water. Because these tests do not suggest that the sanitation campaign had a significant effect on these other diarrhea-related behaviors, we have some reason to believe that the independence assumption may be valid in this context.

Rather than implement the Wald estimator directly (which does not allow calculation of standard errors), we use several instrumental variables estimators where the sanitation campaign serves as an instrument for IHL adoption. Table 8 presents results of these different models for children under 5. In each of these regressions, the dependent variable is measured at the individual level: did that child experience a diarrhea episode within a two week recall period.[13] We test this for two age groups – *under 3* kids and *under 5* kids. To control for pre-existing differences among households and trends over time, we include various household and village characteristics. Columns 1 and 2 present intention to treat effects for *under 3* and *under 5* respectively. Columns 3 and 4 presents two-stage IV estimates, where the first stage is a probit regression of IHL adoption on treatment (and other covariates), and the results of this regression are used to generate predicted variables, IHL_hat, which are used in the second stage regression to estimate

[13] Results were also performed at the household level for children under 3. These results are qualitatively similar to those presented here. In addition, we are in the process of replicating these analyses at the individual level for both children under 5 and children under 3—in this case, the outcome variable is binary (did the individual experience a diarrhea episode or not).

effects on diarrhea outcomes, including corrections for the standard errors because we are using a predicted value.

We explored one additional method, fairly similar to the IV approach, for identifying the impact of IHL ownership on child diarrhea rates. This method uses a propensity score matching technique to compare diarrhea outcomes among IHL adopters in the treatment village to outcomes for non-adopters in control villages who *would have adopted* IHL if their village had been exposed to the campaign. In the first stage, we conduct a probit regression of IHL adoption on household characteristics using only treatment villages. (This corresponds to the first model presented in Table 6.) We then used the estimated coefficients from this regression to predict the likelihood of adoption for households in control villages. Finally, the sample was limited to adopters in treatment villagers and non-adopters in control villages, and households were matched based on predicted likelihood of adoption. Each treatment household was matched to four control households, and diarrhea rates were compared.[14] This model does not show a significant effect.

Across these different models, we observe that the estimated effect of IHL adoption and use on child diarrhea outcomes is consistently negative, indicating that IHL adoption may have decreased diarrhea rates. However, ITT result is only significant in 1 model (*under 3*) and the IV estimate is significant in 1 model (*under 5*). Thus, we are cautious about over-interpreting or misinterpreting these results due to concerns about the validity of our instruments, exclusion restrictions, and functional form across the different models.

This discussion leads to some general concerns regarding the purported identification of the sanitation and health linkage. First, our post-intervention survey was conducted only a few months after the campaign concluded, and the new IHLs that were constructed in the wake of the campaign had only been in use for a short amount of time. Furthermore, while the sanitation campaign did result in a substantial amount of new IHL construction, the average percentage of households owning IHL is still fairly low, at 32%, even in the treatment villages, and our use results show that only 22% of men and women in treatment villages were actually using latrines on a daily basis in 2006. While this is substantial progress over the baseline situation, open defecation is still the dominant practice throughout the study area. If the relationship between fecal load in the community and diarrhea rates displays some kind of "threshold effect," we would expect to see decreases in diarrhea rates only after some critical mass of households had switched over to using IHL. We can test this proposition by examining water quality results. Preliminary DID estimates of water quality at the community level suggest that intervention communities experienced a 27 points decrease in E.coli, compared to control communities. Overall impacts on household-level water quality are less clear. At the household level, we analyzed both E.coli and total coliform levels using a variety of

[14] The matching estimator is derived in Abadie & Imbens (2006a), who also provide the code for conducting the matching analyses: http://emlab.berkeley.edu/users/imbens/estimators.shtml.

methods to test the effect of the sanitation intervention and IHL uptake. Across these different models, we consistently find negative but insignificant effects on E.Coli. For total coliforms, a simple DID model for the effect of the sanitation campaign actually reveals a small increase, but this result is highly insignificant. However, using both DID and IV approaches, we do find some evidence that IHL adoption decreased total coliform levels. In turn, we find that these indicators of microbial contamination (either *e.coli* or total coliforms) significantly increase the explanatory power of our diarrhea regressions and village level total coliform is positively correlated with diarrhea incidence. This last result is robust across all 4 models.[15]

Finally, one additional factor working against us finding significant diarrhea impacts is that, for some reason, overall diarrhea rates were substantially lower in 2006 than in 2005 for *both* treatment and control villages. This suggests that some other factor, not controlled for in our analyses, led to an abnormally low level of diarrhea in 2006. This highlights a larger issue, which is that we are ultimately not able to explain very much of the variation in diarrhea rates in our study area with our current model. Across the different models we estimated, the R-squared ranges from about .03 to .11. Thus, there appear to be many unobservable factors driving diarrhea rates, complicating our efforts to isolate the impact of IHL ownership.

Impacts on Household Welfare

Child diarrhea imposes significant coping and averting costs on households. We present some early ‘reduced form’ assessment of this by comparing means across treatment and control households across 5 variables – days that the child was unproductive, nights spent in hospital, overall medical costs (including on medicines and doctor fees), work days lost by primary care giver, and the time spent walking to the open defecation site. As shown by the DID estimates in Table 9, we cannot detect a statistically significant impact of the toilet use on any of these variables – except the averting costs avoided, expressed in terms of time spent walking every day for defecation, which is reduced by 17 minutes per family member per day (or 540 hours per household per year). Furthermore, we find an impact on hospitalization (nights spent) and medical costs, if we define our treatment category to include partially constructed toilets. Collectively, these statistics represent some preliminary evidence on the types of welfare impacts we can quantify. A more rigorous analysis that explicitly addresses the endogeneity of toilet use, including an ‘intent to treat’ assessment (similar to the diarrhea impact analysis), is currently underway.

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[15] Additional quality assurance and quality control processes are being completed on the laboratory result of the fecal load data and, thus, firm conclusions would be premature.

VI. A closer look at IHL adoption

These treatment effects analyses provide valuable information on *what* the sanitation has been able to achieve in terms of sanitation and health improvements thus far. To gain additional insight into *why* these changes occurred, we conduct a set of analyses designed to analyze the adoption decision for households in the study area. For households that were exposed to the sanitation campaign, which factors were associated with higher or lower probability of adoption?

Adoption in the treatment villages only

In the simplest setup, the sample is limited to households in treatment villages, and latrine adoption is regressed on a vector of household and village characteristics. We also include an indicator for whether or not the respondent said that she was aware of the CLTS campaign that occurred in the village. Results from this regression are presented in Table 10. Several of the variables in this regression are significant and worth noting. First, we see that households within CLTS villages were more likely to adopt a latrine if they were actually aware that the campaign occurred. Second, population density increases latrine adoption. One interpretation of this result is that higher population density leads to more crowding and less space available for open defecation, increasing the benefits of latrine adoption. Third, distance to an all-weather road decreases latrine adoption, possibly due to less access to building materials and higher costs. Fourth, indicators for housing materials (mud floor, mud or thatch walls, thatch roof) have a jointly significant impact on latrine adoption. Other wealth indicators, such as recent expenditure on food and non-food items and number of mattresses owned, have an insignificant effect on adoption. However, an indicator for the number of mosquito nets owned in 2005 shows a significant impact on latrine ownership in 2006. This suggests that households who have adopted one "averting behavior" (nets) may be more likely to adopt another (latrines). Finally, households that expressed the belief that "community is as important as family" were significantly more likely to adopt a latrine compared to households that put their own family first. This may reflect a perception that latrines are a public, rather than a private, good.

Does adoption depend on time and risk preferences?

We follow Harrison et al. (2005) in eliciting time and risk preferences from households. Essentially, in one module of the survey, households are asked to choose between a smaller gift now (or 12 months later) and a larger gift later (3,12 and 15 months after the earlier gift). Each household is asked 5 such questions reflecting one version (or combination) of the time delays, gifts and implied discount rates. Four such versions are randomized across the sample households. Household responses to these questions can reveal their implicit discount rate. In another module of the survey, households are asked to choose between a smaller certain gift and an uncertain gift with a larger expected value. Four different versions reflect different implicit risk aversion estimates that can be recovered from household responses. Collectively, these survey data provide estimates of household time preferences (e.g., discounting) and risk preferences (e.g., risk aversion). Following Agee and Crocker (2002), we use household responses to time and risk preference questions as determinants of IHL adoption. In our preliminary analysis of this data, we find no effect. There is evidence that households do not exhibit constant exponential discount rates. A hyperbolic discount rate could be consistent with the alternative patterns that we observe in the data.

Is adoption prevalence elastic?

An additional set of analyses explores the hypothesis that households' decisions to adopt latrines are driven by the actual risk of contracting diarrhea. That is, if households' primary motivation for adopting a latrine is to avoid contracting diarrhea and related diseases, we would expect households facing a greater risk to have a greater incentive to adopt, all else equal. This is related to the concept of "prevalence elasticity" (Pattanayak et al. 2006b). To explore this hypothesis, we regressed 2006 IHL adoption on various different measures of 2005 diarrhea risk: 1) 2005 village-level diarrhea rate for all individuals; 2) 2005 village-level diarrhea rates for children under 5; 3) 2005 household-level diarrhea rates for all individuals, and 4) 2005 household-level diarrhea rates for children under 5. All regressions included household and village covariates as well as the social preference indicators. Results for the different diarrhea indicators are summarized in Table 11. These results show that 2005 diarrhea rates tend to have a positive correlation with 2006 IHL adoption. For household-level under 5 diarrhea, this effect is marginally significant at the 10% level. That is, households with higher rates of diarrhea among children under 5 in 2005 were more likely to adopt latrines in 2006. This provides some support to the hypothesis that previous diarrhea exposure, and possibly, perceived diarrhea risk, is one factor influencing household IHL adoption.

Are social interactions at play?

The analysis discussed till now assumes that the factors influencing a household's decision to adopt a latrine are limited to the characteristics of the household itself (e.g., wealth, household size) or to village characteristics (population density, distance to road). Alternatively, household choices may indirectly reflect choices of others, e.g., through the prevalence elasticity concept where the disease prevalence reflects choices made by others. However, prior discussion of the theoretical model drew attention to the possibility that, for both social and epidemiological reasons, households' adoption decisions may depend on the actual or expected decisions of other households in the village. Socially, there is likely to be pressure to conform to community norms around defecation. In particular, a primary goal of the CLTS campaign is to move communities from one social norm (open defecation) to another (universal latrine use). Furthermore, learning about how to use a latrine and/or the health benefits of latrine use may create an additional source of social interactions (see Kremer & Miguel 2006). Epidemiologically, the benefits of latrine adoption may depend on how many others in the community are using latrines. As more of one's neighbors use a latrine, a household may have an incentive to "free ride" on others' contributions to village cleanliness. Thus, it is important to estimate the role of social interactions in determining households' decision to adopt a latrine. Fortunately, there is a growing theoretical and appied literature on this topic on which we may draw (e.g., Manski 1993, Moffitt 2001, Brock & Durlauf 2001, Case 1992; Conley and Udry, 2006).

Adoption by non-targeted households

An initial test of the role of social interactions takes advantage of apparent variation in the incentives provided under the CLTS campaign. According to Moffitt (2001), one way to look for social interactions is to examine the effects of an intervention that changes incentives (e.g., prices) for one group, but not for others. If changes in behavior are observed for those who were not directly affected by the incentive change, this may provide evidence for social interactions. In the case of the sanitation campaign, the intervention involved a social component that was intended to address social norms, as well as a subsidy for latrine adoption. However, in theory the subsidy should only have been available to households classified as "below the poverty line" (BPL). Thus, if we observe increases in latrine uptake among households that should not have received the subsidy (APL households), this may provide evidence that the impact of the intervention was partially due to social interactions. Table 12a partitions the sample into BPL and APL households, and estimates the effect of the campaign separately for each group. This table shows that estimated treatment effects are very similar whether we examine the whole sample or restrict the analysis to either BPL or APL households only. Thus, the treatment effect was not confined to BPL households. However, in order for us to be able to attribute the effect of the campaign on APL households to social effects, rather than prices, it must be the case that APL households in treatment villages really did not receive any subsidies for latrine construction. Table 12b shows reported costs paid by the household for two types of latrines (pit and flush) that were constructed in the past year in treatment and control villages. However, it is difficult to come to any firm conclusions based on this data because of the very low number of households in control villages who built latrines in the past year. Among households in control villages, only one APL household and only five "non-BPL" households built a latrine in the past year *and reported construction costs* for that latrine. The meager data we do have suggests that costs were in fact lower in APL households, suggesting that they may also have received some form of subsidy. (This may have been in the form of increased access to supplies and expertise, rather than a direct subsidy.) Thus, we cannot conclude that the increase in uptake among APL households was entirely due to social effects.

Does adoption depend on the predicted adoption by others?[16]

An alternative social interactions analysis that is underway draws on a two-stage approach following Bajari et al. (2006). This method is similar to the approach presented in Brock & Durlauf (2001), but rather than relying on functional form assumptions for identification, this method uses a set of exclusion restrictions. The basic setup of the analysis is as follows. The payoff to each household from adopting a latrine depends on a vector of own and village characteristics, such as those included in the analyses at the beginning of this section, as well as the expected adoption decisions of other households in the reference group. If we assume that there is some set of household characteristics that enter into the household's own payoff function, but do not directly affect other households' payoffs, these characteristics can serve as exclusion restrictions in the estimation of social interactions. Previous analysis suggests housing material as candidate variables: whether or not the household has a mud floor, mud or thatch walls, and a thatch roof are jointly significantly correlated with the probability of latrine adoption. It seems reasonable to assume that whether or not one's neighbor has a mud floor will not affect a household's own payoff to adopting a latrine. Thus, the housing material variables may serve as a valid exclusion restriction. Another possible restriction is the number of children under five within each household.

Once a valid set of exclusion restrictions have been identified, estimation then proceeds in two stages. In the first stage, the household's (discrete) latrine adoption choice is regressed on a vector of household and village attributes as well as mean values of each of these variables for all other households in the village. (This is essentially the full reduced-form model in which other households' characteristics enter the payoff function through their expected impact on other households' adoption.) Results from this nonlinear regression are then used to generate predicted adoption for each household. In the second stage, household's actual adoption decision is again regressed on household and village characteristics, as well as the predicted level of adoption among other households in one's reference group. The coefficient on this indicator of others' adoption provides a valid estimate of the aggregate social effect.

Initial estimation using a predefined unit, the village, as the reference group, produces large, positive, and significant social effect estimates. However, these results are somewhat limited by the ad hoc definition of the reference group. Additional data on household's self-defined contacts will be collected in the fall of 2007, and this data will be used to generate a more refined estimate of the social effects. Nonetheless, our initial indication is that social interactions may be quite important in driving latrine adoption. Further investigation of this hypothesis will be a primary focus of future work.

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[16] This section draws on on-going work with Chris Timmins. We have benefited from extensive discussions with him on the identification strategy.

VII. Discussion

The theoretical model outlined in this paper identified several key inter-related barriers to latrine adoption: knowledge, ability, and social norms/collective action problems. What do our results tell us about the role of each of these factors in preventing or facilitating latrine adoption in our study area?

First, our study confirms the assertion by Kar (2003), Knowledge Links staff, and others that knowledge of the "germ theory" linking open defecation to diseases like diarrhea is not the most important barrier to latrine adoption. Even before the sanitation campaign, over 90% of households in our study area cited open defecation as a cause of diarrhea, yet this knowledge alone was not enough to generate widespread latrine use. However, for infectious water-borne diseases, it is specific information (not general knowledge) on risk exposure (infectious people, vector, parasites and pathways) that influence people's choices, particularly in endemic areas (Pattanayak et al., 2006b; Gersovitz and Hammer, 2003). Here we find significant heterogeneity in household KAP and their knowledge of and interactions with neighbors. These KAP factors in turn appear to influence demand for IHL. For example, we find that one specific campaign activity, the discussion of latrine technology options, increased latrine uptake. This activity may have introduced new expertise and provided households with technical knowledge about disease control (as well as other aesthetic aspects of personal latrines) and ability that facilitated IHL adoption.

Turning to abilities, broadly defined to include wealth, costs, and technical know how, there is some evidence that certain factors were limiting households' ability to construct latrines prior to the intervention. We find that indicators of household wealth, such as housing quality, ownership of consumer durables, and expenditure on food and non-food items, tend to be positively correlated with latrine adoption. Moreover, in the household survey and in interviews, households that had not adopted latrines cited cost as the main reason for their decision (see Table 13). However, after the campaign, Table 13 shows that the number of households citing this barrier decreased in both treatment and control villages, with a significantly larger decrease in treatment villages. Thus, at least some of the intervention's impacts were most likely due to the subsidies provided under this program, which substantially reduced the cost to households of constructing a latrine. It is worth noting, however, that subsidies have long been a part of the Government of India's Total Sanitation Campaign, yet government staff members report that TSC has not been as effective in inducing latrine ownership in use in other areas.

In addition to knowledge and cost barriers, the CLTS experiment placed a considerable weight on addressing social norms and helping households to overcome collective action problems. It seems likely that much of the campaign's success was due to these social factors. By focusing on creating a community-level resolve to end open defecation, the campaign may have played an important role in helping village members come together and creating mutual expectations of latrine adoption. We find evidence that some of the "social preference" indicators were correlated with latrine adoption. For example, households that expressed a commitment to improving their communities were more likely to adopt latrines than those who were primarily concerned with their own families. Another important observation is that, when households without latrines were asked why they continued to practice open defecation, the majority of households said they had "no choice" (Table 14). However, a significantly lower proportion of treatment households cite this reason following the intervention. This highlights the fact that, in the study area, open defecation is a long-standing and accepted tradition. However, one key goal of the sanitation campaign was to raise awareness of alternative practices, thereby empowering households and communities to move toward a new norm.

Finally, there are some general factors that impact IHL adoption such as distance from road. We find that distance from a road decreased the probability of latrine ownership in the overall sample as well as within the treatment villages. Environmental variables such as distance to roads (remoteness), landscape features (e.g., water logging) and population density are correlated with each other as well as several supply side factors (e.g., unwillingness of masons to come to work) and demand side factors (e.g., effective prices faced by households and exposure to other latrine owners). More work is required to disentangle their impacts, and more critically, their implications.

Furthermore, as suggested in section II, we are using a coarse and loose description of how households perceive the risks of diarrhea. This strategy partly stems from a reluctance to build a complicated framework for risk perceptions such as an adaptive expectations model. However, our fieldwork and analysis reveal that several variables reflecting knowledge, attitude and other proxies for risk perceptions seem to influence prevention behaviors and disease outcomes. These data are in a 2 x 2 format – existing for before and after the intervention surveys and from both treatment and control communities at the household level. Collectively, this wealth of data provides tremendous flexibility for a better specification and comprehensive understanding of how households think of and respond to disease risks. Thus, we will focus on this in the next stage of our analysis.

Some Preliminary Conclusions

Understanding what drives households' decisions to adopt health-related behaviors like latrine use, and what interventions can do to increase these behaviors, is an important concern for development economists and others interested in improving the lives of some of the world's poorest people by reducing disease risks. This paper presented the results of a randomized sanitation promotion experiment in Orissa, which used the "CLTS" approach to motivating latrine construction and use. Using a number of different treatment effects estimators, we find that the sanitation campaign – which addressed a mix of information, cost, and norms-based factors - had a substantial impact on latrine ownership and use in the rural villages included in this study. This increase in latrine ownership, in turn, may have reduced child diarrhea and household welfare, although these results are less robust to different model specifications.

The theoretical model of the latrine adoption decision we developed emphasizes the mixed public-private nature of this good. The model suggests that households weigh psychic and health benefits against opportunity costs of time and material in deciding to adopt IHLs. Furthermore, households' expected benefits of adopting and using a latrine depend not only on their own decision, but also on the decisions of other households in their community. As with other public goods, households may not find it in their own self interest to build latrines if they believe they can "free ride" on the contributions of others. This classic market failure provides part of the impetus behind a government-led intervention. The desire to overcome the coordination failure problem and introduce social incentives for improved sanitation is consistent with one of the main features of the CLTS intervention employed in this study, namely, its emphasis on *communities* rather than *individuals*. This campaign was intended to induce more widespread contributions to the public good of improved sanitation and move communities from one social norm, open defecation, to another, universal latrine use.

Our results suggest that several treatment villages are moving in that direction, although we believe the campaign has not yet achieved its full impacts as many households state that they intend to build IHL in the near future. A benefit of the short follow-up period employed in this study is that it allows us to rapidly identify the short-term impacts of this campaign, and to get an initial sense of whether it "worked." However, it is also important to monitor outcomes over a longer period, since many impacts will only be apparent over time. Health impacts, in particular, would be expected to increase over time as IHL use is maintained and, hopefully, increased. Thus, we are in the planning stages for follow-up data collection to measure these longer-term effects.

Perhaps the most substantive prognosis at this preliminary stage stems from an incomplete, but potentially major aspect of our study. We find that community level measures of infection, prevention and contamination are significant determinants of household behaviors and individual health outcomes. Currently, we cannot say whether these are due to social interactions, epidemiological dynamics, disease ecology or some mix of these factors. However, the panel and randomized nature of our study suggests that careful analysis of these processes (which is possible given the wealth of data) offers a potentially rich vein of knowledge on the pervasiveness of externalities in prevention, infection and cure. Until we have a clearer picture of these Bowlesian 'generalized increasing returns, "Little is settled. Nothing is complete." (Bowles, 2004).

VII. References

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Figure 1: Map Showing Location of Bhadrak District

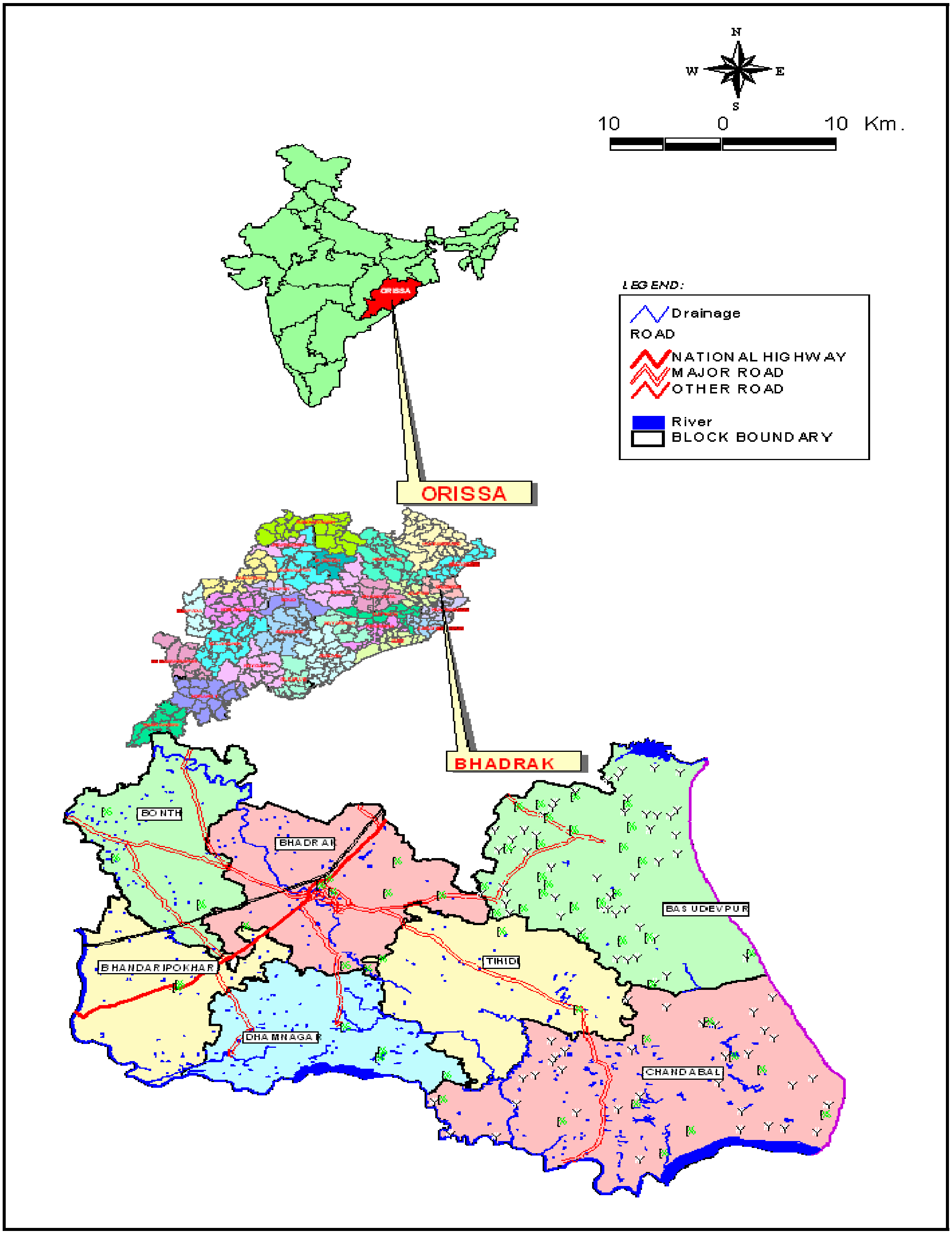

Figure 2: Location of Treatment and Control Villages in Tihidi and Chandbali Blocks, Bhadrak, Orissa

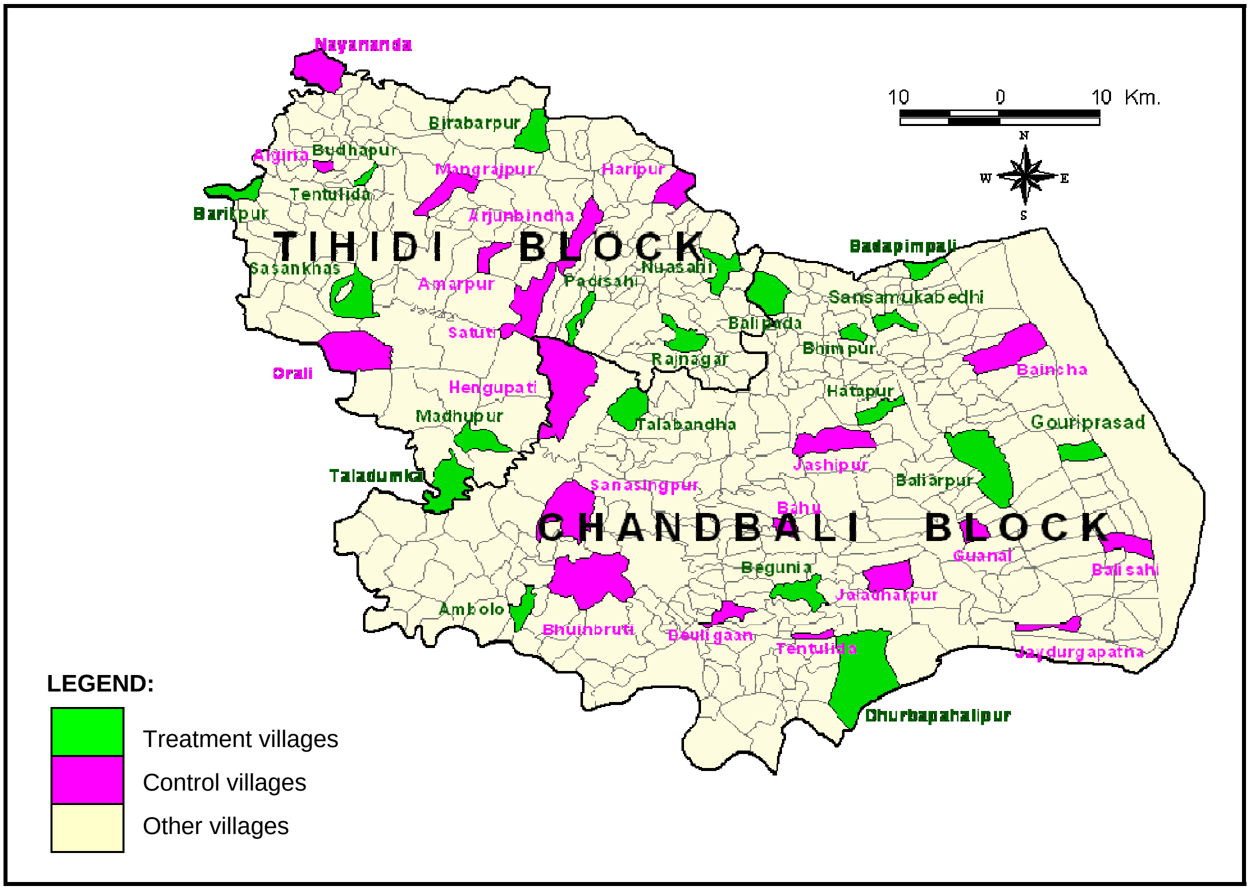

Figure 3: Frequency of Treatment and Control Villages by Percentage of Households with IHL in 2005 and 2006

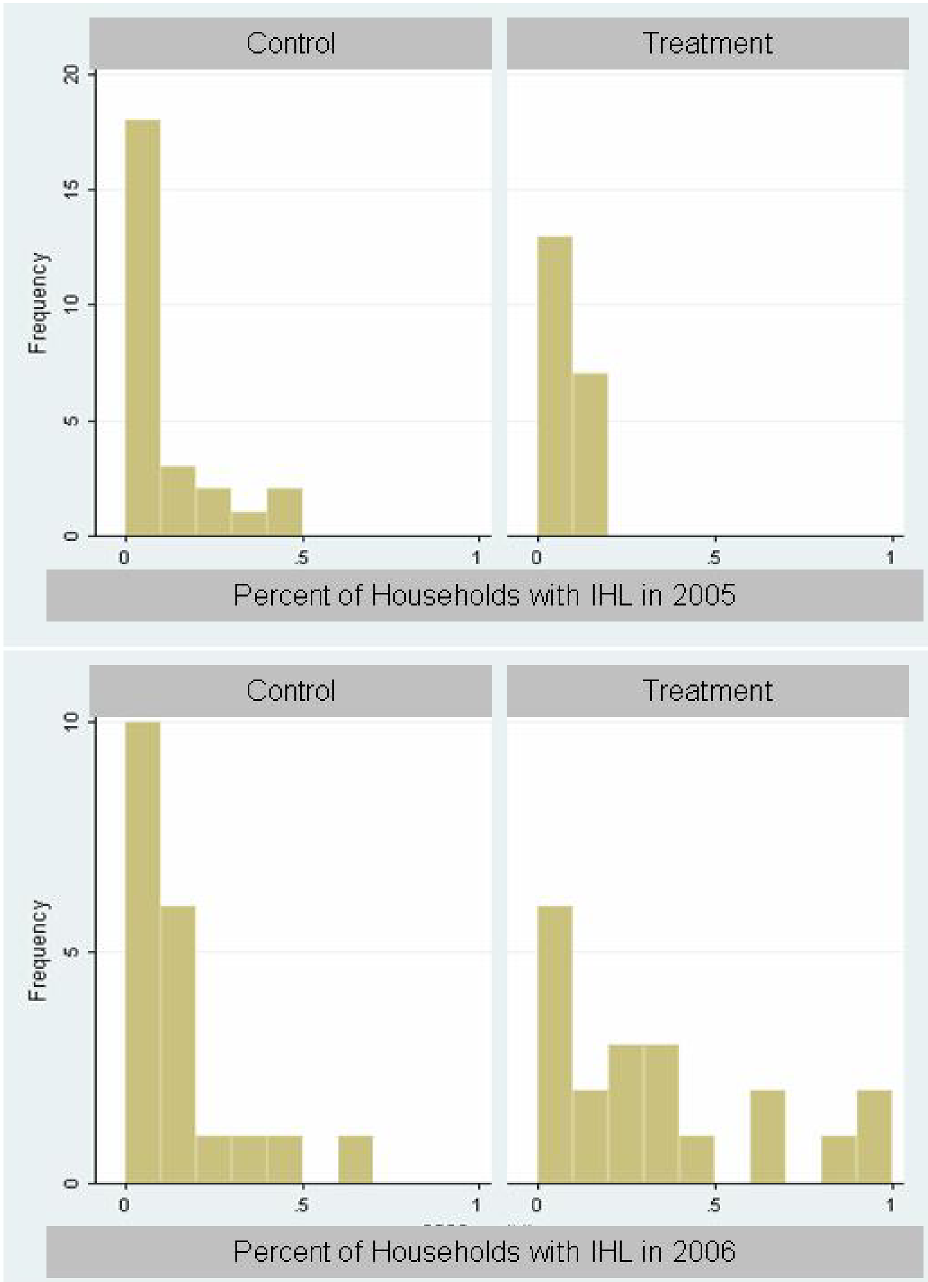

Table 1: Comparison of Means for Selected Household & Village Characteristics†

Variables		Overall	Treatment	Control	T-C
Village population		1509 (445)	957 (102)	2034 (856)	-1076 (862)
Village area (acres)		456 (67.6)	372 (47.6)	535 (123)	-163 (132)
Village population density (people/acre)		15.9 (8.4)	7.04 (3.62)	24.2 (16.0)	-17.2 (16.4)
% BPL		69% (1.5%)	67% (2.2%)	72% (2.1%)	-5.3%* (3.0%)
% Hindu		97% (.5%)	96% (.8%)	98% (.6%)	1.6% (1.0%)
% SC/ST		28% (1.4%)	29% (2.0%)	27% (1.9%)	2.5% (2.7%)
Distance from all-weather road (minutes by foot)		45 (1.4)	51 (2.0)	40 (2.0)	11*** (2.6)
Distance from nearest surface water (minutes by foot)		16 (.8)	16 (1.0)	16 (1.2)	.4 (1.6)
% using tubewell		87% (1%)	89% (1.4%)	85% (1.6%)	4.0%* (2.1%)
Education: % of HH heads with >primary education		53% (1.5%)	52% (2.2%)	54% (2.1%)	-1.3% (3.1%)
Education: % of survey respondents with >primary education		56% (1.5%)	56% (2.2%)	56% (2.2%)	.3% (3%)
HH Size	2005	6.96 (.09)	6.95 (.13)	6.97 (.12)	-.02 (.18)
	2006	7.27 (.09)	7.26 (.13)	7.28 (.13)	-.02 (.18)
Number of children<5	2005	1.44 (.02)	1.48 (.03)	1.40 (.03)	.08* (.04)
	2006	1.20 (.03)	1.24 (.04)	1.15 (.03)	.09* (.05)
Number of children<3	2005	.78 (.02)	.81 (.03)	.75 (.03)	.06 (.04)
	2006	.64 (.02)	.67 (.03)	.61 (.03)	.07 (.04)
Food expenditure in past 30 days (Rs.)	2005	713 (24)	687 (32)	736 (36)	-49 (48)
	2006	1075 (65)	1043 (91)	1105 (91)	-62 (129)
Non-food expenditure in past 30 days (Rs.)	2005	1885 (72)	1762 (94)	2003 (108)	-241* (144)
	2006	1507 (67)	1449 (94)	1562 (96)	-114 (134)

Variables		Overall	Treatment	Control	T-C
% owning TV	2005	14% (1.1%)	10% (1.4%)	18% (1.7%)	-8.0%*** (2.2%)
	2006	15% (1.1%)	11% (1.4%)	18% (1.7%)	-7.4%*** (2.3%)
% owning cell	2005	1.9% (.4%)	1.1% (.4%)	2.6% (.7%)	-1.5%* (.9%)
	2006	4.8% (.7%)	4.0% (.9%)	5.6% (1.0%)	1.6% (1.4%)

† Standard errors are in parentheses

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 2: Comparison of Means for Outcome Variables†

Variable	Year	Overall	Treatment	Control	T-C
% owning IHL	2005	9.7% (.9%)	6.4% (1.1%)	13% (1.4%)	-6.4%*** (1.8%)
	2006	23% (1.3%)	32% (2.0%)	13% (1.5%)	19%*** (2.6%)
% of children<5 suffering from diarrhea in past 2 weeks	2005	26% (1.2%)	28% (1.8%)	23% (1.7%)	4.9%** (2.4%)
	2006	15% (1.1%)	15% (1.5%)	16% (1.7%)	.8% (2.3%)
% of children<3 suffering from diarrhea in past 2 weeks	2005	31% (1.7%)	36% (2.5%)	26% (2.3%)	9.6%*** (3.4%)
	2006	16% (1.5%)	16% (2.1%)	16% (2.1%)	.2% (3.0%)
Total coliform level in household drinking water††	2005	107 (5.17)	101 (7.26)	112 (7.34)	-10.7 (10.3)
	2006	130 (5.08)	126 (7.23)	134 (7.14)	-8.59 (10.2)
E. coli level in household drinking water††	2005	10.8 (1.61)	10.4 (2.26)	11.2 (2.31)	-.80 (3.23)
	2006	14.4 (2.00)	14.7 (2.94)	14.1 (2.73)	.56 (4.00)

† Standard errors are in parentheses

†† Water quality testing was performed for a sub-panel of 50% of surveyed households in 2005 and 2006. Sample sizes for water quality measures are thus 553 (270 treatment, 283 control) in 2005 and 529 (263 treatment, 266 control) in 2006.

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 3: Comparison of Means for Sanitation & Hygiene-related Knowledge, Attitudes, and Practices†

Variable		Overall	Treatment	Control	T-C
% aware of IEC campaign		38% (1.5%)	67% (2.1%)	9.6% (1.3%)	58%*** (2.4%)
% participated in IEC campaign activities		35% (1.5%)	63% (2.1%)	8.7% (1.2%)	54%*** (2.5%)
Number of diarrhea symptoms correctly identified	2005	2.34 (.024)	2.32 (.032)	2.36 (.035)	-.037 (.048)
	2006	3.16 (.048)	3.37 (.070)	2.97 (.065)	.398*** (.095)
% believe that open defecation causes diarrhea	2005	94% (.7%)	94% (1.0%)	95% (1.0%)	-1.1% (1.5%)
	2006	88% (1.0%)	91% (1.3%)	85% (1.6%)	5.4%*** (2.1%)
% who say that it is safe for women to practice open defecation at night	2005	26% (2.9%)	23% (4.5%)	30% (3.4%)	-7.6% (5.9%)
	2006	35% (2.0%)	31% (3.5%)	38% (2.2%)	-6.8%* (4.1%)
% who say that women have privacy during open defecation	2005	11% (5.0%)	1.5% (8.1%)	20% (5.7%)	-18%* (9.9%)
	2006	23% (1.8%)	24% (2.2%)	23% (2.8%)	1% (3.5%)
% who treat water	2005	11% (1.0%)	9.4% (1.3%)	13% (1.4%)	-3.7%* (1.9%)
	2006	13% (1.0%)	12% (1.4%)	13% (1.5%)	-.6% (2.0%)
Number of times mother reports washing hands	2005	6.28 (.068)	6.49 (.096)	6.09 (.097)	.397*** (.136)
	2006	8.30 (.090)	8.44 (.124)	8.16 (.131)	.275 (.180)
Number of times mother reports washing child's hands	2005	2.43 (.025)	2.43 (.035)	2.43 (.037)	.001 (.051)
	2006	2.48 (.041)	2.54 (.056)	2.42 (.059)	.121 (.082)

† Standard errors are in parentheses

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 4: Comparison of Means for Responses to Social Preferences Questions†

Responses to Social Preference Questions	Treatment	Control	T-C
Percent choosing statement “Improving our community is just as important as looking after my immediate family “ over “Taking care of my immediate family (household members) is my first responsibility”	41%	41%	-.1% (3.0%)
Percent choosing statement “We should embrace progress and adopt new technologies and behaviors “ over “It is important to maintain our community’s customs and traditions”	39%	40%	-1.3% (3.0%)
Percent choosing statement “We are often the first household in the village to adopt new technologies and practices” over “We tend to wait until several others in our community have adopted a new technology before we try it ourselves”	35%	42%	-6.8%** (3.0%)
“If we see someone breaking one of our community’s laws, we usually:”			
Percent choosing “Scold him publicly and report him to the village council” over “Don’t say anything; it is better to mind one’s own business”	90%	88%	2.1% (1.9%)
“Imagine that someone has given you some sweets (or, if you don’t like sweets, think of something you do like a lot!). You know that eating them all right away may give you an upset stomach. Do you usually:”			
Percent choosing “Eat a little immediately and save the rest for later” over “Eat them all anyway”	92%	86%	5.9%*** (1.9%)
“It is important to our family:”			
Percent choosing “To be accepted by our village people” over “To make our own choices whether others approve or not”	60%	52%	7.3%** (3.1%)
“You are walking through the village and you come across a large puddle blocking your path. Do you:”			
Percent choosing “Find some stones and sticks and build a path through the puddle” over “Take a different path”	83%	82%	.9% (2.3%)

† Standard errors are in parentheses

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 5: Treatment Effects Analyses for Impact of Intervention on IHL Uptake

Y = household has toilet	Model 1: Probit (2006) & Controls ‡	Model 2: Probit DID‡	Model 3: Probit DID & Controls ‡	Model 4: Linear DID, Village FE & Controls
CLTS ('treat')	**0.293*** **	-0.092**	0.043~	
Post		0.003	-0.182**	0.019
CLTS ('teat') x Post		**0.305*** **	**0.303*** **	**0.247*** **
IHL-2005	***Yes***			
SES-2005 Controls†	***Yes***		***Yes***	***Yes***
KAP-2005 Controls††	***Yes***		***Yes***	***Yes***
N	1043	2136	2122	2122
Pseudo R.Sq	0.275	0.075	0.25	0.202

Table reports marginal effects calculated from probit regressions.

‡ errors are clustered at village level

† includes household's religion (Hindu), caste (open caste), land ownership, TV ownership, and electricity connection in 2005

†† includes whether household knowledge, attitudes and practices. Attitudes include if they think their village is very dirty, if they completely dissatisfied with their current sanitation situation. Knowledge includes ability to correctly identify symptoms and causes of diarrhea and exposure by 2005 to TV and radio campaigns that focused on toilet and sanitation. Practices include whether they treat or boil their drinking water, how often adults and children wash hands (after critical daily activities – eating, defecating), and their participation in community activities such as sweeping streets and cleaning drains.

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 6: Comparison of Means for IHL use and Open Defecation Practices†

		Overall	Treatment	Control	T-C
Whole sample					
Men use IHL	2005	6.6% (.8%)	3.4% (.8%)	9.8% (1.3%)	-6.4%*** (1.5%)
	2006	15% (1.2%)	22% (1.8%)	8.2% (1.2%)	14%*** (2.1%)
Women use IHL	2005	8.6% (.8%)	5.6% (1.0%)	11% (1.3%)	-5.8%*** (1.7%)
	2006	15% (1.1%)	22% (1.8%)	8.0% (1.2%)	14%*** (2.1%)
Children use IHL	2005	5.2% (.7%)	3.6% (.8%)	6.7% (1.1%)	-3.1%** (1.3%)
	2006	7.2% (.8%)	10% (1.3%)	4.0% (.8%)	6.5%*** (1.6%)
	2006	3.58 (.16)	3.42 (.22)	3.70 (.22)	-.28 (.31)
Only HHs that have IHL					
Men use IHL	2005	67% (4.6%)	53% (8.7%)	73% (5.3%)	-20%* (10%)
	2006	68% (3.0%)	70% (3.5%)	64% (5.8%)	6.0% (6.8%)
Women use IHL	2005	86% (3.4%)	85% (6.2%)	86% (4.2%)	-.6% (7.4%)
	2006	67% (3.0%)	69% (3.6%)	63% (5.8%)	6.2% (6.8%)
Children use IHL	2005	52% (4.9%)	56% (8.6%)	51% (6.0%)	5.2% (11%)
	2006	33% (3.0%)	33% (3.6%)	31% (5.6%)	1.9% (6.7%)

Sample sizes:
Whole sample (2005): 534 treatment HHs, 552 control
Whole sample (2006): 521 treatment, 529 control
With IHL (2005): 71 treatment, 34 control
With IHL (2006): 70 treatment, 168 control

† Standard errors are in parentheses
* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 7: Results of Specification Tests for Impact of Sanitation Campaign on Other Diarrhea-related Behaviors

	Dependent variable: Number of times mother washes hands	Dependent variable: Number of times children under 5 have their hands washed	Dependent variable: HH treats drinking water
Explanatory variables:			
Treatment	.331	-.026	-.038
Post	2.00***	-.038	-.002
Treatment*Post	**-.056**	**.147**	**.035**

† Standard errors are in parentheses

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 8: Estimates of IHL Adoption on Diarrhea Rates for Children Under 5

	Intention to Treat		Instrumental Variable	
Y = Child has diarrhea	Model 1: Under3 ‡	Model 2: Under5‡	Model 3: Under3‡	Model 4: Under5‡
Treatment	0.098***	0.051**		
Post	-0.042	-0.051	-0.182**	-0.321**
Treatment x Post	**-0.098***	**-0.051**		
IHLhat			**-0.191**	**-0.318***
Community WQ (total coliform)	**0.001*****	**0.001***	**0.004***	**0.001***
SES-2005 Controls †	*Yes*	*Yes*	*as IV*	*as IV*
KAP-2005 Controls †	*Yes*	*Yes*	*as IV*	*as IV*
N	1440	2720	1440	2720
Pseudo R.Sq	0.05	0.03		

‡ errors are clustered at village level

† same as in latrine adoption model – see table 5.

* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 9. Estimates of IHL Adoption on Other Welfare Outcomes

		Treatment		Control			
Outcome of interest	**Year**	**N**	**mean**	**N**	**mean**	**T-C**	**DID**
Days unproductive	2005	157	3	929	3	0.86	-1.08
	2006	157	2	929	2	-0.21	
Hospital nights	2005	157	0.1	929	0.05	0.08	-0.08
	2006	157	0.04	929	0.04	-0.005	
Medical costs (Rupees)	2005	157	237	929	152	85	-327
	2006	157	130	929	371	-242	
Work/school days lost	2005	157	1	929	1	-0.003	-0.03
	2006	157	1	929	1	-0.03	
Time spent walking to place for defecation (minutes)	2005	157	28	929	27	2	-17***
	2006	157	3	929	19	-16***	

Table 10: Analysis of IHL Uptake for Treatment Villages Only

	Dependent Variable: HH has IHL N= 495 Pseudo-R^2=.195
Explanatory variables:	
Aware of Campaign	.1518***
Population density	.0069**
SCST	-.1557
HH Head Education	.0038
Respondent's Education	.0160
Household size	-.0129
Children <5	-.0105
Distance to all-weather road	-.0015**
Distance to surface water	-.0005
Mud floor ‡	-.2135*
Mud or thatch walls‡	.2895***
Thatch roof‡	-.2113*
Ln(expenditure)	.0900
Tubewell	.0157
Mosquito Net	.0360***
TV	.1437
Mattresses	-.0071
Social preference 1: Community as important as family‡‡	.2145***
Social preference 2: Embrace progress‡‡	-.0085
Social preference 3: First to adopt new technology‡‡	-.0380
Social preference 4: Report offenders‡‡	-.1696
Social preference 5: Willpower‡‡	.0444
Social preference 6: Important to be accepted‡‡	-.0688
Social preference 7: Solve problems‡‡	-.0316
‡χ^2-stat for joint significance of housing material variables	13.46***
‡‡ χ^2-stat for joint significance of social preference variables	36.60***

Table reports marginal effects calculated from probit regressions.
* = significant at 10% level, **= significant at 5% level, ***= significant at <1% level

Table 11: Estimated Effects of 2005 Diarrhea Rates on 2006 IHL Uptake

Dependent Variable: HH has IHL in 2006	
Diarrhea Rate Variables:	**Coefficient (Standard error)**
Village-level diarrhea rate in 2005	.961 (.864)
Village-level diarrhea rate for children under 5 in 2005	.267 (.272)
Household-level diarrhea rate in 2005	.125 (.117)
Household-level diarrhea rate for children under 5in 2005	.085* (.045)

Note: Other explanatory variables included in these regressions are those listed in Table 5.

Table 12a: Comparison of treatment effects for APL and BPL households

	Estimated impact of campaign on IHL adoption	
Sample	**Regression w/controls**	**DID w/controls**
Whole sample (N=872)	28.6%***	29.9%***
BPL only (N=494)[ϕ]	29.9%***	31.4%***
APL only (N=227) [ϕ]	29.1%***	38.0%***
Non-BPL only (N=378) [ϕ]	28.6%***	29.8%***

Table 12b: Comparison of reported latrine costs for APL and BPL households

		Pit latrines			Flush latrines		
		Number who built	**Average cost**	**Difference in cost (T-C)**	**Number who built**	**Average cost**	**Difference in cost (T-C)**
Whole sample	Treatment	107	420	-138	26	1341	-11325
	Control	10	558	(p=.54)	3	12667	(p=.21)
BPL only [ϕ]	Treatment	58	291	-156	19	1522	--
	Control	8	448	(p=.52)	0	--	
APL only [ϕ]	Treatment	28	807	--	4	815	-24185
	Control	0	--		1	25000	
Non-BPL only [ϕ]	Treatment	49	574	-426	7	851	-11815
	Control	2	1000	(p=.54)	3	12667	(p=.20)

[ϕ] The "non-BPL" category includes all households that did not identify themselves as below the poverty line (i.e., this group includes households that identified themselves as APL as well as households that did not provide a response to this question).

Table 13. Responses to the questions - Why doesn't your HH have a latrine? (households that practice open defecation)

	2005			2006		
	Treatment N=495	**Control N=481**	**T-C**	**Treatment N=353**	**Control N=459**	**T- C**
No health benefits	1%	2%	-1%**	.8%	1.3%	.5%
Lack of privacy	1%	2%	-1%	.6%	.4%	.2%
Lack of safety	1%	2%	-1%	.8%	.2%	.6%
Too expensive	51%	52%	-1%	**11%**	**16%**	**-5%****
Don't know how	2%	2%	0%	.6%	0%	.6%
Gov't should provide	16%	13%	3%	10%	10%	0%
Inconvenient	23%	25%	-2%	12%	11%	1%
To make village cleaner	*Option not included*	*Option not included*		0	0	0
Sanitation campaign	*Option not included*	*Option not included*		.3%	0	.3%
No space	*Option not included*	*Option not included*		.6%	.2%	.4%
Other	0	.2%	-.2%	**66%**	**64%**	**2%**

Table 14. Responses to the question - Why does your HH practice open defecation? (households that practice open defecation)

	2005			2006		
	Treatment N=495	**Control N=481**	**T-C**	**Treatment N=353**	**Control N=459**	**T-C**
No choice	87%	76%	11%***	**92%**	**96%**	**-4%*** **
Health benefits	2%	7%	-5%***	4%	3%	1%
Privacy	0	1.2%	-1.2%**	0	0	0
Safety	3%	1.5%	1.5%*	0	0	0
Reasonable cost	2%	1%	1%	.3%	0	.3%
Know how	0	0	0	1.4%	0	1.4%**
Gov't provided subsidy/information	0	0	0	.3%	0	.3%
Convenient	4%	11%	-7%***	.6%	0	.6%
Plenty of space	*Option not included*	*Option not included*		.9%	.7%	.2%
Other	.4%	.2%	.2%	.9%	0%	.9%*