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**Games for Groundwater Governance: Field Experiments in Andhra Pradesh, India**

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Groundwater is a common pool resource which experience depletion in many places around the world. The increased use of irrigation and water demanding cash crops stimulate this development. We present results of field experiments on groundwater dilemmas performed in hard rock areas of Andhra Pradesh, India. Two NGOs (Foundation for Ecological Security and Jana Jagriti) ran the games in communities in which they were working to improve watershed and water management. Games were played with groups of five men or five women, followed by a community debriefing. Results indicate that longer time of NGO involvement in the village was associated with more cooperative outcomes in the games. Individuals with more education and with higher perceived social capital played more cooperatively, but neither gender nor method of payment had a significantly effect on individual behavior. When participants could repeat the game with communication, similar crop choice patterns were observed. The games provided an entry point for discussion on the understanding of communities of the interconnectedness of groundwater use and crops choice.

**Keywords:**
Andhra Pradesh, India, Field experiments, Experimental games, Collective action, Groundwater

# Games for Groundwater Governance: Field Experiments in Andhra Pradesh, India*

## I. Introduction

Groundwater use is a pressing issue in global water management. The key use of groundwater is irrigation which uses 70% of global freshwater withdrawals and 43% of the water for irrigation is coming from groundwater (Siebert et al. 2010). Groundwater use for irrigation is increasing in absolute and relative terms (Seibert et al. 2010).

India is the biggest user of groundwater for agriculture, in the world (Shah 2009). According to 4th Minor Irrigation Census (2006-07) (http://micensus.gov.in/), the number of shallow tube wells and deep tube wells increased from 8.35 million and 0.53 million to 9.12 million and 1.44 million respectively. Today, more than 60% of the irrigation requirements are being met by groundwater alone, clearly indicating the increasing dependence on wells for irrigation. When juxtaposed against the fact that more than 85% of the drinking water requirements in India are met from groundwater (World Bank 2010), there is tremendous pressure on groundwater resources in India. This is reflected in the falling groundwater levels, indicated in pre-monsoon decadal trends captured by the Central Groundwater Board (2013): About 50% of the wells tested showed a decline, with 36.77 % of the total wells showing a decline of between 0-2 meters below ground level (bgl) and about 13% of the wells showing a decline of more than 2 meters. Decline in water levels in excess of 4 meters bgl is prominent in the states of Rajasthan, Punjab, Haryana, Delhi and Andhra Pradesh. In total, 1494 out of the 4277 blocks (sub-district administrative units) assessed, or about 26%, fall under the categories of 'critical, 'semi-critical' and 'over-exploited'.

Groundwater is a common pool resource: exploitation by one user reduces groundwater availability for the rest of the users, but it is very difficult to exclude users or limit their extraction, provided they have the land and financing necessary for a well and pump (Ostrom et al. 1999). Detection of free riding behavior is typically a challenge since the resource is not directly observable, and, unlike surface irrigation, users are not drawing from a visible common channel but individually from an invisible aquifer. Like users of many other common pool resources, farmers using groundwater in many places around the world face a dilemma: they have to choose between short terms individual gains from water extraction and long-term sustainability of the resource, especially where recharge is limited and highly water-consumptive crops are more profitable than crops with low water consumption.

Collective institutions have evolved to address such common pool resource dilemmas in many contexts, including surface irrigation, forests, and rangelands. However, groundwater presents particular challenges to the evolution of such commons management owing to the lack of clear boundaries or visibility of the resource stocks and flows, and the difficulty of regulating the installation and use of wells on individual land holdings. In India, the government has had limited capacity to regulate groundwater use (Shah et al. 2012). The major state regulatory measure consists of restricting the issuance of electricity connections for pumps within a certain distance of existing wells within blocks that have been declared to use too high a proportion of recharge, or regulating electricity supplies to wells. However, those who can purchase diesel pumps can get around even these regulations.

One response is to work through NGOs to raise awareness of the problems of groundwater overextraction, and ways of addressing them, including forms of community groundwater budgeting or limitations on types of crops grown or technologies for water extraction and application (notably drip

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irrigation). Ultimately, however, the success of such measures depends on farmers' decisions on what crops to grow, and how.

Several studies have looked at the determinants of collective action and human behavior, using different approaches including qualitative and quantitative data collection and analysis, common-pool resource experiments and action research (Baland and Platteau 1996, Meinzen-Dick et al. 2002, Poteete et al. 2010, Janssen and Anderies 2011). A growing number of researchers use field experiments with farmers in rural communities to collect information on how people, facing real-life resource challenges like scarce water supplies, behave and work together to solve collective problems. Such field experiments are increasingly used to measure collective action and test theories about behavior regarding common pool resources, including irrigation (Cardenas 2000, Cardenas et al. 2013, Anderies et al. 2011, Janssen and Anderies 2011, Janssen et al. 2012).

This paper examines the main factors that affect the behavior and attitudes of groundwater users regarding the management of this common pool resource in Andhra Pradesh, India. We use a field experiment to look at how people make decisions related to what crops to plant and how much groundwater to use. Most of the earlier studies on groundwater experiments were performed with student participants (but see Salcedo Du Bois 2014). Our study is performed with farmers who experience groundwater problems in Andhra Pradesh, India. We aim to understand the social and biophysical contextual variables that can explain the decisions of the participants. A better understanding of the factors that influence people's behavior about groundwater use can be very valuable for the design of future programs aiming at improving groundwater management in India.

In the next section we briefly review the literature on field experiments on common pool resource management in irrigation. The third section provides background on the field study context in Andhra Pradesh. This is followed by a description of the design of the overall study and the experimental game. We then present and analyze the results at the individual and group level, and conclude with implications of these findings for groundwater management.

**II. Experimental Games to Study Irrigation**

Experiments are frequently used to get a better understanding about how decisions on the use of natural resources are being made and which factors affect cooperation decisions (Anderies et al. 2011, Prediger et al. 2011, Cardenas and Carpenter 2008, Vollan 2008). Several studies have used controlled experiments to analyze the factors that influence collective action in groundwater contexts. Those experiments are extensions of traditional static common-pool resource experiments (Ostrom et al. 2004). By including dynamics, such as the depletion of the groundwater resource, experiments show that participants are more sensitive to myopic behavior (Herr et al. 1997, Moxnes 1998a, 1998b). Gardner et al. (1997) show that a quota system leads to best outcomes of groups sharing groundwater compared to restricting entry to a smaller number of participants. Suter et al. (2012) show that a spatial representation of a groundwater game leads to less myopic behavior compared to a non-spatial representation. Salcedo Du Bois (2014) compared groundwater experiments with student participants and Mexican farmers and found less myopic behavior with student participants.

Groundwater resources show some particular challenges that hinder the development of collaborative outcomes. On the one hand, individual farmers can easily gain access to groundwater resources if they own or lease land and can invest in a well. On the other hand, developing self-governance norms for groundwater systems is usually more challenging because irrigators may have limited information about the boundaries, structure and capacity of the common-pool resource (Schlager 2007). Owing to the "invisible" character of groundwater resources, appropriation and provision problems are initially less obvious to groundwater users. The game designed for this study makes explicit the impact of individuals' crop choice on overall groundwater levels, and then examines the factors that affect farmers' choice of water-consumptive (but profitable) or less water-consumptive (but less profitable) crops. Since our participants will be farmers with small land holdings and few alternatives of income generation, the use of irrigation or not can make a difference in subsistence level living or slightly better living standards.

**III. Groundwater Situation in Andhra Pradesh**

The state of Andhra Pradesh in India is highly dependent on groundwater. Groundwater is used to irrigate an area of 3.17 million hectares, more than half of the total area under irrigation (6.28 million ha) and to meet about 80% of the drinking water needs of the growing population (Directorate of Groundwater 2011). During the last three decades, groundwater use has dramatically increased leading to falling groundwater tables. Since the 1980s, the number of wells has increased from 800,000 to 2.5 million and the land under groundwater irrigation has almost tripled (Directorate of Groundwater 2011). The state is divided into 1,227 groundwater blocks, out of which 300 were at critical or overexploited levels in 2008 and 208 were at semi-critical levels (World Bank 2010). Kumar et al. (2011) depict a more pessimistic picture and argue that groundwater overexploitation has been underestimated because of an underestimation of the outflows of the systems. They argue that groundwater irrigation reached a saturation point in 2000-01.

Reversing this situation is not an easy task. Even though groundwater is a common pool resource, in most of Andhra Pradesh groundwater is not managed under a common property regime, which poses serious risks for the future of the resource. Owing to the invisible character of the resource and the difficulties to monitor private pumping, enforcing specific legislation to regulate groundwater use is difficult and expensive. Individuals construct and operate wells, and although there are regulations on the development of wells within a certain distance of an existing well, unless the well owner applies for an electricity connection, there is little that the state does to enforce even well development, much less their operation. Lack of information about the underlying resource dynamics, especially in hard rock aquifers, makes it difficult for communities to act. Moreover, groundwater can take a long time to renew, further masking the relationship between use, recharge, and water availability. Private financing for wells also means that wealthier farmers have an advantage in obtaining groundwater because they are better able to afford pumps and well deepening.

Several programs and initiatives have been developed in India and Andhra Pradesh to address the problem of groundwater overexploitation. In 2002 the government of India developed The National Groundwater Recharge Master Plan to encourage the recuperation of groundwater levels through artificial groundwater recharge (Central Groundwater Board 2002). The plan estimates that a total of 36 billion cubic meters can be recharged by using specific recharge structures and rooftop rainwater harvesting in urban areas (Central Groundwater Board 2002, World Bank 2010). However, World Bank (2010) argues that the Master Plan may fail to reach the areas where groundwater overexploitation is more severe because of the criteria used to identify the most suitable recharge areas, which include availability of surplus water and availability of storage space in aquifers. Two major strategies for addressing groundwater depletion are increasing recharge through watershed management, and reducing extractions through community-based groundwater management, which may include restrictions on new wells, sharing water from existing wells, groundwater budgeting and limitations on water-intensive crops (for a review of three major approaches used in Andhra Pradesh, see Reddy et al. 2014).

Foundation for Ecological Security (FES) and Jana Jagriti (JJ) are two NGOs that have been working with communities in Andhra Pradesh to strengthen management of common property resources, including water management. The NGOs have provided the tools and expertise for villagers to measure their groundwater levels and worked with the villagers to see the relations between water budgets, crop choice and groundwater levels.

FES and JJ work on watershed management in Ananthapur and Chittoor districts, which are classified as arid to semi-arid, with an average of 500 to 700 mm of rainfall per year. Ananthapur is one of the most water-hungry districts in the country, with more than 100,000 minor irrigation units (4$^{th}$ Minor Irrigation Census; http://micensus.gov.in/). In Ananthapur, the percentage area irrigated by tube wells rose from 44% in 1998-2001 to 76% in 2010-12; during the same period, the percentage area irrigated by dug and open wells declined from 27% to just 4% and that by tanks declined from 22% to about 15% (based on three-yearly averages derived from figures from the Department of Irrigation and Canal Area Development of the Government of Andhra Pradesh for 1998-99 to 2011-12).

Given the absence of perennial rivers, Ananthapur has always relied upon the indigenous rainwater harvesting and management systems like feeder channels, cascading chains of tanks and networking water bodies (Rukmini and Manjula 2009). These water bodies were an integral part of the economic and cultural fabric of the rural communities of Ananthapur. A survey conducted in 2004, by the District Collector of Ananthapur identified more than 5800 water bodies, of which 1373 were large tanks with a command area of more than 100 acres and 2094 were small tanks. The survey found that only one-fourth of the identified water bodies were dysfunctional; the meteoric rise in the number of tube wells put paid to community-based irrigation systems that had been the bulwark of agriculture and indeed much of rural economy in Ananthapur. The fact that many households in the district could not afford tube wells, and the simultaneous enfeebling of traditional irrigation sources like tanks has meant that a large number farmers cannot practice agriculture with reasonable assurance. These farmers are finding themselves in a position where they are forced to cut down on cultivation or walk into unmanageable debt-traps.

Ananthapur predominantly has crystalline rock formations, which translates into wide fluctuations in groundwater levels. While water levels are healthy during the rainy season, and after a good monsoon, they rapidly drop with the advance of the dry season; in years when rainfall is sub-par—and this is often considering that Ananthapur is one of the most drought-prone districts in India—the decline in groundwater levels is precarious. This needs to be looked at in light of the changing agricultural patterns in the district; today, water-intensive crops like tomatoes, sunflower, mulberry and paddy dominate the agri-scape of the district, gradually elbowing out crops like millets and pulses. This trend, together with that of oft-recurring droughts, has brought the district to the brink of water-starvation; analysis of time-series data indicates that 55% of the wells in Ananthapur show falling water levels, ranging between 0.15 to 0.65 meters per year. Pre-monsoon trends indicate that 87% of the wells in Ananthapur have witnessed a fall in water levels (Central Groundwater Board 2012). More than 40 out of the 65 mandals (administrative divisions) in the district come under 'critical', 'semi-critical' and 'over-exploited' categories (Central Groundwater Board 2007, 2012).

Experimental games were mostly conducted in the NP Kunta and Tanakal mandals of Ananthapur. While both these mandals fall under 'safe' category, groundwater depletion is a clear and present danger. Many of the Gram panchayats in these Mandals experience acute water shortage during summers, which gets accentuated during droughts. This brings significant losses to the farmers, but even nonfarmers are affected by falling water tables depleting domestic water supplies, with women particularly affected because they are generally responsible for household domestic water supplies. In many villages where the games were organized, the groundwater has high fluoride content, posing significant health hazards. Paucity of potable water is forcing many people to buy water cans on a regular basis, which in turn adds to the financial burden of the rural households. Finally, in some cases, shortage of water for drinking and irrigation is forcing households to migrate. The facts presented here point to the urgency of effecting sound groundwater governance mechanisms, to strengthen the backbone of the rural economy of Ananthapur.

**V. Methodology**

Most field experiments pay individuals based on their "earnings" during the game. In line with the principles of experimental economics, a real, substantial incentive is provided for the decisions to be made. The earnings vary depending on how they play the game, recreating the kind of "commons dilemma" faced in practice—individuals will get more monetary earnings if they choose the more water-intensive crop, but if the whole group does that, the water is depleted faster and they will get less than if they chose the more sustainable crop. So some individuals will be paid more than others, and this is expected to affect how they play (Smith and Walker 1993).

In this project, the participating NGOs are interested in using the groundwater games in their community organizing work after the project is completed and the experiences are positive. But based on their approach to community organizing, they would not plan to pay people individually. However, it is becoming standard practice for NGOs to make a contribution to a community fund when the community

members participate in studies. We therefore ran the experiments with both payment method to test whether it affects behavior in the way people play the games.

Participants in the individual-payments treatment received Rs. 5 for each unit of income earned in both games. Their earnings varied depending on how they played the game and total earnings could range between Rs 200-500 per participant in the individual payment treatment. (For comparative purposes, the daily wage for National Rural Employment Guarantee Act (NREGA) projects is Rs 115. All households are entitled to up to 100 days of employment at NREGA sites, but this is often hard physical labor.) In the flat-fee treatment, individual participants were not paid, but the local watershed committee was given a donation of Rs. 2000. Only one approach—either individual or group payments—was used in each community to prevent cross contamination. People who participated but did not get individual payments did not see others being paid individual earnings. We also included control communities who were covered by the same watershed management programs from the government and the NGOs, but did not receive the games. This was to allow us to subsequently test whether the games had an effect on collective action. However, because the control communities did not play the games, they are not included in this paper.

To allocate habitations to these treatments and control, we drew a stratified systematic sample with a random start. The process was to list all the habitations according to watershed (four where FES is working, and three where Jana Jagriti operates), and then within watershed, by number of houses. We verified that each habitation has groundwater use for irrigation from bore wells or open wells. We then randomly drew a number between 1 and 3 for the start. That habitation on the list received treatment A (individual payment), then went down the list with treatment A, B (flat fee to watershed committee) and C (control).

This sampling method was used because with relatively small sample sizes, it is an efficient way to ensure that the sample is distributed across key variables that are likely to affect outcomes. In this case, we stratified on watershed and size of community. Watersheds might affect behavior because of different rainfall patterns or other factors, such as different effectiveness of the watershed development programs, NGOs, or field staff assigned to the watershed. Number of houses is a good proxy for number of households or decision-makers; the size of the community is often hypothesized to affect collective action (Agrawal 2001, Olson 1965, Ostrom 1990).

The resulting sample had 9 habitations in treatment A and 8 habitats in treatment B (see Appendix 2 Table 2.1 for details). To select the participants within each site, the study team contacted the watershed community to ask them to identify five men and five women from households that use groundwater for irrigation to participate in an activity that looks at how people make these decisions of what crops to plant. They were told that the activity would take approximately 2 ½ hours and the participants would need to come together in a group for that whole time, and to answer a short survey on a later day. The participants do not all need to own wells—if they use water from a neighbor that is also acceptable. The men and women should not be from the same household, and the committee was asked to select participants that come from different farm holding sizes. The committee was also told whether individuals would be paid based on the outcome of the activity or there would be a joint payment to the watershed committee (but was not told that other payment options were being used in other habitations), and that a debriefing would be held for the whole community after the activity.

**VI. Experimental Design**

The field experiment is framed as a groundwater management exercise to simulate the effects of crop choice on groundwater levels (see Appendix 1 for the detailed experiment protocol). In each habitation, two groups of participants were recruited: five men and five women. During the session, other community members were excluded from the room where the experiment was conducted to minimize distractions or outsiders' influence on the participants. Each group played two sequential games of ten rounds each (although the players were not told how many rounds there would be). In the first game, no communication between the participants was allowed. After the first game was completed, the group was

instructed to discuss the game with each other for 3 minutes. A field team member acted as secretary, recording the topics discussed during the communication periods. Following their discussion, a second game was played, this time with short communication periods of up to one minute following each round.

At the beginning of each experiment, the group shares a single shared groundwater resource of 50 units. During each round, the participants were asked to choose one of two crops for planting—"Crop A", which used one unit of groundwater and provided two units of income, or "Crop B", which used three units of water and provided 5 units of income. Players were instructed that each round simulated the rabi, or dry season, which depends primarily on groundwater. The participants recorded their crop choice in private on a handheld paper form. Their decisions were recorded by a field team member and the resulting payoff for each participant was written onto their decision form. The total number of water units consumed by the group was recorded publicly on the presentation board to show how many units of groundwater remained (Figure 1). Designed to be used for the instruction process at the beginning of the experiment session and for conducting the game itself, the presentation board was printed with an illustration of different types of crops, a bore well, a column to show the water table, an illustration of the water consumption and payoffs for each crop, and a demonstration chart of the water table at the end of each round if all players were to choose Crop A, or Crop B. At the beginning of each round following round 1, aquifer recharge was simulated by adding 5 units of water to the total groundwater resource. The group played the game for ten rounds or until at the end of a round the groundwater resource had less than ten units of water available. This condition ensured that at least 15 units of water would be available after replenishment and all participants could choose crop B without having negative groundwater levels.

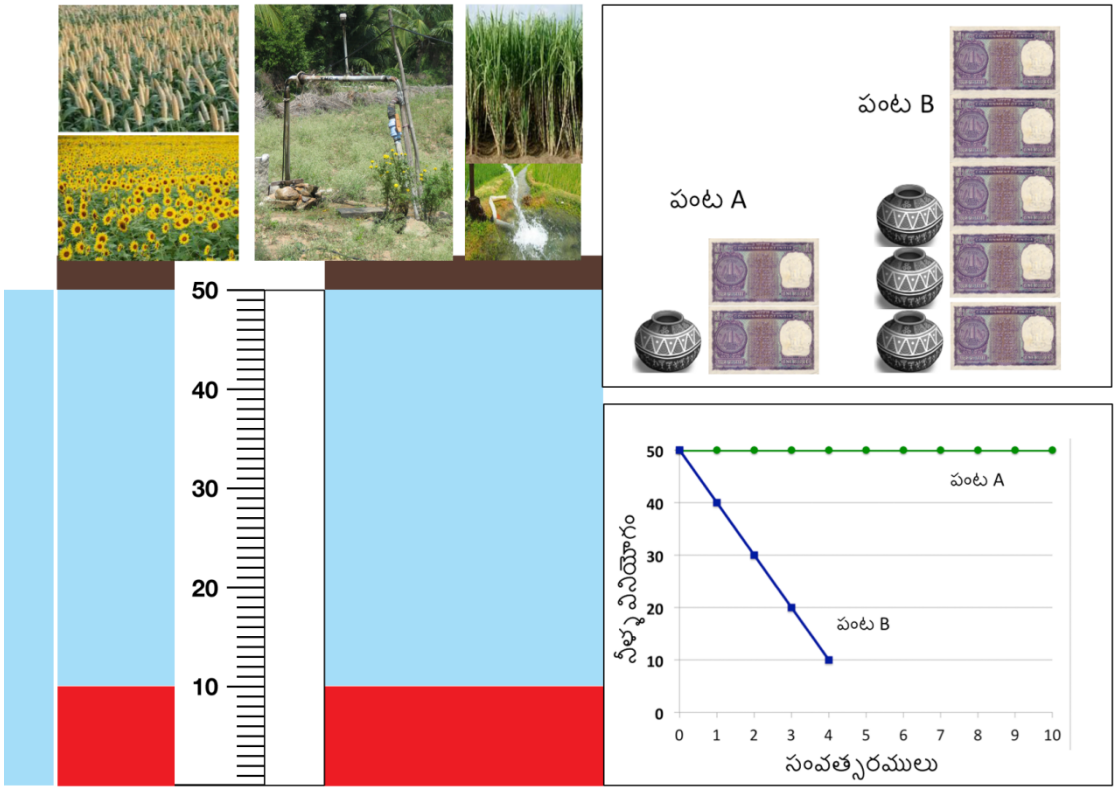


Figure 1. Game poster used to explain the game

The water demand, payoff structure of the game was set up so that if all participants chose to plant Crop A every round, the game could continue indefinitely. If all chose Crop B, the groundwater resource would be depleted and the game ended after four rounds, which is the Nash equilibrium. The group earnings under the Nash equilibrium would be 100 units of income. There are many variations of

mixtures of crop B (22 times) and A (28 times) that leads to group earning of 166 units. If properly coordinated, the groundwater resource will last for the full 10 rounds, only becoming exhausted at the end of the tenth round. Note that the participants were not told that there would be 10 rounds in the game, although after playing the first game, it would have been generally clear for the second game.

Following the experiment sessions with both men's and women's groups, the field team conducted a community-wide debriefing meeting to discuss the groundwater exercise and aggregate results from the games. The community debriefing was usually held in the afternoon or evening after the games, but in some cases, it had to be held on a following day. The debriefing was a guided conversation for game participants to relate their experiences to the situation with groundwater in their area, and to discuss with other community members what could be done. As in the experiment sessions, a field team member acted as secretary, writing notes on the discussion and comments raised during the meeting. We also collected a brief survey from each participant after they had participated in the game. The survey covered background information about the participant as well as their attitudes toward environmental issues, to be used to assess factors that might explain the individual's choices in the game.

## VII. Data Analysis

The data used in the analysis of water use in the groundwater game is derived from 34 sessions of experiments performed in Andhra Pradesh, India between February and May 2013. The dataset consists of 170 people in 34 groups from 17 villages. Each group played two games, once without communication and once with. Two groups were recruited in each village, a men's group and women's group. Each group consisted of 5 participants, and each participant recorded their crop choice for 10 rounds or until the water table dropped below 10 units, whichever came first, resulting in a total of 3,400 observations (summary statistics provided in Appendix 2.)

The average age of the participants was 38.5 years, with men significantly older than women (42.9 years vs 34.0 years). The education level varied among participants: 30% had not received any formal education; 26% had completed primary education and 34% had completed secondary school. The rest had completed higher levels of education such as intermediate school or university. Significant differences are also observed if we disaggregate the education data by gender. Only 15% of the men had not received any formal education in comparison to 45 % of the women. 35% men had completed primary school in comparison to 17 % women. In higher levels of education the differences between men and women was smaller although the percentage of men that had received higher levels of education was higher (38% men had completed secondary school vs. 31 % of women).

The dependent variable is crop choice (and consequently water use). We analyze both individual- and group-aggregate decisions to verify the robustness of our results. The individual analysis uses logistic regression (logit) to estimate the probability of choosing the more water-consumptive crop (B); the group level analysis used ordinary least squares regression (OLS) with robust standard errors.

Table 1 reports the independent variables chosen to describe the characteristics theorized to affect cooperation in the games. The first set of variables relate to the game structure: the level of groundwater at the start of each round, the payment type (individual or flat fee), and whether communication was allowed. The next is the number of years that the NGO has been working in the habitation. We also include basic demographic variables including gender, age, caste, education, household size, and an interaction effect for gender and education (to deal with women having lower education, overall than men have). We hypothesized that women would be more water-saving, because they are most severely affected by groundwater depletion, and that education would make people more aware of the interactions between irrigation and water levels, hence more water-conserving.

A Social Capital indicator was derived from a series of questions on the individual survey and normalized to values:

1) If a neighbor in this village lends some money to another neighbor, it is very likely that the lender gets her money back (values 1 to 5).
2) Suppose that 10 of your neighbors are invited to help in community activities. How many would show up? (values 0 to 10)

3) If a mother in this village has an emergency and needs to leave her baby for the day, she will easily find someone in this village she can trust with her baby (values 1 to 5).
4) If someone loses a pig, goat or chicken he or she will easily find others in this village to help to seek and find it (values 1 to 5).

The Social Capital metric is calculated by adding the scores of the four questions and dividing it by the maximum score (25). We made a selection of the questions from the survey and chose the questions above since they represent concrete questions related to trust and social capital. We would expect that those with higher social capital (trust in others) would be less likely to overexploit groundwater.

In Model 2 we added total land owned and irrigated by tanks and well to account for dependence on agriculture and irrigation, as well as knowledge of the resource (in the case of area of groundwater irrigated).

Table 1. Definitions of the independent variables used in analysis.

| **Variable** | **Definition** | **Value** | **Mean** |
|---|---|---|---|
| Avail. Water | Quantity of groundwater available at beginning of round, after recharge | [0, 50] | 1.502 |
| Flat Fee | Flat Fee treatment used? | {0, 1} | 1.471 |
| Communication | Communication allowed? | {0, 1} | 33.287 |
| Round | Round number in game | [1, 10] | |
| Years in Program | No. of years village has participated in NGO program | [6, 20] | 6.688 |
| Female | Female participant | {0, 1} | 0.498 |
| Age | Participant's age | [1, n] | 38.500 |
| Caste | Participants' caste category | {1=Scheduled Tribe, 2=Scheduled Caste, 3=Other Backward Castes, 4=Other Castes} | 3.224 |
| Education | Highest education level achieved | {0= none, 1=adult literacy class, 2= primary school, 3=secondary school, 4=intermediate, 5=technical school, 6=university} | 2.024 |
| Female x Education | Interaction effect for Women and Education level | [0, 6] | 0.817 |
| Household Size | Number of people, adults and children, living in household | [1, n] | 4.805 |

| | | | |
|---|---|---|---|
| Soc. Capital | Social capital metric based on related questions from the individual survey | [0, 1] | 0.967 |
| Area Owned | Total area of land owned | [0, n] | 5.205 |
| Area, Tank irrigated | Area of land irrigated by tank water | [0, n] | 0.323 |
| Area, GW irrigated | Area of land irrigated by groundwater | [0, n] | 1.592 |

## VIII. Results

On average, each game was played for 9.12 rounds with the shortest game lasting 4 rounds and the longest being 10 rounds (See tabulated results in Appendix 2.) About 65% of the games were played for the maximum number of rounds (i.e. 10 rounds). On average, the games with communication were played for more rounds (9.44) in comparison to the games without communication (8.79) ($p < 0.001$, using the Wilcoxon Matched-Pairs Signed Ranked test). The level of water remaining at the end of the 10 rounds was not different before or after communication was allowed ($p = 0.12$, using the Wilcoxon Matched-Pairs Signed Ranked test) while the group income at the end of the game was higher in the game with communication ($p=0.045$ using the Wilcoxon Matched-Pairs Signed-Ranks test). A closer look to the behavior of the players over the ten rounds of the game shows that communication was particularly effective at the beginning and at the end of the game when on average players maximized their earnings (Figure 2). Surprisingly, communication did not favor water conservation although group earnings were higher when communication was allowed. Water use was greater in the rounds with communication (Figure 3) although the differences were not significant.

The earnings of the groups were between 97 and 160. Recall the Nash equilibrium was 100 units and the social optimum was 166 units. The median group earnings in treatment A were 136.5 and 140.5 in treatment B. This shows that overall, the decisions made are closer to the social optimum than the Nash equilibrium. The communities where FES ran the experiments earned on average 132.4 units versus 135.7 units for communities where JJ ran the experiments. This is not significant different using the Mann-Whitney test ($p>0.1$). In both cases communication led to a significant improvement using Wilcoxon Matched-Pairs Signed Ranked test ($p<0.01$), with 140.4 and 137.4 respectively. This suggest that communication had a bigger influence in communities where FES was participating ($p=0.095$ with Mann-Whitney test). Contrary to expectations, we did not find any significant effects for gender or payment system.

Figure 4 shows that the water use was highest when groundwater levels were near the maximum. As groundwater levels depleted, participants switched to the less water intensive crop A. This slowed down the decline of the group water levels, but did not stabilize the groundwater levels.

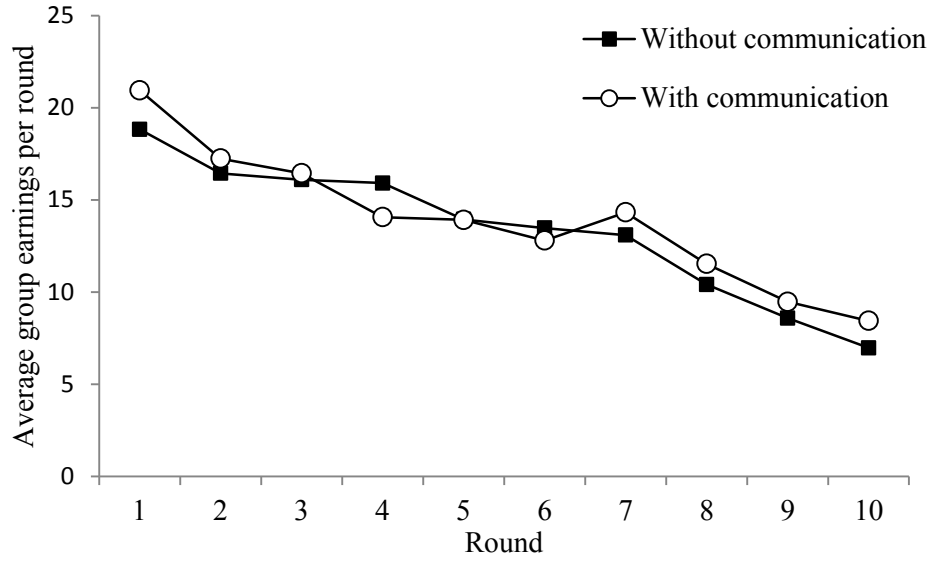


Figure 2. Average earnings for the 34 groups for the conditions that participants could not communicate and for the rounds after which communication was allowed.

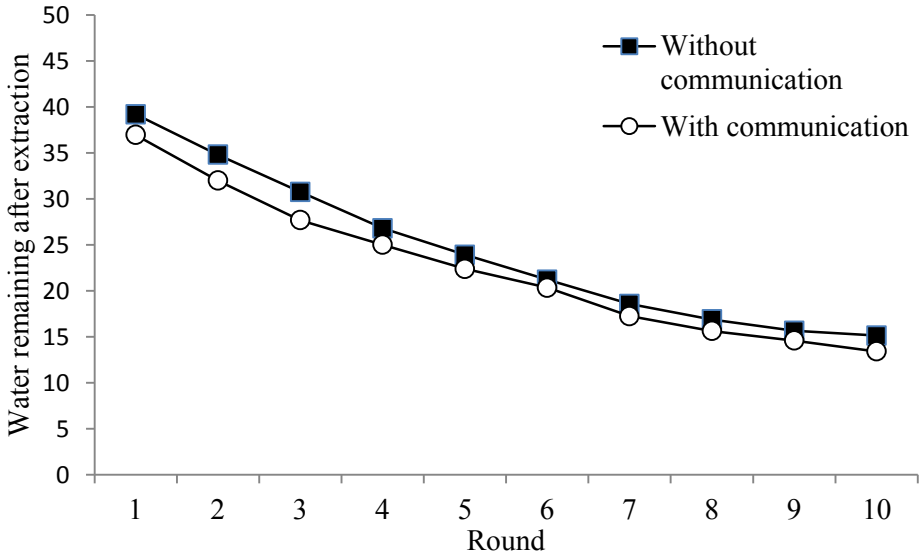


Figure 3. Average amount of water remaining after extraction for the 34 groups for the conditions that participants could not communicate and for the rounds after which communication was allowed.

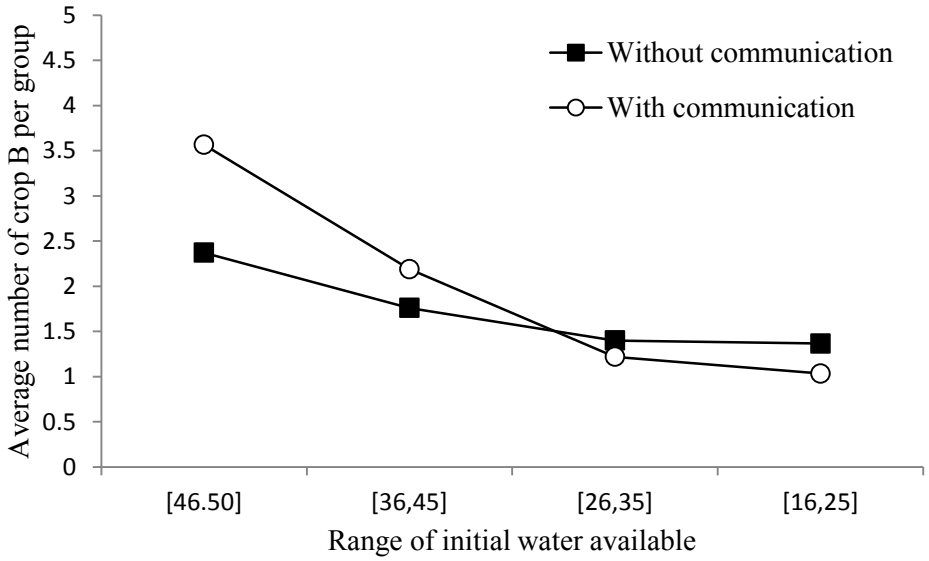

Figure 4. Average number of crop B per group for different levels of groundwater available

In the individual payment treatment, the average payment per participant was Rs. 271 (min=Rs.175 and max=Rs.395). There are no significant differences between the behaviors of the participants in both treatments. The earnings of the "flat rate" treatment ($\bar{x}$ = Rs. 280, min=Rs.190 and max=Rs.395) are essentially the same as the individual payment treatment, suggesting that the game had equal salience to decision-making, whether or not players were paid cash based on the outcomes of their decisions.

Table 2 reports results from the individual- and group-level models where the individual and group-average water use are considered as the dependent variable. The strongest effect on water usage is the length of time villages are involved with NGOs. Both NGOs have similar practices but JJ was involved for 19 to 20 years with these communities on watershed management, while FES only 6 years. Their relationships with these communities may be more deeply established, thus leading the members of these communities to a stronger understanding of groundwater problems and water management. It is also possible that this result indicates an experimenter effect. The field teams received separate trainings, and due to the need for additional test sites in our project, the Jana Jagriti team was recruited and trained at a later date, potentially receiving less background on field experiment principles and protocols compared to the FES field team. However, the long history of JJ work in the communities seems to be a stronger explanation of the result.

The second-strongest effect comes from the Social Capital metric. Participants reporting stronger agreement with trust and social capital indicators in their communities also used less water. The control variable on water use, water availability at the beginning of each round, is highly significant as expected—the higher the water table at the beginning of the round, the more water used in that round.

Contrary to expectations, gender is not significant. However, higher education leads to lower water use and women have a lower education level than men, which is supported by the data (t-test $p < 0.001$; See Appendix 2). An interaction effect between education and gender suggests that crops choice of female participants is less affected by education. Although gender is not significant after controlling for education, the fact that women, on average, chose more water-consumptive crops is somewhat surprising. Women are primarily responsible for domestic

water use, and are therefore most affected when the water table falls and domestic water wells in the villages go dry. Follow-up qualitative research indicated that women associate the failure of domestic water wells with low rainfall, and not with groundwater use for irrigation. A second factor may also be at work: women's time constraints. Although the teams tried to schedule the women's games at a convenient time, it is difficult for women to set aside the time for the full games. Thus, some of the women's groups were willing to deplete the groundwater more rapidly in order to end the game. This indicates the need to be aware of other factors that may affect the way people make choices in the games.

Amount of land irrigated is significant for increased water use, especially for groundwater irrigation. However, there is a negative effect of the amount of land owned and groundwater use. Those bigger landowners might be more familiar with the connection of groundwater levels and crop choice.

Communication has a significant effect in water use compared to the first 10 rounds without communication. A possible reason for the lack of impact is the familiarity of the participants with each other and the context of the game. Chat between the participants may not affect the expectations in the actions of others nor a better understanding of the experiment. The lack of effect of individual payments also indicates that participants make decisions as they are used to in the social-ecological context they experience in the game.

Age is only weakly significant at the group level, and caste is not a significant effect at either level. Likewise, the number of people living in the participant's household is not significant.

There is no effect of the way we pay participants. This suggests that the decisions participants make is not significantly affected by the individual monetary incentives. More research is needed how participants perceive the experience to explain the lack of effect of individual monetary incentives.

**Table 1. Statistical models**

| | Individual-level (Logit) | | Group-level (OLS) | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Avail. Water | 0.030*** | 0.032*** | 0.089*** | 0.095*** |
| Flat-Fee Treatment | -0.047 | -0.115 | -0.139 | -0.119 |
| Communication | 0.058 | 0.050 | 0.134 | 0.139 |
| Round | -0.136*** | -0.133*** | -0.208*** | -0.188*** |
| Years in Program | -0.053*** | -0.054*** | -0.128*** | -0.128*** |
| Female | -0.096 | -0.091 | -0.206 | -0.636 |
| Age | 0.003 | -0.004 | -0.048*** | -0.067*** |
| Caste | -0.050 | -0.040 | -0.144 | 0.121 |
| Education | -0.136*** | -0.143*** | -0.198 | -0.309 |
| Female x Education | 0.107** | 0.104* | 0.040 | 0.241 |
| Household Size | 0.004 | 0.005 | 0.096 | 0.243* |
| Social Capital | -0.537** | -0.580** | -5.204*** | -5.861*** |
| Area Owned | | -0.031** | | -0.079 |
| Area Tank Irrigated | | 0.123* | | 0.095 |
| Area GW irrigated | | 0.099*** | | 0.607** |
| Constant | 0.474 | 0.485 | 14.260*** | 13.312*** |
| N | 3044 | 2900 | 620 | 620 |
| AIC | 3562.629 | 3388.838 | 2936.475 | 2933.551 |
| LL/$R^2$ | -1755.285 | -1664.560 | 0.295 | 0.305 |

Significance at the 1%, 5%, and 10% are denoted by ***, **, and * respectively. Significance level derived from robust standard errors.

## IX. Conclusion

In this paper we present the results of experimental games on crop choice and groundwater use in 17 habitations of Andhra Pradesh (India). The groundwater situation in Andhra Pradesh is delicate as groundwater is the main source of water for many households and many aquifers in the state are overexploited and wells are running dry. A common pool resource game was used to observe how people make decisions about groundwater use and to understand which factors influence people's decisions related to groundwater management. As is commonly found in field experiments (e.g. Cardenas and Carpenter 2008, Cardenas et al. 2013, and Janssen et al. 2012), participants do consider group interests, not only their individual interests. Almost 65% of the games were played for the maximum number of rounds, which suggests that group gains and groundwater conservation were pursued by most participants.

There was a considerable difference in crop choices between the communities facilitated by the two NGOs, with participants choosing less water consumption where the NGO had been working for a longer time. The individual water use level is partly explained by social capital: those participants reporting highest social capital in their community used less water. This finding can have important policy implications, indicating the value of programs that promote collective action and community cooperation for the management of groundwater resources.

Two variables that did not have a significant effect are particularly important: gender and treatment. The fact that women were not more likely to limit water-consumptive crops to maintain the groundwater levels was surprising, given that women are most responsible for domestic water, which becomes scarcer when water tables fall.

The lack of significant difference between individual payments and flat rate compensation to the watershed committee has methodological relevance for future experimental games design. On the other hand we find that the decisions are in line with actual behavior of individuals, such as higher water use by those who have more groundwater irrigation, and higher water use when groundwater levels are higher.

More research is needed to understand some of the surprising findings such as the lack of impact of individual monetary incentives and the lack of gender effect. On the other hand we found a remarkable effect of the length of time communities where involved with participatory projects of NGOs. Future research will focus on solicitation of mental models to derive a better understanding on how participants see the relationship between crop choice, groundwater use and the performance of the community, to help assist government and NGO programs identify the factors that contribute to community management of groundwater resources.

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# Appendix 1. Protocol for Experimental Game, Survey, and Community Debriefing

## Groundwater Field Experiment Protocol

*[FACILITATOR: Make sure everyone is sitting and not distracted by other matters. Read aloud, from the script, and always alert to any questions; be alert for facial expressions of the participants to detect lack of understanding of the activity.* [†]

## Instructions to read to the participants

Hello, I am _____ from FES. As a part of our hydrology project, we want to understand how you make your decisions on what crops to plant. This is a voluntary experience for you to help us to understand what you do. In case there is something you do not understand during the instructions, we invite you to raise your hand and we will be glad to respond to any question. We ask you to turn off your mobile phones to avoid any distractions during the activity. You are free to leave any time you wish, however if you leave, this session will end for everyone else also.

The types of crops that you choose to plant affect how much groundwater is used and how much money you make. We all know that crops like paddy and sugar cane require more water to grow than crops like groundnut and ragi, but paddy and sugar cane also can fetch more income than groundnut and ragi. Isn't that so?

So, if everyone grows paddy or sugar cane, then the groundwater levels are likely to fall more than if everyone grows groundnut or ragi. Does that make sense?

*[Wait for responses]*

We are going to play an activity that looks at how people make these decisions of what crops to plant. This is not a test; it is just an opportunity for you to make decisions just like you do all the time. But in this situation, you will be playing through several years of planting crops in a short period of time. This activity is very simple, and it doesn't include all the things that you usually deal with in your fields. We are just focusing on the *rabi* season, which depends only on *boru* (groundwater). And we are focusing on how you decide between planting one or two different kinds of crops. They are not actual crops that you use; they are pretend crops. One requires a little amount of water to grow and it gives you a small amount of money. We will call that Crop A. The other crop requires more water to grow but gives you more money. We will call that Crop B.

*[ONLY for the Individual Payments treatment:] You will be paid cash at the end of this session based on the crops you choose to plant.*

[†] Text highlighted in gray are instructions for the experimenters.

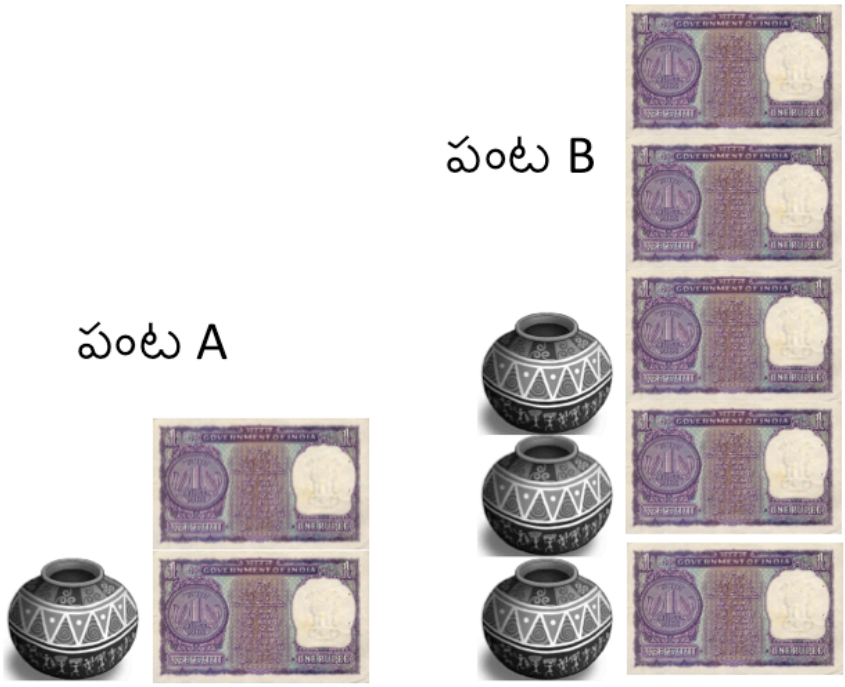


**Figure 1. Crop A/B Comparison**

Any Questions? *[Wait for any questions]*

We will begin by playing an activity. After we have finished playing the activity, we will have a discussion period to allow you to talk about the activity and your thoughts. When we have completed our discussion, we will play the activity again so you can try out the ideas that you may have talked about. During the first activity, you are asked not to speak; we also ask that you not tell other people in the village about this activity until the community meeting. During the second activity, you will have 45 seconds to talk after each year to discuss your plans.

This activity is intended to recreate the situation in which people must make decisions about using water to grow crops. You have been organized into a group of five individuals. You will play a number of years, which have one pretend growing season, when all your water comes from groundwater. Though each of you may have different amounts of land, for this activity you should pretend that you all have the same amount of land, say 1 hectare.

At the beginning of the activity, there are 50 units of groundwater available for your group to grow crops. The amount of groundwater available is shown on the board as blue water in a bore well. As water is used, we will move the blue column down to show you how much groundwater is remaining. Every year, you will have to make a decision, which of the two crops to plant: Crop A or Crop B. Crop A costs one unit of water and gives two units of income. Crop B costs three units of water and gives five units of income. At the beginning of each year, the groundwater supply recharges by 5 units of water. We will show this recharge happen by moving the blue column up by 5 units of water in the bore well.

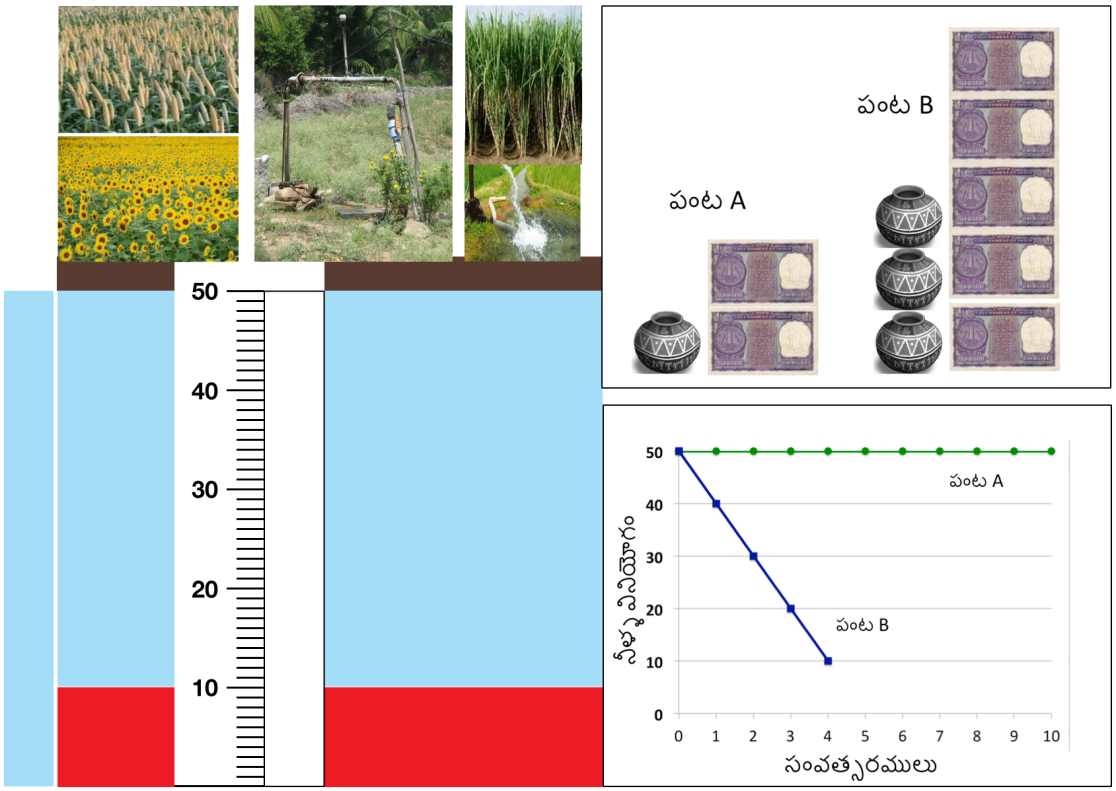


**Figure 2. Water Level Indicator**

So looking at our picture of a bore well, if everyone plants crop A, 5 units of water will be used, leaving 45 units of water. At the beginning of the next round, the groundwater will recharge with 5 units of water, so there will be 50 units of water available for the group.

If everyone plants crop B, 15 units of water will be used, leaving 35 units of water. At the beginning of the next round, the groundwater will recharge with 5 units of water, so there will be 40 units of water available.

If some people choose Crop A and others choose Crop B, then the amount of water that will be used will between these two possibilities.

*[ONLY for the Individual Payments treatment, state:] At the end of the game, we will pay you Rs 5 for every unit of money you earn in this game. So if you earn 20 units of money in the game, we will give you 100 rupees. We will give you your earnings in private, so that no one else knows how much you made.*

We will play the activity for a number of years. If the groundwater level drops below 10 units of water, which is marked here with this red line, for simplicity's sake, the activity is ended due to insufficient water for the group.

When the activity is ended, we will begin a discussion period, where you can talk about the activity, and share any thoughts or observations you may have about your experience. After the discussion session, we will play the activity again, starting with a fresh groundwater supply of 50 units.

I will now describe how we will play the activity in detail. We are handing each of you a piece of paper, your Decision Form. Each year, you will choose which crop to plant by circling one of the two options in the “My Crop” column. Circle “A” if you want to plant crop A, or circle “B” if you want to plant crop B. We will come around to record which crop you want to plant, and we will write how much income you receive for your crops in your Income column. Hold the Decision Form in your hand so only we can see which crop you have chosen to plant.

| Decision Form | | | |
|---|---|---|---|
| Participant: 1 | | | |
| WS: | Vill: | | HU: |
| Group: 1 / 2 | Game: 1 | | |
| | | | |
| | My Crop | | My Income |
| Practice | A | B | |
| Practice | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |

**Figure 3. Participant Decision Form (also shown in large-format to participants for instruction)**

We will calculate how much water the group has used, and we will move the blue column down to show you how much groundwater remains. This is the end of the year.

At the beginning of the next year, we will move the blue column up by 5 units of water to show you the groundwater recharge and announce how much groundwater is available to your group.

So for example, if everyone were to plant Crop A every round, the groundwater supply will fully recharge every round. Each participant would earn a total of 20 units of income from their crops.

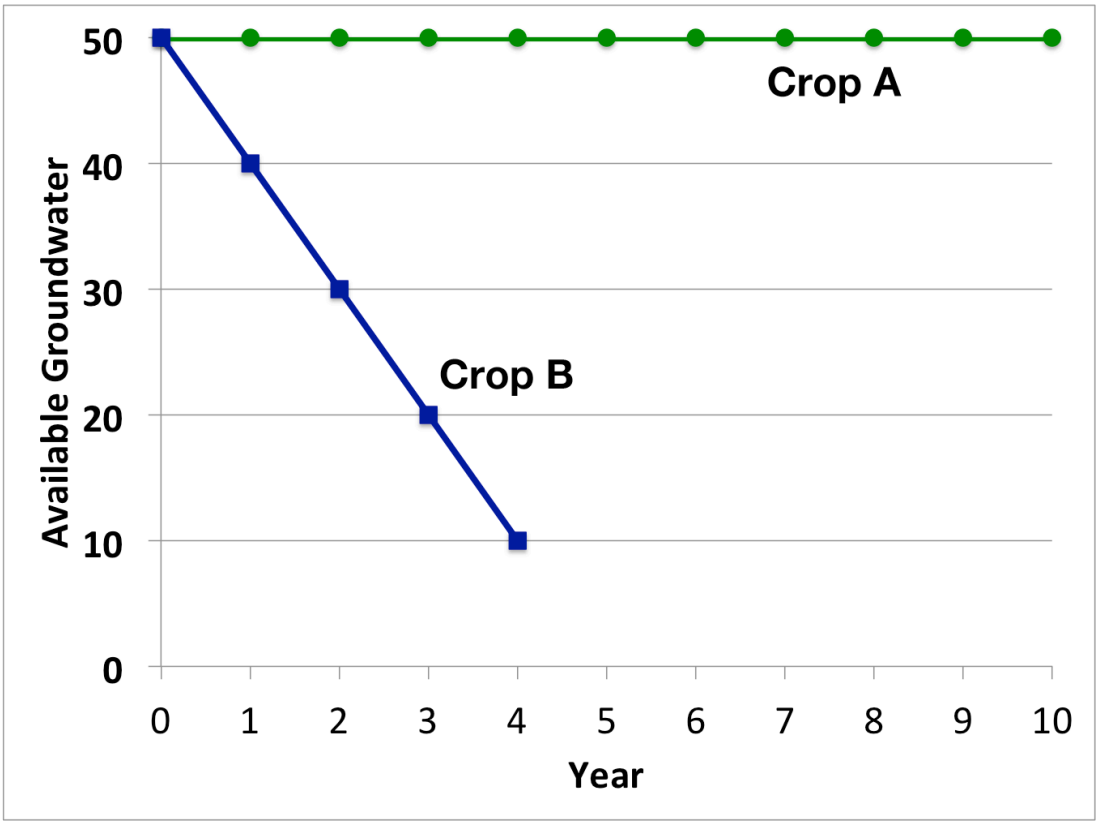


**Figure 4. Comparison of Everyone Playing A vs Everyone Playing B (AAAAA vs BBBBB)**

If everyone plants Crop B every round, the groundwater supply would last for 5 rounds. Each participant would earn 25 units of income from their crops.

Keep in mind that your decisions are private, and everyone can decide for themselves which crop they wish to plant each round. This means when you show us your Decision Form, only we see the crops you circled on your form.

Do you have any questions about this? *[FACILITATOR: pause to resolve questions.]*

Keep in mind that from now on you are not allowed to talk to each other until we tell you it is ok for you to do so.

First, we will play three practice years that will not count toward the results of the groundwater levels. These practice rounds are just an opportunity for you familiarize yourself with the activity.

After we have completed the practice years, you will have another opportunity to ask any questions you may have. After that, we will begin the actual activity.

# Practice Year:

*[FACILITATOR: If this is the second practice round, add 5 units of water to the groundwater diagram.]*

This is the beginning of a new practice year. [5 units of groundwater have recharged.][‡] There are ___ units of groundwater available. Please make your decision on which crop you will plant for this round, Crop A or Crop B. Please carefully show your Decision Form to the monitor when they come to you.

*[MONITOR: Write down each participant's crop decision on the Monitor Form. Calculate the amount of water used, and the remaining water. Show these numbers to the Facilitator.]*

For the practice years only, we are going to tell you how many people chose to plant crop A and crop B, so you can tell us how many units of water was used, and how many units of income each person received.

____ people chose to plant Crop A, and ____ people chose to plant Crop B.

How many units of water have been used?

How many units of income do the people who planted Crop A receive?

How many units of income do the people who planted Crop B receive?

*[FACILITATOR: If this is not the last practice round, return to the beginning of the practice round instructions above. Otherwise, continue to the Beginning of the actual activity rounds below.]*

[That was the last practice year. Do you have any questions?]

[Look for any questions]

[We will now reset the groundwater level to 50 units of water and begin the real exercise.]

[‡] Text underlined inside brackets is conditional. Only recite this text if it applies to the current status of the activity (as in there is recharge for years following the first year.) Skip it if it doesn't apply now.

# ACTIVITY 1: YEARS WITHOUT COMMUNICATION

*[FACILITATOR: If this is round 2 or later, add 5 units of water to the groundwater diagram.]*

This is the beginning of a new practice year. [5 units of groundwater have recharged.] There are ___ units of groundwater available. Please make your decision on which crop you will plant for this round, Crop A or Crop B. Please carefully show your Decision Form to the monitor when they come to you.

*[MONITOR: Walk around to each participant and write down their crop decision on the Monitor Recording Form. Calculate how much water has been used by the group's crops. Announce how much water was used by the group.]*

*[FACILITATOR: subtract the water usage from the water level poster.]*

*[FACILITATOR: If the remaining amount of groundwater is less than 10 units, announce the end of the activity. Otherwise, move to the next round.]*

IF CONTINUE TO NEXT YEAR:

This year has now ended.

END ACTIVITY:

[There is no longer sufficient groundwater available for the group.]

This was the last year and the activity is now ended. We are now going to gather your Decision Forms and we are going to discuss your experience in the exercise.

*[MONITOR: Gather the participants' Decision Forms. Store the forms in the correct envelope.]*

*[FACILITATOR: Use the Discussion Guidelines to ask questions and encourage talking between the participants.]*

*[RECORDER: Use the Discussion Topics Instrument to check off the topics that are brought up by the participants. Also write down any issues or interesting points that are brought up by the group.]*

# ACTIVITY 2: YEARS WITH COMMUNICATION

*[FACILITATOR: If this is round 2 or later, add 5 units of water to the groundwater diagram.]*

This is the beginning of a new practice year. [5 units of groundwater have recharged.] There are ___ units of groundwater available.

You have 45 seconds to talk with each other about the next year.

[MONITOR: time the group for 45 seconds. When that time has elapsed, raise your hand so the Facilitator can announce that there is no more talking.]

Your discussion time has ended.

Please make your decision on which crop you will plant for this round, Crop A or Crop B. Please carefully show your Decision Form to the monitor when they come to you.

*[MONITOR: Walk around to each participant and write down their crop decision on the Monitor Recording Form. Calculate how much water has been used by the group's crops. Announce how much water was used by the group.]*

*[FACILITATOR: subtract the water usage from the water level poster.]*

*[FACILITATOR: If the remaining amount of groundwater is less than 10 units, announce the end of the activity. Otherwise, move to the next round.]*

IF CONTINUE TO NEXT YEAR:

This year has now ended.

END ACTIVITY:

[There is no longer sufficient groundwater available for the group.]

This was the last year and the activity is now ended. We will gather your decision forms and hand you a short survey to be filled out. We will go over the survey with you. Thank you for providing this very valuable information.

*[Only in the communities that are to be paid individual earnings, say:]*
Once your questionnaire is filled out, we will give you your payment.

*[MONITOR: Gather the participants' Decision Forms. Store the forms in the correct envelope.]*

When the survey is done, we will shortly begin a community-wide discussion meeting about this activity, and it would be wonderful if you could join us all to talk about your experience and ideas from the activity. We will not tell anyone about how each of you individually played, or what you (singular) decided, but we hope you will feel free to share your experiences and ideas on how this game might apply to groundwater management in this area.

Thank you so much for you time and attention!

# Sampling

The primary unit for site selection are villages/habitation units (in contrast to the higher level political unit, the panchayat.) 1 or more villages compose a panchayat. There are on average 4 panchayats within each watershed. FES has five watersheds in which it has field teams. However, only four watersheds have habitations that use bore wells, a necessary contextual feature for the project. The participants need to use groundwater in their agricultural practices, which necessitates bore wells.

In these 4 watersheds, there are 17 habitations available for running the field experiments or control. To expand the number of field sites for the study, Venkat will contact Jana Jagruthi, a partner NGO, to invite them to participate in the project. They have 3 watersheds available to bring he total number of villages to 30 project sites. We will end up with 29 project sites because we contaminated one of the available FES sites as a pilot test during the Horsley Hills workshop.

With 29 sites, we will divide the sites into unequal thirds for the two treatments and the control group: 10-10-9 ("earnings"-"flat-fee to community"-"control").

Sampling strategy:

- NGO staff will go to the community in advance tell the Watershed Committee about plans to do the games (or the surveys in the control sites). The Watershed Committee will be asked to select 7 women and 7 men from different households that use groundwater (no couples from same household), with a request that they select households with a range of holding sizes. Explain that we want to have a discussion and activity related to groundwater use, and we would like to invite men and women from households that uses groundwater to come to the meeting at X time. Those who participate would spend approximately 3 hours, but it is a rather fun activity and [depending on the type of community] we will make a donation to the community fund to recognize their participation OR they will have a chance to make some money—between 200 and 500 rupees. Ask the committee to select 7 each men and women, but explain that on the day of the game, only 5 of each will be needed.
- From those who show up, separate them into men and women. Put 5 slips of paper numbered 1 through 5 into a bowl, along with blank slips, and let each person draw a slip. Those with a numbered slip would play.
- Before the rest leave, check that no couples were slected (man and woman from the same house). If they were, let them "draw straws" or something else to randomly select which one plays. The other goes home, and is replaced by another man or woman.

***Also remember in our analysis that we need to calculate the reverse sampling fraction [via Ruth]***

When invited, the household needs to understand that approximately **3 hours** will be required to participate (from being seated, through the exercises, discussion, and survey, to the end of the community debriefing.) If the household declines to participate, the recruiters move on to the next household on the list. Continue until all 10 participants have been recruited.

## Request Letter to Watershed Committee:

To: Watershed committee in habitation XX:
FES **[or FES and Jana Jagruthi]** is doing a study of groundwater management in your community. We want to understand how people using groundwater make decisions on what crops to plant.
We are going to play an activity that looks at how people make these decisions of what crops to plant.
We are asking the Watershed Committee to select 5 men and 5 women from households that use groundwater for irrigation to participate in the activity. We will be coming to your community on **[give date and time]**
This activity will take approximately 2 ½ hours. The 5 men will need to come together in a group for that whole time, and then 5 women will need to come together for that much time.
Participants will be asked to answer a short survey on a later day.
We will hold a debriefing for the whole community to discuss the outcomes of the activity, and how this can help your community with groundwater management.
Please identify 5 men and 5 women from households that use groundwater for irrigation, who would be willing to participate in this activity on **[give date and time]**.
The participants do not all need to own wells—if they use water from a neighbor that is also OK. The men and women should not be from the same household. Please try to select participants that come from different farm holding sizes.
*[ONLY for the Individual Payments treatment:] The participants will be paid cash at the end of the activity and survey. The amount each participant will be paid will depend on the outcome of the activity, based on the individual's performance in the activity..*

# Session Organization

Each field site will consist of two groups of five participants each. One group will consist of men only and the second group will consist of women. The gender-segregated sessions will ensure each group is willing and able to speak freely about the exercise and its relevance to their lives.

The goal is to complete a site in a single visit. Group sessions are held sequentially. The Community Debriefing is scheduled for later in the day or evening, when the entire village will be available to meet.

Upon arriving at a village to begin the group sessions, a brief introduction is read to the village:

Thank you for allowing us to visit your community today. Before we get started, we want to briefly explain why we are here. As you are aware, groundwater depletion is major problem in this area and we are seeing increasing incidence of crop failures due to unavailability of water. Watershed activities being undertaken aim to address the availability of water from both demand and supply side. Today we are here for an activity which is part of a research project. This research is being undertaken in collaboration with International Food and Policy Research Institute and Arizona State University. We have requested the watershed committee to select 5 men and 5 women from your community to participate in a series of small activities. These activities are designed to allow us to learn a little about your community and your farming situation. This will be followed by a village Gram Sabha where the selected participants will share their experience and we will discuss on the probable options to address groundwater management.

Although we would love to have everyone join us in these activities today, we are only able to work with the ten people already invited. We need to begin our work, and we ask the first group of (Men/Women) to join us in the meeting area. We ask the other group to leave for a while and come back later when we can meet with you. Everyone else, you are welcome to watch us, but we request that you stay outside of the area, and please do not talk.

Thank you!

Each group session will require a minimum of three individuals to run:

1. Facilitator
2. Monitor
3. Recorder

The Facilitator reads the instructions and answers questions about the exercise. He or she also updates the Water Level indicator on the pin board when announcing the new water levels after the crop decisions.

The Monitor records the crop decisions selected by the participants, and he writes their income on their Decision Forms. The Monitor also makes sure that the participants follow the rules (do not talk when not permitted, are not looking at each other's forms, etc.)

The Recorder writes down what participants talk about during discussion periods, using the Discussion Topic Instrument. They note who says what and notes any interesting discussions relevant to the history of the habitation. The Recorder also takes notes during the Community Debriefing.

When calculating the total number of trained staff required for the project, additional staff should be fully trained as redundant backups in case any of the primary staff become unavailable (due to sickness, family emergency, etc.)

In all sites, an FES hydrology team member will be the Facilitator. In the FES watersheds, the Recorder will be an FES field staff person, familiar with the habitation. In the Jana Jagruthi watersheds, one of the JJ staff will fill the role of Recorder.

In the Individual Payment villages, following the end of the two games, earnings are calculated and a Payment Voucher is filled out and given to each Participant, indicating how much they will receive after they have filled out the Survey. In the Flat-Fee villages, the participant id number is given to the participant, to hold onto until they complete the survey.

The surveys are completed after the experiment sessions, during the break period before the Community Debriefing. Each field staff person sits with a participant and assists them with completing the survey. The Payment Voucher/Participant ID is used to ensure the survey is completed and marked with the correct Participant ID number. In the Individual Payment villages, after the survey is completed, the participant receives their cash payment.

# Treatments

There are two treatments, plus a control group. In the two treatments, all sites will participate in the same set of activities: An initial exercise without any communication, followed by a discussion period facilitated but not dictated by the Facilitator, and concluded with a second exercise that includes a 45-second discussion period between each round. Following the exercises, the participants will complete a survey and then be paid according to the assigned treatment.

In Treatment (A), the individual participants will be paid a fee according to their earnings in the two exercises. Each unit of income in the exercises will be worth 5 rupees. According to that figure, the minimum payment a participant can receive is 200 rupees (Choosing Crop A every round: 2 units x 20 rounds = 40 units x 5 rupees = 200 rupees), and the theoretical maximum that can be earned by an individual is 500 rupees (Choosing Crop B every round: 5 units x 20 rounds = 100 units x 5 rupees = 500 rupees). Because every participant is guaranteed a minimum payment of 200 rupees, no show-up fee is needed.

In Treatment (B), the community will be paid a flat fee for participating in the study.

# Documents & Forms:

In addition to the Checklist and this master Protocol document, additional forms need to be completed and translated into the needed site languages.

1. **Consent Letter** – All participants must read or have the Consent Letter read to them, so that we know they fully understand the meaning in the letter and so they can give their informed consent to participate in the project. THIS IS CRITICAL. IT CANNOT BE SKIPPED, OR GLOSSED OVER QUICKLY. Each participant must either sign a copy of the letter or their verbal consent must be recorded on the letter by a project staff person.
2. **Signup/Payment Form** – The name of each participant must be recorded into the signup sheet. At the end of the session, after each participant has completed their survey, they must sign that they have received the payment allotted for their project treatment.
3. **Scripts** - The session facilitators will need a concise script or bullet-point list of things to say every session. It is very important that the same things are said every time (and said the same way) and nothing is accidentally left out or added.
4. **Participant ID Tags** – Numbered slips 1-5 in plastic conference badges on lanyards, to make sure staff don't mix up participant positions. The participants wear the id around their necks for the session.
5. **Monitor Forms** – Two forms are needed for each group, one for each exercise (1 and 2). Ideally, the forms would be printed double-sided, so exercise 1 would be on one side, and exercise 2 on side two. Alternately, if double-sided printing is not possible, at time of printing each form pair should be stapled together. These forms need to be labeled correctly for the watershed, village, habitation, group, name of habitation (Location), and date and time, and game number (1 or 2). The watersheds, villages, and habitations need to be coded with numbers prior to the start of the project.
6. **Decision Forms** – The forms used by participants for recording their crop decisions each round and for the monitor to write their round earnings. Each participant will use two forms, one for each exercise.
7. **Discussion Topic Journal** – This is the form used by the Recorder to note what topics are discussed by the group during the discussion session. Who speaks and what they say should be noted.
8. **Survey Instrument**
9. **Community Debriefing Protocol**
10. **Habitation Attributes Instrument** – It may be very useful to use a standardized form for capturing the attributes of the habitation study sites currently recorded in FES' village records. The document included in the Dropbox folder is an example based off an attributes instrument from another study, which provides some example attributes that may be very useful (with tweaking.)

# Wrapping up Site Visit and Data Collection:

The Facilitator is responsible for collecting and securely storing all experiment forms. Double-check that all the forms have been completed fully and correctly: Session details are completed: Date, time, Watershed, Village, Habitation Unit, and Group number. It is critical that all this information is filled out correctly on all the forms. Also make sure that the surveys are completed, and no questions are skipped (whenever possible.)

At the end of the day, the field staff should sit down and discuss the session. Record the team's observations in a journal: Did anything unusual happen? Did something go wrong or differently than usual? All of these details are useful, and when problems or surprises occur, it is very important to record that so they can be accounted for when analyzing the data.

# 1A. Consent Letter: Individual Payments (Treatment A)

**CONSENT FORM**

**Watershed No.: _____ Village No.: _____ HU No.: _____**

**Group No.: _____ Participant No.: _____**

**Place and Date: _____ Time of the activity: ___:___ AM/PM**

You have been invited to participate in an activity that is part of a research project about the management of natural resources, especially groundwater irrigation. Due to your experience with groundwater irrigation, your participation is very important for this research. The exercises and discussions will provide important information for all of us, including your community. The funding for this project came from international organizations.

The duration of the activity is three hours. There are no foreseeable risks for your participation.

At the end of the activity, you will receive an amount of cash depending on your earnings during the activity.

You will be participating in the exercise twice. In each exercise, you will earn income for your cash payment. Between the two exercises, you will have an opportunity to talk about your experience and thoughts of the exercise.

After the activities are over, we will call you forward one by one to give you a voucher that shows you how much money you will receive. _____ (date/time), we will meet with you and ask that you answer some questions on a short questionaire about yourself, your household, and your community. Your thoughts and answers to these questions will be very helpful to us. What you earned in the activity and your answers on the questionaire will be **confidential. This information will be used for academic purposes only.**

In addition to this activity you are invited to participate in a community discussion session to discuss the results of the activity. The discussion will be held in _____ at _____am/pm.

Your participation in the activity is completely voluntary. You may leave the activity at any time, and you will receive what you earned up to that point. However, if you decide to leave before the activity is over, the activity also ends for the other group members.

The cash payment that you earn during the activity will be given to you after you finish answering the questions on the survey. All decisions in the activity are made in private and we will keep your decisions confidential. However, we cannot control participants' conversations about the activity after the activity is over.

If you want a copy of this consent form, please ask us for it.

AGREEMENT:

I, _____ state that I understand the information given above and my rights and commitments during the exercise. I also understand that I can leave the exercise at any time declining to receive any money I might have earned by continuing the exercise to its completion.

I will receive payment for the income units I have earned up to the point I choose to leave.

Signed, _____

I, Ruth Meinzen-Dick, certify that this information will be used in a confidential manner and only for academic and community educational purposes. I also certify that we will pay to each participant the amount of money earned during the activity.

Signed, Ruth Meinzen-Dick,
2033 K St. NW, Washington DC 20006-1002, USA

If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact Jagdeesh Rao, Executive Director, FES, ed@fes.org.in, Tel : 02692-261303.

Investigator: Ruth Meinzen-Dick, Senior Research Fellow, IFPRI, 2033 K St. NW, Washington DC 20006-1002, USA, r.meinzen-dick@cgiar.org, Tel: +1 202-862-5600

Local Contact for Concerns: Jagdeesh Rao, Executive Director, FES, PB No. 29, Anand- 388001, Gujarat India, ed@fes.org.in, Tel : 02692-261303

International Food Policy Research Institute
Federalwide Assurance (FWA) No. FWA00005121
Institutional Review Board (IRB): 00003487

# 1B. Consent Letter: Flat-Fee (Treatment B)

**CONSENT FORM**

**Watershed No.: _____ Village No.: _____ HU No.: _____**

**Group No.: _____ Participant No.: _____**

**Place and Date: _____ Time of the activity: ___:___ AM/PM**

You have been invited to participate in an activity that is part of a research project about the management of natural resources, especially groundwater irrigation. Due to your experience with groundwater irrigation, your participation is very important for this research. The exercises and discussions will provide important information for all of us, including your community. The funding for this project came from international organizations.

The duration of the activity is three hours. There are no foreseeable risks for your participation.

Your community will be paid 2000 Rp. today as a thank you for everyone's participation in today's activities.

You will be participating in the exercise twice. Between the two exercises, you will have an opportunity to talk about your experience and thoughts of the exercise.

_____ (date/time), we will meet with you and ask that you answer some questions on a short questionaire about yourself, your household, and your community. Your thoughts and answers to these questions will be very helpful to us. Your decisions in the activity and your answers in the questionaire will be **confidential. This information will be used for academic purposes only.**

In addition to this activity you are invited to participate in a community discussion session to discuss the results of the activity. The discussion will be held in _____ at _____am/pm.

Your participation in the activity is completely voluntary. You may leave the activity at any time.. However, if you decide to leave before the activity is over, the activity also ends for the other group members.

All decisions in the activity are made in private and we will keep your decisions confidential. However, we cannot control participants' conversations about the activity after the activity is over.

If you want a copy of this consent form, please ask us for it.

AGREEMENT:

I, _____ state that I understand the information given above and my rights and commitments during the exercise.

Signed, _____,

I, Ruth Meinzen-Dick, certify that this information will be used in a confidential manner and only for academic and community educational purposes. I also certify that we will pay to each participant the amount of money earned during the activity.

Signed, Ruth Meinzen-Dick,
2033 K St. NW, Washington DC 20006-1002, USA

If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact Jagdeesh Rao, Executive Director, FES, ed@fes.org.in, Tel : 02692-261303.

Investigator: Ruth Meinzen-Dick, Senior Research Fellow, IFPRI, 2033 K St. NW, Washington DC 20006-1002, USA, r.meinzen-dick@cgiar.org, Tel: +1 202-862-5600

Local Contact for Concerns: Jagdeesh Rao, Executive Director, FES, PB No. 29, Anand- 388001, Gujarat India, ed@fes.org.in, Tel : 02692-261303

International Food Policy Research Institute
Federalwide Assurance (FWA) No. FWA00005121
Institutional Review Board (IRB): 00003487

## 2. Signup/Payments Form

## Payment Amount Form

Watershed: ____ Village: ____ Habitation: ____ Group: ___

Date/Time of Session: _____

| Printed Name | Signature | Amount Paid |
|---|---|---|
| | | |
| | | |
| | | |
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# 2a. Payments Voucher

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**Payment Voucher** Participant Number: **1** **Payment: _____**

Group: **M/F** Watershed: _____ Village: _____ Habitation: _____

You will receive your payment later when an FES survey staff will return to your village. To receive your payment, you must complete the survey questionnaire and give this voucher to the FES survey staff.

---

**Payment Voucher** Participant Number: **2** **Payment: _____**

Group: **M/F** Watershed: _____ Village: _____ Habitation: _____

You will receive your payment later when an FES survey staff will return to your village. To receive your payment, you must complete the survey questionnaire and give this voucher to the FES survey staff.

---

**Payment Voucher** Participant Number: **3** **Payment: _____**

Group: **M/F** Watershed: _____ Village: _____ Habitation: _____

You will receive your payment later when an FES survey staff will return to your village. To receive your payment, you must complete the survey questionnaire and give this voucher to the FES survey staff.

---

**Payment Voucher** Participant Number: **4** **Payment: _____**

Group: **M/F** Watershed: _____ Village: _____ Habitation: _____

You will receive your payment later when an FES survey staff will return to your village. To receive your payment, you must complete the survey questionnaire and give this voucher to the FES survey staff.

---

**Payment Voucher** Participant Number: **5** **Payment: _____**

Group: **M/F** Watershed: _____ Village: _____ Habitation: _____

You will receive your payment later when an FES survey staff will return to your village. To receive your payment, you must complete the survey questionnaire and give this voucher to the FES survey staff.

---

# 5. Monitor Form

| Monitor Calculation Form | | | | |
|---|---|---|---|---|
| WS: | Village: | Habitation: | Location: | |
| Date: | Time: | Group: **1** | Exercise: **1** | Men / Women |

| Round | Water Available | Player Crops | | | | | Water Used | Water Remaining |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| **Practice 1** | **50** | | | | | | | |
| **Practice 2** | + 5 = | | | | | | | |
| **1** | **50** | | | | | | | |
| **2** | + 5 = | | | | | | | |
| **3** | + 5 = | | | | | | | |
| **4** | + 5 = | | | | | | | |
| **5** | + 5 = | | | | | | | |
| **6** | + 5 = | | | | | | | |
| **7** | + 5 = | | | | | | | |
| **8** | + 5 = | | | | | | | |
| **9** | + 5 = | | | | | | | |
| **10** | + 5 = | | | | | | | |
| | TOTAL WATER UNITS: | | | | | | | |
| | TOTAL EARNINGS: | | | | | | | |

# 6. Participant Decision Form

| Decision Form | | | |
|---|---|---|---|
| Participant: **1** | | | |
| WS: | Vill: | | HU: |
| Group: 1 / 2 | Game: 1 | | |
| | | | |
| | **My Crop** | | **My Income** |
| Practice | A | B | |
| Practice | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |
| | A | B | |

# 7. Discussion Journal

**Discussion Journal**

Watershed: _____ Village: _____ Habitation: _____ Group: _____

Date/Time: _____ Habitation Name: _____

| Speaker | Topics |
|---|---|
| | |
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# 8. Survey

**INDIVIDUAL SURVEY (updated 1 February 2013)**

**Staff Use Only**

Date (dd/mm/yy) _____/_____/_____ Time _____:_____ Habitation Name _____

Watershed _____ Village _____ Habitation _____

Group M/F Participant _____ Surveyor _____

**SECTION I. RESPONDENT CHARACTERISTICS**
**Please answer for yourself**

1. How old are you? _____ years

2. Sex ☐ Male ☐ Female

3. Your Marital Status

☐ 1. Married ☐ 3. Divorced ☐ 5. Common law /Cohabiting

☐ 2. Widowed ☐ 4. Separated ☐ 6. Single

4. Your Caste

| | |
|---|---|
| OC | ☐1 |
| OBC | ☐2 |
| SC | ☐3 |
| ST | ☐4 |

5. What is the highest grade you have completed in school?

| | |
|---|---|
| None | ☐0 |
| Adult literacy class | ☐1 |
| Primary school (1-5) | ☐3 |
| Secondary school (6-10) | ☐4 |
| Intermediate (11-12) | |
| Technical School | ☐5 |
| University | ☐6 |

6. How long have you lived in this habitation? _____ YEARS

7. Who will work on your farm five years from now?

| | |
|---|---|
| You | ☐1 |
| Child | ☐2 |
| Other Relative | ☐3 |
| Hired Labor | ☐4 |
| Land Sold to Someone Else | ☐5 |

8. Are you a member or leader of any community groups?

| | Member | Leader |
|---|---|---|
| Water Committee | ☐1 | ☐9 |
| Water & Sanitation Committee | ☐2 | ☐10 |
| Panchayat | ☐3 | ☐11 |
| Self-Help | ☐4 | ☐12 |
| Forest Protection (VSS) | ☐5 | ☐13 |
| Farmer's Club | ☐6 | ☐14 |
| Mother's Committee | ☐7 | ☐15 |
| Other: _____ | ☐8 | ☐16 |

## SECTION II. HOUSEHOLD CHARACTERISTICS
**Please answer for your entire household**

9. Number of people (adults and children) who lived in house during last year for at least six months

| | Male | Female |
|---|---|---|
| Adult | _____ | _____ |
| Children (under age 16) | _____ | _____ |

10. How long has your family (ancestors) lived in this habitation?
(For married women, answer for your husband's family)

| | |
|---|---|
| < 4 Years | ☐1 |
| 5 – 10 Years | ☐2 |
| 11 – 20 Years | ☐3 |

| | |
|---|---|
| 21 – 50 Years | ☐4 |
| > 50 Years | ☐5 |

11. What are the sources of livelihoods for your household and which are the three most important (please rank in order 1, 2, 3)?

| | | Rank |
|---|---|---|
| Irrigated Farming | ☐1 | _____ |
| Rain-Fed Farming | ☐2 | _____ |
| Animal Husbandry | ☐3 | _____ |
| Farm Wage Labor | ☐4 | _____ |
| Off-Farm Wage Labor | ☐5 | _____ |
| Business | ☐6 | _____ |
| Salaried Employment | ☐7 | _____ |
| Remittances, Pensions | ☐8 | _____ |
| Other | ☐9 | _____ |

If Other, please write that livelihood: _____

12. Do you own or rent:

| | Own | Rent |
|---|---|---|
| Bicycle | ☐1 | |
| Motorcycle | ☐2 | |
| Car | ☐3 | |
| Tractor/Harvester | ☐4 | |
| Cell Phone | ☐5 | |
| Television | ☐6 | |
| Pakka House | ☐7 | ☐9 |
| Kacha House | ☐8 | ☐10 |

13. If you have a cell-phone, how many people in your habitation have you put into your cell phone address book?

| | |
|---|---|
| No One | ☐0 |
| Very Few | ☐1 |
| About Half | ☐2 |
| More Than Half | ☐3 |
| Almost Everyone | ☐4 |

## SECTION III. COLLECTIVE ACTION

14. Please tell me whether in general you agree or disagree with the following statements:

Please check the most appropriate response A, B, C or D.

A = Agree Strongly
B = Agree Somewhat
C = Disagree Somewhat
D = Disagree Strongly

| | A | B | C | D |
|---|---|---|---|---|
| 1. Most people in this community are basically honest and can be trusted. | ☐ | ☐ | ☐ | ☐ |
| 2. People are always interested only in their own welfare. | ☐ | ☐ | ☐ | ☐ |
| 3. In this community, one has to be alert or someone is likely to take advantage of you. | ☐ | ☐ | ☐ | ☐ |
| 4. I do not pay attention to the opinions of others in the community. | ☐ | ☐ | ☐ | ☐ |
| 5. Most people in this community are willing to help if you need it. | ☐ | ☐ | ☐ | ☐ |
| 6. I feel accepted as a member of this community. | ☐ | ☐ | ☐ | ☐ |
| 7. If a mother in this village has an emergency and needs to leave her baby for the day, she will easily find someone in this village she can trust with her baby | ☐ | ☐ | ☐ | ☐ |
| 8. If someone loses a pig, goat or chicken he or she will easily find others in this village to help to seek and find it. | ☐ | ☐ | ☐ | ☐ |
| 9. If a neighbor in this village lends some money to another neighbor, it is very likely that the lender gets her money back | ☐ | ☐ | ☐ | ☐ |

15. Think about the people that live in this village. If you had a newly born baby, in how many houses would you be able to leave your baby and trust them in case you had to leave for the day because of an emergency?

| | |
|---|---|
| No One | ☐0 |
| Very Few | ☐1 |
| About Half | ☐2 |
| More Than Half | ☐3 |
| Almost Everyone | ☐4 |

16. If you had to borrow a small amount of money for an emergency, from how many of your neighbors would you be able to get the money with no interest?

| | |
|---|---|
| No One | ☐0 |
| Very Few | ☐1 |
| About Half | ☐2 |
| More Than Half | ☐3 |
| Almost Everyone | ☐4 |

17. How much influence do you think you and people like you can have in making this village a better place to live?

| | |
|---|---|
| A Lot | ☐3 |
| Some | ☐2 |
| Not Much | ☐1 |
| None | ☐0 |
| Don't Know/Unsure | ☐-1 |

18. Suppose that 10 of your neighbors are invited to help in community activities. How many would show up?

_____ Neighbors

**Section IV. Land & Water use**

19. Last year, how much land did your household have and how was it watered:

| | Acres |
|---|---|
| Land Owned | _____ |
| Land Leased In | _____ |
| Land Leased Out | _____ |
| Total Land That Can Be Cultivated | _____ |
| Tank Irrigated | _____ |
| Bore Well Irrigated | _____ |
| Open Well Irrigated | _____ |
| Land Fallow | _____ |

20. Who owns the bore well that you use to irrigate your crops? (Check One)

| | |
|---|---|
| My Household | ☐1 |
| Shared With Relatives | ☐2 |
| Shared with non-Relatives | ☐3 |
| Purchased Water | ☐4 |

21. If you use water from an open well to irrigate your crops, who owns the open well? (Check One)

| | |
|---|---|
| My Household | ☐1 |
| Shared With Relatives | ☐2 |
| Shared with non-Relatives | ☐3 |
| Purchased Water | ☐4 |

22. What kind of crops did you grow last year?

| Crops Grown | Total Area (acres) | Total Production (quintal) | Irrigation | | |
|---|---|---|---|---|---|
| | | | Surface | Ground Water | Rain Only |
| Kharif Season | | | | | |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| Rabi Season | | | | | |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| | Summer Season | | | | |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |
| _____ | _____ | _____ | ☐ | ☐ | ☐ |

23. How much did you pay last year?

Water Purchased _____
System Maintenance _____

24. Over the last ten years, do you think the water table

Has Fallen ☐-1
Is Unchanged ☐0
Has Risen ☐1

25. What do you think should be done to improve the water table?

_____
_____

26. Do you have some final remarks on the groundwater exercise? You can write them here:

_____
_____
_____
_____

# 9. Community Debriefing Protocol
# Community Debriefing Protocol

The debriefing session will be held immediately following the conclusion of the Experiment sessions. By holding two simultaneous sessions, Men and Women groups, followed by the Community Debriefing, hopefully it will be possible to include all or most of the experiment participants in the debriefing with the experience and lessons fresh on everyone's minds. If it is necessary to schedule the Debriefing at a different time, it should be set for a time recent enough to the experiment for the participants to have fresh memory of the experience. The Debriefing is open to the entire community; ensure during the scheduling and setup for the field visit that the local contacts in the community advertise clearly that everyone from the community is welcome to join this session.

Open the session, explaining that the staff will not reveal the actions taken by any individuals in the games, but during the debriefing, the participants are free to share or keep private their own actions in the game, they are free to share what they are comfortable sharing.

There are several main points each debriefing session should cover in all communities, but beyond these general points, allow the community to drive the discussion. Allow the session to go where it needs to for the community.

1. Tell everyone: This is a fun activity to create dialog between them, academics and policy makers about a subject that they all care about. We use games because we want to understand how people make decisions. [With villages where we give cash payments: We use money because we want to study the decision-making process with real consequence for their pockets, just like in reality.]

2. Give a brief presentation about the game. Most debriefing participants won't be familiar with the game, so explain the game, similar to how the game was presented during the experiment. (We should be able to reuse the posters used for the games: Water/Payoff for Crop A vs. B; Results planting AAAAA vs. BBBBB).

2. Show the decisions that will lead to the most earnings (AAAAA) and the effect on available water, and the decisions that will lead to the least earnings (BBBBB) and its effect on water level. DON'T: use any language that implies one is worse or wrong. We DO NOT judge one option against the other; just describe the effects neutrally. (Reuse the poster that shows the difference between Planting AAAAA vs BBBBB.)

3. Show the results of the games, describe the general averages (NO SPECIFIC ABOUT INDIVIDUAL PARTICIPANTS). If a whiteboard is available, the general averages could be drawn as lines or bars on a picture. Alternatively, it may be easier to print a large poster to point at the different levels. Show the amount of Crop A and Crop B planted, on average, by each group. State how much each group earned.

4. Begin open discussion with community. Ask them questions to jump-start the discussion, but let the community members to talk freely, particularly the game participants:

- What happened during the first game (first 10 rounds)? What do you think was happening? What were you thinking?
- What did you talk about during the discussion between games?
- What happened during the second game?
- Was there a difference; why do you think that happened? Were you surprised by anything that happened? Why or why not?
- Was there a difference between the groups? If so, why was there a difference?
- "What did you think about when making your decisions?"
- Does this game relate to your situation? What are differences that you think are important?
- Are there different kinds of crops that you have to choose between that require different amounts of water? How do you decide which to grow? What is important to you when you decide what crops to plant?
- Are groundwater levels falling, rising, or steady in this community? (refer to the groundwater records of the watershed committee, if available)
- Do you think that groundwater levels are a problem? Do you think it will be a problem in the future?
- Does what you do affect water available for others (or does what others are doing affect the water you have available?)
- Does the game give you any ideas about your situation? Do you have any suggestions?

# DOS & DONTS

- DO: Get the community's trust that you will not show anyone the individual data, their decisions. The Facilitator is responsible for collecting all the experiment forms and storing them securely in a backpack. Make a fuss in the community discussion that all the forms are safe in your backpack and no one can look at it.

- DO: Allow participants to discuss and share their thoughts and opinions. The debriefing must be a comfortable environment for the community--those who participated in the games AND those who did not--to talk freely about the games.

- DO: Balance the community discussion between the "loud and extroverted" talkers and the shy, quiet members. Make sure no one is monopolizing the truth.

- DONT: Reveal how any individual acted in the game. Do not show any individual results.

- DONT: Tell the community that we are expecting/hoping to see them change their water-use because of the game. We are watching and learning from them.

- DONT: Tell the community that we are continuing to measure their water in order to test the effects of the games.

- DONT: Tell them what they SHOULD DO or MUST DO. DONT tell them how they should play the game to make more money or save water. They must come up with their own ideas and suggestions, if they feel like it. We record what they say and the ideas that they come up with.

# Appendix 2. Supplemental Statistics

**Table A2.1 Study Locations Summary Statistics**

| Treatment | WS Number | Panchayat Number | Vill. No. | No. of Houses | Agri-land (Acres) | No. of Bore wells | NGO | Years in Program |
|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 193 | 1250 | 15 | FES | 6 |
| A | 1 | 1 | 2 | 14 | 95 | 4 | FES | 6 |
| C | 1 | 1 | 3 | 30 | 220 | 6 | FES | 6 |
| B | 1 | 1 | 4 | 33 | 165 | 1 | FES | 6 |
| A | 2 | 1 | 5 | 33 | 100 | 2 | FES | 6 |
| B | 2 | 1 | 6 | 31 | 48 | 0 | FES | 6 |
| B | 2 | 1 | 7 | 100 | 210 | 9 | FES | 6 |
| C | 2 | 1 | 8 | 64 | 110 | 10 | FES | 6 |
| C | 2 | 1 | 9 | 28 | 250 | 4 | FES | 6 |
| A | 2 | 1 | 10 | 19 | 250 | 5 | FES | 6 |
| C | 3 | 1 | 11 | 66 | 640 | 6 | FES | 6 |
| B | 3 | 1 | 12 | 107 | 896 | 67 | FES | 6 |
| B | 4 | 2 | 13 | 114 | 560 | 9 | FES | 6 |
| A | 4 | 2 | 14 | 30 | 125 | 4 | FES | 6 |
| C | 4 | 2 | 15 | 52 | 25 | 0 | FES | 6 |
| A | 4 | 2 | 16 | 250 | 550 | 16 | FES | 6 |
| C | 5 | 3 | 17 | 68 | 70 | 13 | JJ | 20 |
| B | 5 | 3 | 18 | 95 | 80 | 10 | JJ | 20 |
| A | 5 | 3 | 19 | 27 | 120 | 19 | JJ | 20 |
| B | 5 | 3 | 20 | 22 | 70 | 14 | JJ | 20 |
| C | 6 | 4 | 21 | 82 | 125 | 14 | JJ | 19 |
| B | 6 | 4 | 22 | 54 | 30 | 6 | JJ | 19 |
| C | 6 | 4 | 23 | 54 | 24 | 4 | JJ | 20 |
| A | 6 | 4 | 24 | 43 | 32 | 9 | JJ | 19 |
| A | 6 | 4 | 25 | 65 | 22 | 5 | JJ | 20 |
| C | 7 | 4 | 26 | 92 | 130 | 11 | JJ | 19 |
| A | 7 | 4 | 27 | 61 | 92 | 11 | JJ | 20 |
| B | 7 | 4 | 28 | 94 | 140 | 14 | JJ | 19 |

Treatments: A = Individual Payments, B = Flat Fee, C = Control

**Table A2.2 Summary Statistics**

| Variable | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Water Use | 3100 | 1.664 | 0.950 | 0 | 3 |
| Team, JJ | 3400 | 1.414 | 0.493 | 1 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| Game | 3400 | 1.502 | 0.500 | 1 | 2 |
| Water Avail. | 3100 | 33.287 | 9.960 | 16 | 50 |
| Female | 3400 | 0.498 | 0.500 | 0 | 1 |
| Age | 3380 | 38.500 | 12.872 | 20 | 86 |
| Caste | 3380 | 3.224 | 0.870 | 1 | 4 |
| Education | 3380 | 2.024 | 1.511 | 0 | 6 |
| # of Ppl in Hhld | 3360 | 4.805 | 2.126 | 2 | 12 |
| Irrigation Livelihd | 3400 | 0.800 | 0.400 | 0 | 1 |
| Soc. Capital | 3340 | 0.967 | 0.078 | 0.333 | 1 |
| Area Owned | 3380 | 5.205 | 3.457 | 0 | 25 |
| Area, tank irrigated | 3380 | 0.323 | 0.661 | 0 | 4 |
| Area, GW irrigated | 3240 | 1.592 | 1.532 | 0 | 10 |

**Table A2.3 Tabulated Summaries**

| **Caste** | Freq. | Percent | Cumulative |
|---|---|---|---|
| ST | 220 | 6.51 | 6.51 |
| SC | 320 | 9.47 | 15.98 |
| OBC | 1320 | 39.05 | 55.03 |
| OC | 1520 | 44.97 | 100.00 |
| Total | 3400 | 100.00 | |

| **Game Length** | Freq. | Percent | Cumulative |
|---|---|---|---|
| 4 | 50 | 1.47 | 1.47 |
| 5 | 100 | 2.94 | 4.41 |

| | | | |
|---|---|---|---|
| 6 | 50 | 1.47 | 5.88 |
| 7 | 300 | 8.82 | 14.71 |
| 8 | 400 | 11.76 | 26.47 |
| 9 | 300 | 8.82 | 35.29 |
| 10 | 2200 | 64.71 | 100.00 |
| Total | 3340 | 100.00 | |

**Table A2.4 Number of rounds played in the games.**

| **Rounds** | **Games** |
|---|---|
| 4 | 1 |
| 5 | 2 |
| 6 | 1 |
| 7 | 6 |
| 8 | 8 |
| 9 | 6 |
| 10 | 44 |
| **Total** | **68** |