Water quality information, WATSAN-agriculture hygiene messages and water testing with school students: Experimental evidence for behavioral changes in Bangladesh

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Abstract

This paper attempts to reveal the effectiveness of the package of water, sanitation and hygiene (WASH) interventions with the school students' network "*student brigades*" in terms of their impacts on water and sanitation (or WATSAN) behavior of household members both in household and farm level and on their health and productivity outcomes. We conduct Randomized Control Trial (RCT) with students' brigades in six WATSAN hotspots (sub-districts) of Bangladesh in several phases: a water quality census, baseline survey, treatment implementation at treatment areas and end line survey. Our treatment consists of three actions: informing the households about the prior water testing results, delivering hygiene messages through a poster and equipping the student brigades with water testing toolkits and letting them test water at different points and communicate the results back to their households. Impression from the implemented treatments indicates that the suggested intervention package can be an effective strategy to motivate households and communities, particularly by using school students as the agents of change.

Key words: Water quality information/testing, WATSAN-agriculture hygiene messages, school students, randomized control trial, behavioral changes, Bangladesh

JEL codes: C9, I15, Q11, Q15.

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1. Introduction

Bangladesh has made enormous health advances and now has the longest life expectancy, the lowest total fertility rate, and the lowest infant and under-5 mortality rates in south Asia, despite spending less on health care than several neighboring countries, but still challenges remains with water supply and sanitation in Bangladesh (Lancet 2013). Generally, poor water quality results in health impacts ranging from high mortality and morbidity rates, malnutrition, and reduced life expectancy and the related economic costs associated with higher incident of illness (Srinivasan & Reddy, 2009). USAID (2013) mentioned that every year 2.5 million children of under-five years are affected by diarrhea leading to 1.5 million child deaths due to food and water being mixed with fecal matter. Van Derslice & Briscoe (1995) mentioned that those families who live on good sanitary conditions, only for them improved water quality can help reduce diarrhea. It is to be noted that Bangladesh has already achieved most of the MDG targets related with prevalence of underweight children, child mortality rate, maternal mortality rate, access to improved water sources, etc. except access to improved sanitation facility (Box 1).

- **MDG Target 33%-** In Bangladesh, prevalence of underweight children of under-five years of age (6-59 months) is **36.4%**, (BDHS, 2011)
- **MDG Target 48 per 1000 live births**-Under-five mortality rate reduced to **44 per 1000 live births** (SVRS, 2011)
- **MDG Target 143/100,000**-Maternal Mortality ratio is **194 per 100,000 live births** (BMMS, 2010)
- **Target 100%**- Proportion of population using improved drinking water source is **86%** (MICS 2009)
- **Target 100%**- Proportion of population using improved sanitation facility is **63.6%** (SVRS 2011).

Box 1- Achievements of MDG targets by Bangladesh- related with water, sanitation and hygiene

Although some control of diarrhea has contributed to a reduction in child and infant deaths, diarrhea still constitutes a major health problem in Bangladesh like many other developing countries which can be combated by the contribution of clean water, sanitation and hygiene facilities and practices. Thus, the attainment of the 2015 MDG target regarding improved water supply raises an important question- whether access to improved water sources means use of improved water supply sources. Poor personal hygiene might have detrimental consequences on water supply sources rendering them unimproved. There is the need for further studies addressing issues on water quality, especially the microbial properties, at the household level and how dissemination of this information could help improve health outcomes and water, sanitation and hygiene (WASH) behavior. Another dimension of the 2015 MDG targets on water and sanitation is its lack of adequate addressing of water quality issues. The mismatch in the attainment of the 2015 MDG targets on improved water sources and sanitation services present an opportunity in providing basic WASH education to both rural and urban households in order to optimize the benefits from the attainment of improved water sources' targets thereby compensating for the weaknesses in the slow pace of progress in the achievement of the improved sanitation facilities' targets. We should also note that though the average achievements in both rural and urban areas are nearly equal, there are some hotspot areas in advanced rural/peri-urban and marginal rural areas of Bangladesh where those pictures including prevalence of diarrhea are reasonably poorer than average rural and urban areas.

The economic literature has established that wealth is a key driver of the willingness-to-pay to protect oneself from environmental and health hazards. On the other hand, public health literature emphasizes the role of water, sanitation and hygiene information and knowledge to improve household behavior and achieve health outcomes. Knowledge and practices about contamination along the path from the drinking water source to the use/consumption both in the households and farm fields is thus crucial to improve the health and developmental outcomes of farm households. How can the capacity of households and communities in monitoring their own water and sanitation environment be developed? How can water, sanitation and hygiene (WASH) behavior be improved? We start from the assumption that information can increase demand for environmental quality, improve water sanitation and hygiene behavior, and thus improve health outcomes at the household level. We test the effectiveness of packages of WASH interventions with the school students in terms of their impacts on the water and sanitation (or WATSAN) behavior of adult household members both in the households and in the farm fields and on health outcomes for the household members in some hotspot areas.

To put that into effect, we devise Randomized Control Trial (RCT) with secondary school students in six WATSAN hotspots (sub-districts) of Bangladesh, conducted in four phases. Firstly, following a multi stage cluster random sampling, a sample of 648 fecal-contaminated households is drawn from a water quality census conducted by the trained staffs. Second, we conduct a baseline survey (i.e. pre-intervention) to establish the similarity between the treatment and the control groups. The baseline survey also highlights the salient WATSAN and agricultural hygiene issues. Thirdly, we implement the treatment, consisting of three actions: informing the households about the initial water testing results obtained from the earlier census, delivering hygiene messages through a poster related with farm field and households use, and equipping the student brigades with water testing toolkits and let them test water at different points and communicate the results back to their households. Finally, we conduct the end-line survey and form the panel dataset that will be analyzed using standard analytical techniques.

Initial water quality census and baseline survey found the justification of the interventions that we suggested for this study. Baseline results also confirm similarities for most of the outcome indicators among treatment and control groups. Treatment implementation is already done and the end line survey is now in progress. Impression from the implemented treatments indicates that the suggested intervention packages can be an effective strategy to motivate households and communities, particularly by using school students as agents of change and as a channel of conveying messages.

This paper is organized as follows: The next section describes study objectives and hypotheses. Section 3 gives a brief description of the study sites. Section 4 describes treatment design, impact pathway, treatment and survey implementation including sampling strategies. Section 5 depicts analytical methods for impact analysis. Section 6 gives brief results from the census and baseline survey and impression from the treatment implementation. Finally, we conclude the study.

2. **Study Objectives and hypotheses**

2.1. Study objectives

Knowledge and practices about contamination along the path from the drinking water source to use/consumption both in the households and farm fields is crucial to improve the health and developmental outcomes of farm households. How can the capacity of households and communities in monitoring their own water and sanitation environment be developed? How can water, sanitation and hygiene (WASH) behavior be improved? We start from the assumption that information can increase demand for environmental quality, improve water sanitation and hygiene behavior, and thus improve health outcomes at the household level. We test the effectiveness of packages of WASH interventions with the school students in terms of their impacts on the water and sanitation (or WATSAN) behavior of adult household members both in the households and in the farm fields and on health and productivity outcomes for the household members.

2.2. Study Hypotheses

Relative to the control groups, it is hypothesized that individuals/households in the treatment group will:

- Have greater changes of WASH behavior/practice and knowledge (at home and at farm field)
- Have changes nature and amount of investment including willingness to pay on WASH related activities
- Have improved microbial quality of drinking water.
- Have less diarrhea prevalence and cost of illness
- Have improved anthropometrics of under 5 years of children
- Have less days of work/school absenteeism

As the sample could be classified into several sub-groups, there might be also different adoption rate for different treatment components which might be linked with the outcome measures. Thus, the heterogeneous effects of the study will be analyzed.

3. Selection of study sites (hotspots)

In terms of coverage of improved drinking water sources and sanitation facilities at national level, the average achievements in both rural and urban areas are nearly equal, for example, proportion of the population using improved drinking water sources is 86% in urban areas and 84% in rural areas and those percentages for improved sanitation facilities are 55% for both rural and urban areas (JMP report 2014). However, there are some hotspot areas in advanced rural/peri-urban and marginal rural areas of Bangladesh where those pictures including prevalence of diarrhea are reasonably poorer than average rural and urban areas. Thus, for selecting hotspots, we used several indicators including: coverage of water supply, sanitation coverage, water related diseases (diarrheal) prevalence, agro-ecological zone, BRAC WASH intervention areas, and level of development (peri-urban/advanced rural vs marginal rural). We used different maps like groundwater level status, agro-ecological zones, flood and drought prone area, diarrhea prevalence sites and also used BRAC WASH intervention area list in Bangladesh. After compiling the above mentioned information, we have selected six study sub-districts in Bangladesh- four sub-districts are BRAC WASH Intervention and two are non-BRAC WASH intervention areas- this forms the study area population.

<**Map 1**>

Despite having differences between those advanced and marginal areas in terms of socio-economic and agricultural practices, the selected hotspots are similar in terms of prevalence of diarrhea- all areas have a bit higher diarrhea prevalence rate. Among the six study sub-districts, we selected two as intervention, two as control and the rest two as pure control areas- these will be explained in latter section.

4. Intervention, impact pathway and sampling strategy

4.1. Design of the interventions

Initially the RCT study was designed where BRAC Wash interventions with student brigades are already working since 2012-13 mainly to see how WATSAN-agriculture treatments (to be explained later) could better impact on SBs' household behavior and health outcomes. The design was presented in front of BRAC WASH Program colleagues and suggested also to include non-BRAC WASH intervention areas in the study as a pure control area- this helps to investigate the impacts of ongoing BRAC WASH intervention and also of WATSAN-Agriculture treatments. In this revised design, we take pure control where BRAC WASH intervention doesn't exist, control is BRAC WASH intervention area where WATSAN-agriculture is not given. Treatment is WATSAN-agriculture treatment area where BRAC WASH intervention also exists.

Pure Control: Neither BRAC WASH intervention nor WATSAN agricultural intervention area

Control: BRAC WASH interventions were introduced in those areas in 2012-13 with hardware support (say, latrine installation) *and general hygiene* messages, etc. BRAC WASH used several platforms, say, door to door household visit, Student brigade, School Management Committee, village WASH Committee and conducting cluster meetings, etc. These interventions and platforms are uniform across the study areas.

Treatment: WATSAN-agriculture treatment area where BRAC WASH intervention also exists. This treatment is given through student brigades (SBs) component of BRAC WASH program.

Student Brigades (SB) are formed under the school component of the BRAC WASH programme focusing on hygiene promotion and education for students, training and orientation for teachers, school compound cleaning and disposal of solid waste, providing separate latrines for girls with menstrual hygiene education. They are formed just after providing some hardware in the school compound and then they are trained to develop their capacities so that they can proactively work both in their respective schools and families in hygiene promotion. Students from grades 6-9 are chosen and then trained up in a way that they are working voluntarily to change unhygienic behaviors as a change agent both in their campus, families and communities. Usually the SB members are active students with commendable grades. Being a member of student brigade, their reputation is enhanced and valued by others in schools and the community as well. SBs also act as a catalyst to develop leadership skills.

WATSAN-Agriculture treatments include following

- A letter (**Annex 1**) to parents containing

  -initial water testing results

  -requesting for further water testing by kits to be given in the school either at POU or

  POS (first time at POU, second time at POS and third time at PoU)

- Knowledge on hygiene messages (at farm fields and households) through SBs through a poster (**Annex 2**) is given for household use
- The teachers responsible for BRAC SBs in the selected schools are trained about the use of water testing kits and a simple implantation guidelines are given. Then, technical knowledge are given to SBs in a group by the trained school teachers (at school class room) about the use of water testing kits. This training leads further water testing of drinking water for SBs' households.

4.1.1. Justification of WATSAN-agriculture treatment using school students' network

Literature in economics unlike that in public health, has laid much more emphasis on household wealth than on information and WATSAN knowledge as a determinant of willingness to pay to protect oneself from environmental and health hazards that contribute to improve household behavior and achieving health outcomes. One relevant study by Jalan and Somanathan (2007) investigated the effect of information on the demand for environmental quality. For this, they drew a randomly selected group of households in an Indian suburb of Delhi whether or not their drinking water had tested positive for fecal contamination using a simple and inexpensive test kit. They found some positive effects of information on further purification of water (in both number and extent, say, willingness to pay/spending for purification), that means, information treatment increases demand for quality WATSAN materials among the treatment households compared to control households. In our study we are interested to see the possible linkages between water, sanitation, agriculture and health involved in different type of agricultural systems in rural (advanced and marginal) areas in hotspot areas in Bangladesh. In our study, in addition to informing households about their POU water quality, water testing kits are given in the community through school student network for their households drinking water further testing at different points and related hygiene messages (both for farm fields and households) are given. Interaction with BRAC WASH program people shows that general hygiene knowledge is not enough to have sufficient impact on farm household behavior/practices and health/nutrition outcomes – thus, some hygiene messages to be practiced for farm fields and the households are included in the WATSAN-Agriculture treatment packages. Therefore, in this study, subject to working conventional WASH interventions of an NGO like BRAC we investigate the role of WATSAN-Agriculture treatment packages (informing the households about the prior water testing results, deliver hygiene messages through a poster and equip the student brigades with water testing toolkits and let them test water at different points and communicate the results back to their households) for changing household behavior and achieving health and productivity outcomes. As mentioned earlier, the treatment is implemented through BRAC SBs network- thus it explores about how (costless) school students' network could be instrumental for adopting such treatment packages and bring some changes in their households and the community as well.

Using school students as the intervention sample population for knowledge dissemination is an effective strategy that is being used in many countries. Studies show that students are more responsive to information and act promptly to the advantage of the respective intervention. For example, a randomized field experiment to study changes in the sexual behavior of Kenyan teenagers in response to information on HIV risk caused startling results to reduce sexual relationships with adults who were five years older or more (Dupas, 2011). Students being more responsive to risk information is in line with other studies of youth behavior in different contexts, such as youths being responsive to information on the returns to education (Jensen 2010) and responsive to prices (Gruber & Zinman 2001; Pacula et al. 2001) among many others. Thus, school children have been increasingly recognized as messengers for carrying information to their community. As such a study on malaria education intervention on three schools (one school assigned as treatment group and two schools assigned as control group) was conducted in Dangme-East district of the Greater Accra Region of Ghana, where school students of 3rd to 5th grades were given various health educational activities, with the support of charts and posters on malaria transmission and prevention by their teachers, to disseminate information to their communities (Ayi et al, 2010). The school children disseminated the information through a one-day anti-malaria campaign where they tried to educate the community people about malaria through drama and poetry recitals (*ibid*, 2010). Moreover a community health nurse explained the benefits of sleeping under treated bed nets and other malaria information along with correct procedure for treatment of conventional bed-nets using insecticide tablets(*ibid*, 2010).Findings showed that in the treatment group, community adults who treated a bed net with insecticide in the past six months increased from 21.5% to 50% ($p<0.001$) and parasite prevalence decreased from 30.9% to 10.3% ($p=0.003$) among school children, whereas no decrease was observed in the control group (*ibid*, 2010). Another quasi-experimental study showed the formation of a group of 80 school children from grade 3 and 5 in two schools in western Kenya and another set of study population consisting of 40 adults show that there was significant increase in health related knowledge among all recipient groups and behavioral changes was more evident among the children than the adults (Onyango-Oum et al, 2005).

Hence it can be stated with evidence that action-oriented and participatory health education intervention can enable school children to assist their peers and family members to acquire health-related knowledge and changed practices and be more empowered to be health agents in the community. Moreover there is an understanding that health interventions often will enhance school achievements (Deveney et al., 1993). There is a positive correlation between unhealthy behavior with underachievement and school-alienation so there is an underlining importance for schools to find ways to adjust to more participatory forms of practice (Nutbeam et al., 1993). Furthermore it was mentioned by Jensen (2004) that action-competence is acquired through children's genuine participation in any intervention where they try to influence 'real life' as part of their education.

Our study differs from the previous literature in the methodology adopted and the impact that is expected to prevail since we hope to get some behavioral change both in the sample populations household members including student members and farm fields. Thus, our study aims to strengthen the capacity of households and communities in selected hotspot areas of Bangladesh in monitoring their own water and sanitation (WASH) environment through experiment with school children and household members on the provision and use of water testing toolkits and subsequently the information about household water quality and some hygiene messages.

4.2. Impact Pathways

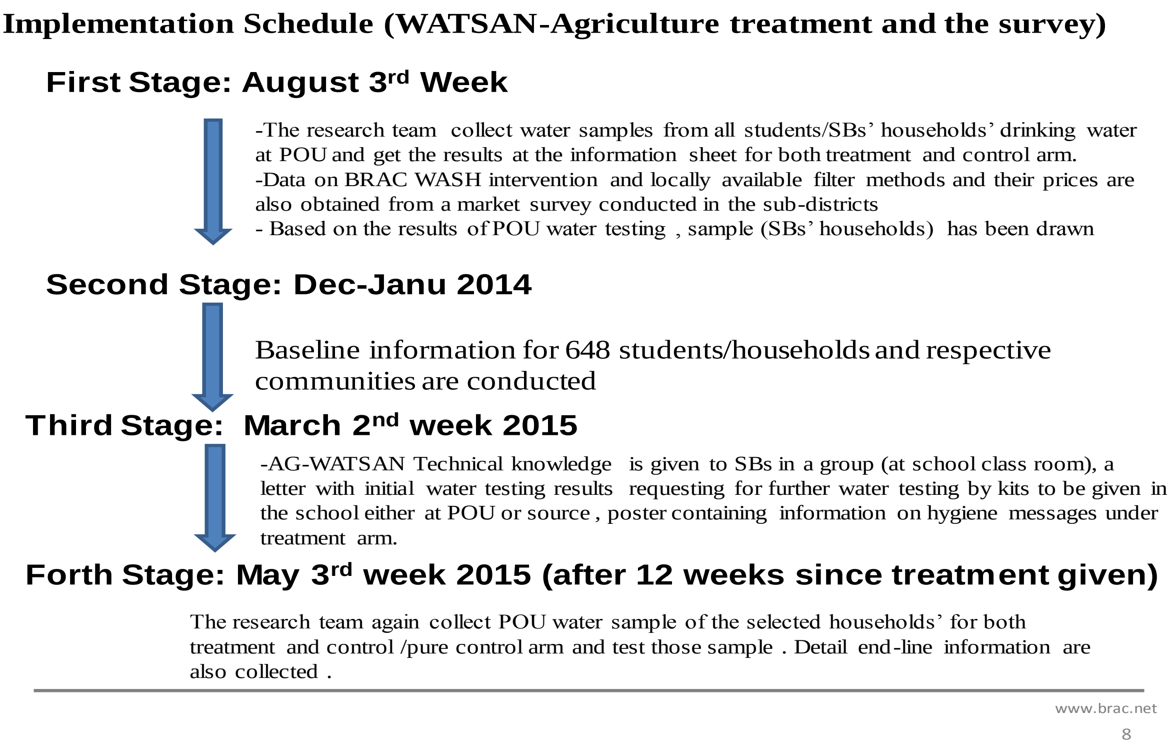
<Fig 1>

Figure 1 shows the impact pathways of our current study. The inputs for the project are census materials for water testing, posters involving hygiene messages (farm fields and households) and water quality testing kit. The first box shows the activities of the project by combining all the relevant inputs. As the intervention, three activities are in consideration. Firstly, treatment households are informed with the initial water testing results of their households from the census. Secondly, hygiene messages related with farm field and households use' are given to the students and their household members through a poster. Finally, the student brigades do water quality testing in the school premise with the trained school teachers three times, at first from the point of use (POU), then from the point of source (POS) and in the end also at PoU.

By building awareness through these activities, the expected immediate output is demand for improved water quality. As a result, household behavioral change and practice (hygiene index, investment/willingness to pay, etc. for WASH) is expected to occur that in turn lead to better short term outcomes of using improved water quality for household drinking, cooking and washing purpose as well as reduce fecal coliform presence in the drinking water to be used for both at the farm fields and household. That means improved water, sanitation and hygiene practice is expected to occur both in the households and in the farm fields. Hence these short term outcomes are expected to translate into long term outcomes of improved health which can be achieved by reducing water borne diseases (such as diarrhea) and child anthropometrics and increasing household productivity (reducing cost of illness, increasing work/school absenteeism, etc.) .

4.3. Time frame and stages of Implementation

Implementation of the treatment packages and related surveys follows several stages and takes about 9-10 months (August 2014- June 2015) as depicted below:



4.4. Sampling design/strategies

The experiment requires attention to which eligible SBs (which households' water has already fecal origin) are selected to participate in the experiment, and the selection of non-treatment (control) group. As in the pure control group (non-BRAC WASH Intervention areas), BRAC WASH student brigades does not exist, households of students of commendable grades from Grade

VI-IX are selected to form the **pure control** group. Based on this, the study plans using the following simple research design: a) half of SBs' households from BRAC WASH intervention areas selected at random does not receive WATSAN-agriculture treatment but receive the existing WASH intervention (**Control**) b) and the rest half of the SBs' households from BRAC WASH intervention areas selected at random receives WATSAN-agriculture treatment with existing BRAC WASH interventions.

For this study, we follow a multi-stage sampling procedure described in Figure 4. At the first stage, the study team themselves conducted water testing at POU using water testing kits for all SBs'/students households (1,560) in selected sub-districts and form the eligible study population (1,094) of fecal contaminated. At the next stage, a total sample size of about 648 (a bit higher than minimum sample size: say, 540 is required at 3% CI and 95% CL) SBs' households are selected for the entire study- the number under control and treatment arms depends on concentration of the fecal origin at the household POU water sample. The first stage randomization is done at SBs'/school level. We took 13 School from each BRAC WASH intervention sub-district (7 school at treatment arm and 6 schools at control arm) and thus we have 28 schools at treatment arm and 24 schools at control arm under BRAC WASH intervention areas. Additionally, we took two (7 schools) from two sub-districts where BRAC WASH interventions do not exist under pure control arm. Under treatment about 228 sample of SBs' households are considered-this number is not small in compared to the similar studies. Additionally, to see the spill-over effects, 125 SBs' households are also included from the eligible (but not treated) study population under treatment arm.

5. Analytical methods for impact analysis

The basic impact evaluation question essentially constitutes a causal inference problem. Assessing the impact of a programme on a series of outcome is equivalent to assessing the causal effect of the programme on those outcomes. Although cause-and-effect questions are common, it is not easy to establish that the relationship is causal. Impact evaluations help us to overcome the challenge of establishing to what extent a particular programme contributed to the change in an outcome. To establish causality between the programme and the outcome, we use experimental impact evaluation methods to rule out the possibility that any factors other than the programme of interest explain the observed impact. In this study, we use RCT method to assess the causal relationships between the interventions e.g. the packages of WASH interventions and the intended outcomes. We chose RCT because it ensures both the internal and external validity of the impact evaluation. Our evaluation is internally valid since it used a valid comparison group. External validity confirmed accurate representativeness of the population of eligible groups by the evaluation sample. We followed a set of sequential steps to evaluate the impact of the programme – designing sampling frame, execution of the intervention activities, data collection at baseline and end-line, and analyze data to estimate the treatment effect. In this study, treatment effect will be estimated since we expect every selected respondent will comply with the assignment. Since RCT design was adopted, it is expected, at least theoretically, that in baseline there would be no significant difference between treatment and control areas for the outcome variables, i.e. both samples are balanced. Balancing between treatment and control areas was checked using the Bonferroni multiple-comparison test. After balancing, given that we have a valid estimate of the counterfactual, the impact (treatment effect) of the intervention could be estimated by simply taking the simple differences of outcomes of interest between intervened households and the counterfactual. **Figure 2** illustrates the estimation technique.

According to the figure, when treatment and control samples are balanced in baseline then the impact of the intervention on any outcome variable is the difference between the treatment and control groups of that outcome in the end-line. However, it is advised in a number of relevant literatures to use difference-in-difference (DiD) or double differences technique to check the robustness of the impact estimates (Gertler *et al*. 2011, Khandaker *et al*. 2010). The DiD multivariate regression model also allows us to control household and community level fixed effects. In the survey we collect some village and school level information. Since DiD regression model has more advantages than simple regression or simple differences of outcomes of interest between intervened households and the counterfactual, we use following DiD regression model for our empirical analyses:

$outcome_{it} = \beta_1 + \beta_2 programme_i + \beta_3 year_t + \beta_4 (programme * year)_{it} + \varepsilon_{it}$........(1)

Where

$outcome_{it}$= Outcome of interest

$programme_i$= a dummy variable taking the value of 1 if the observation is from endline and 0 otherwise. This variable captures possible differences between the treatment and control groups prior to the intervention.

$year_t$= dummy variable taking the value of 1 if the observation is in the treatment group and 0 otherwise. This variable captures aggregate factors that would cause changes in the outcome even in the absence of intervention.

$(programme * year)$= The coefficient of interest, which is the same as a dummy variable equal to one for those observations in the treatment group in the second period.

It can be shown that

$$\beta_1 = (outcome|year = 0, programme = 0)$$

$$\beta_2 = (outcome|year = 1, programme = 0) - (outcome|year = 0, programme = 0)$$

$$\beta_3 = (outcome|year = 0, programme = 1) - (outcome|year = 0, programme = 0)$$

$$\begin{aligned}\beta_4 = [(outcome|year = 1, programme = 1) - (outcome|year = 0, programme = 1)] \\ - [(outcome|year = 1, programme = 0) \\ - (outcome|year = 0, program = 0)]\end{aligned}$$

β_4, is therefore, is the Difference-in-difference estimator.

We estimate (1) on the entire sample of selected individuals, hence β_4 identifies the treatment effect. Standard errors are clustered at the school level throughout to account for the fact that outcomes are unlikely to be independently distributed within the same school. Furthermore, while randomization ensures that individual heterogeneity is orthogonal to treatment in expectation; random differences in individual characteristics at baseline can nevertheless contaminate cross-sectional estimates. Therefore, as robustness check we will also control the baseline characteristics including GPS estimates. Seasonality issue of the interventions need to be carefully addressed during interpreting the results.

The use of packages of intervention (say, prior water quality information in the letter, poster message, repeated water quality testing, water purification/treatment, etc.) to improve WASH behavior at households and farm fields could also be analyzed within the framework of adoption of any given intervention/technology. This means there are adopters and non-adopters- treatment and control comparison under RCT framework will be able to address this issue. However, within the adopters/treatment group, there might be several stages of adoption or intensity of adoption which might be influenced by several factors and their treatment effects on household behavior and on health outcomes might also be different- that will be addressed by adding some questions at the end-line survey. Here we argue that SBs and their households will adopt the technology if the expected utility to be derived from its use is higher than the utility of the current status of water quality information available to the household. Thus, the study sample can be classified into several sub-groups- thus we might also have different adoption rate (for letter water quality info, poster message, repeated water quality testing, water purification/treatment, etc.) –these might be linked with the outcome measures. Accordingly, differential impacts for girls and boys SBs' households may also be estimated.

6. Results

6.1. Results from the census

As mentioned earlier, we conducted water testing at POU using water testing kits for all SBs'/students households (1,560) in selected student brigades in the hotspot areas. Water testing census show about 72% households' (that is, about 1,094 households) drinking water fecal contaminated at POU and the fecal contaminated households had more diarrhea prevalence rate. So drawing sample (about 648 households) for the impact study from the fecal contaminated households makes sense. Despite all households fecal contaminated and using drinking water from so called improved sources, further water testing treatment both at point of use and source and related hygiene messages treatment is also justified. Results presented at Table 1 show that the households associated with farming are more likely to diarrhea prevalent- this also necessitates inclusion of hygiene messages at the farms' fields.

6.2. Results from the baseline household survey

It was expected, at least theoretically, that there would be no significant differences among treatment, control and pure control households for the outcome variable of interests because RCT evaluation design was adopted. To see whether there was any significant difference, the differences between treatment, control and pure control households for the key variables of interests were estimated by performing t-test using the Bonferroni multiple-comparison test. It has been found that the mean differences among treatment, control and pure control groups in terms of different indicators of the surveyed households were statistically similar in most of the cases, which is reasonable and is as expected. Major insights from the baseline survey are depicted below:

- Treatment, control and pure control households' distance from various important places measured in terms of kilometre and minute were almost similar. The same picture was depicted for household characteristics such as size, number of members, age, expenditure, asset, farm size, etc.

- Household sanitation and hygiene profile showed similarity across the three groups for most of the variables under consideration such as- water, sanitation and hygiene expenditure. In case of the variables that showed statistically significant ($p < 0.05$) differences across groups such as toilet facility in the field, soap observed in the hand washing station, etc., the differences were very small and negligible.

- The variables depicting the household types of water source such as improved main drinking water source, improved drinking water sources in the field, households that used other than own shallow tube well source for drinking water, etc. do not show statistically significant differences across the groups.

- Household water treatment behavior in the baseline was almost the same across the three groups. Most of the sample households (about 80%) used soap or detergent to wash storage container. But in contrast, very few households (about 3%) treated water to make it safer to drink.

- Child health and nutrition outcomes were also similar across the groups. Although all households were fecal contaminated, on an average 9.26% of the household members had diarrhea in the past two weeks.

6.3. Impression from the treatment implementation

During March 1st week to May 2nd week in the year 2015, treatment implementation has been completed in all four treatment locations and we found some preliminary observations.

Atrai

Treatment households have not been able to follow the messages of the posters and other interventions to some extent. They still practice open defecation, although somewhat less than before-intervention period, during their work time in the farming fields. The farmers drink water used for irrigation. Women have become more aware about following the messages of the poster than men. Women are now washing hands using soaps or powdered soaps. But most of the men, even when they defecate at home, do not have the practice of using soaps. Female students have now become more aware about maintaining their hygiene. Households are now drinking water from tube well rather than unimproved sources. To sum up, most of the households have gone through some changes due to the interventions.

Bakshiganj

In Bakshiganj, the interventions have had positive effects on the daily lives of the treatment households. The women did not know about washing hands with soap or detergent before cooking. But after getting the poster, they came to know about it and now follow accordingly.

Kalihati

The treatment households in Kalihati now practice washing their hands using soaps after defecation about which they were not much aware before the AG-WATSAN intervention. They do not practice open defecation now. Previously, the children used to defecate in the yards of their houses. Also, the discharges of households were disposed to the backside of the houses. But now, after the interventions, the discharges are disposed to specific places. Before the interventions, they did not use to cover their food. But now they preserve food in closed cupboards and high places. As a matter of sorrow, most households cannot purify water due to lack of purifying kits. They fetch water from tube well and drink directly.

Bauphal

Students who got training on water quality testing have become aware about drinking water. Households who used to wash hands using only water now keep soaps on the top of the tube wells and wash their hands with the soaps. They did not wash their hands after touching hens and ducks. But after the interventions, they do.

7. Conclusion

Initial water quality census and baseline survey found the justification of the interventions that we suggested for this study. Baseline results also confirm similarities for most of the outcome indicators among treatment and control groups. Treatment implementation is already done and the end line survey is now in progress. Impression from the implemented treatments indicates that the suggested intervention packages can be an effective strategy to motivate households and communities, particularly using school students as agents of change and as a channel of conveying messages. To have more concrete results, still we need to wait for few months.

References

Ayi, I., Nonaka, D., Adjovu, J. K., Hanafusa, S., Jimba, M., Bosompem, K. M., Mizoue, T., Takeuchi, T., Boakye, D. A. & Kobayashi, J., 2010. Research school-based participatory health education for malaria control in Ghana: engaging children as health messengers. 9 (98), 9-98.

Devaney, B., 1993. Evaluating the effects of school health interventions on school performance. Design Report, Mathematica Policy Research, Princeton, N.J.

Dupas, P., 2011. Do teenagers respond to HIV risk information? Evidence from a field experiment in Kenya. American Economic Journal: Appl. Econ.. 3 (1), 1-34.

Engell, R. E., Lim, S. S., 2013. Does clean water matter? An updated meta-analysis of water supply and sanitation interventions and diarrheal diseases. The Lancet, 381, S44.

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. (2011). *Impact evaluation in practice*. World Bank Publications.

Gruber, J. & Zinman, J., 2001. Youth smoking in the United States: evidence and implications, in Jonathan Gruber, (ed)., Risky behavior among youths: An economic analysis. University of Chicago Press, Chicago.

Jensen, R., 2010. The (Perceived) Returns to Education and the Demand for Schooling. Quarterly Journal of Economics. 125 (2), 515–48.

Jensen, B. B., 2004. Environmental and health education viewed from an action perspective—a case from Denmark. American Journal of Curriculum Studies. 36 (4), 405–425.

JMP Report, 2014. Joint Monitoring Programme for Water Supply and Sanitation-Estimates on the use of water sources and sanitation facilities Bangladesh. World Health Organization (WHO)/United Nations Children's Fund (UNICEF), Switzerland (April 2014) (wssinfo.org).

Jyotsna, J., & Somanathan, E., 2008. The importance of being informed: Experimental evidence on demand for environmental quality. Journal of Development Economics 87 (2008) 14–28.

Khandker, S. R., Koolwal, G. B., & Samad, H. A. (2010). Handbook on impact evaluation: quantitative methods and practices. *World Bank Publications*.

Nutbeam, D., Smith, C., Moore, L., Bauman, A., 1993. Warning! Schools can damage your health: alienation from school and its impact on health behavior. Journal of paediatrics and child health. 29 Suppl 1, S25-30.

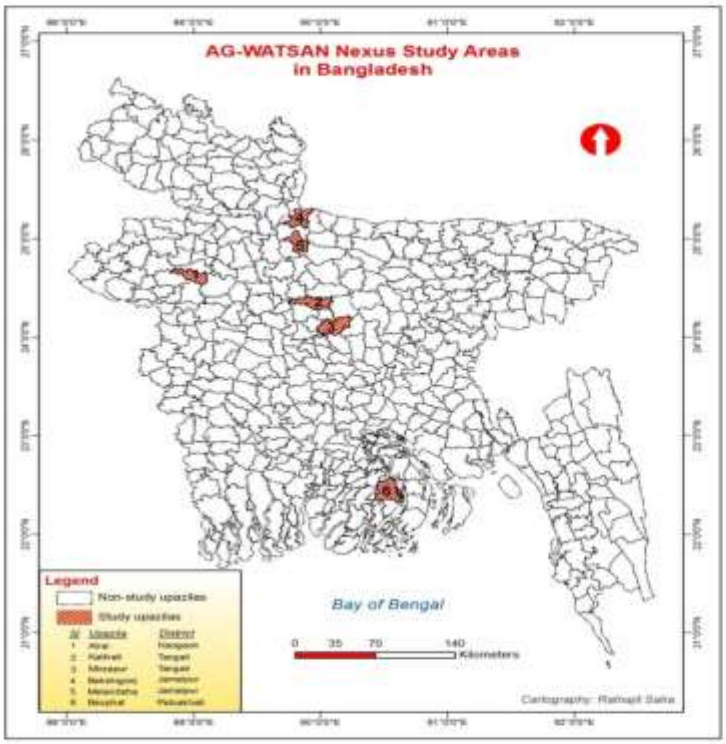
Onyango-Ouma, W., Aagaard-Hanse, J., Jensen, B., 2005. The potential of school children as health change agents in rural western Kenya. Social Science & Medicine. 61 (8), 1711-1722.

Pacula, Liccardo, R., Grossman, M., Chaloupka, F. J., O'Malley, P.M., Johnston, L. D., Farrelly, M. C., 2001. Marijuana and Youth. in Jonathan Gruber (ed)., Risky Behavior among Youths: An Economic Analysis. University of Chicago Press, Chicago.

Srinivasan, J, T. , Reddy, V,R., 2009. Impact of irrigation water quality on human health: A case study in India, Ecological Economics, Vol. 68, no. 11, pp. 2800-2807

USAID, 2013. Water and Development Strategy, 2013-2018. United States Agency for International Development, Washington, D.C.

Van Derslice, J., Briscoe, J., 1995. Environmental interventions in developing countries: Interactions and their implications, American Journal of Epidemiology, Vol.141, no. 2, pp. 135-144.



Map 1. WATSAN-Agriculture Nexus study sites locations in Bangladesh

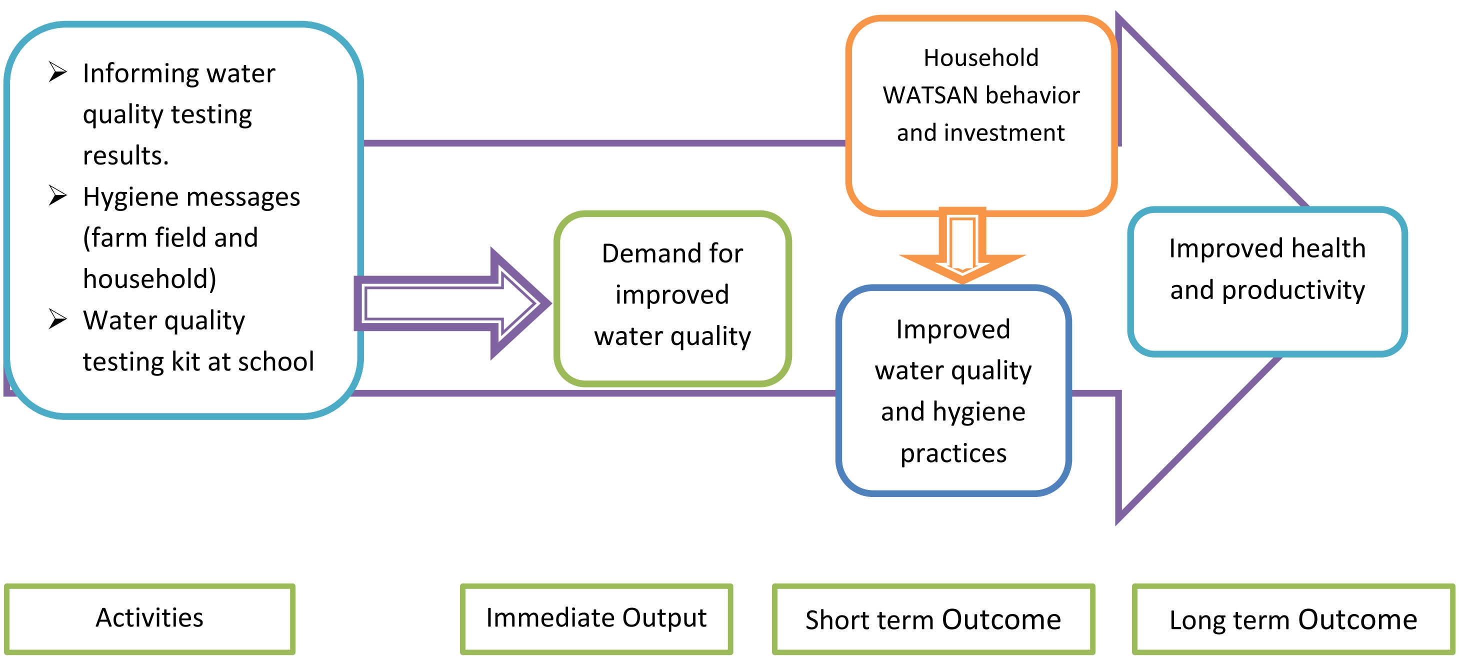


Figure 1: Impact Pathway

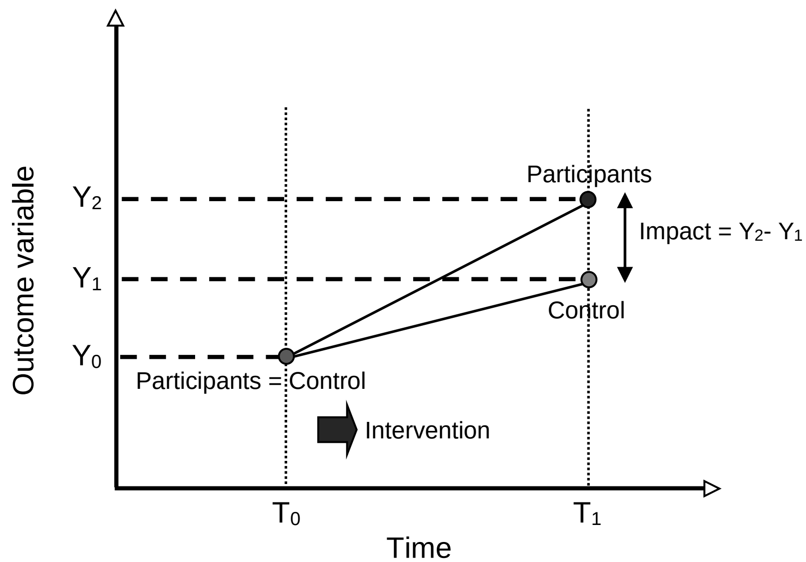


Figure 2: Estimation technique

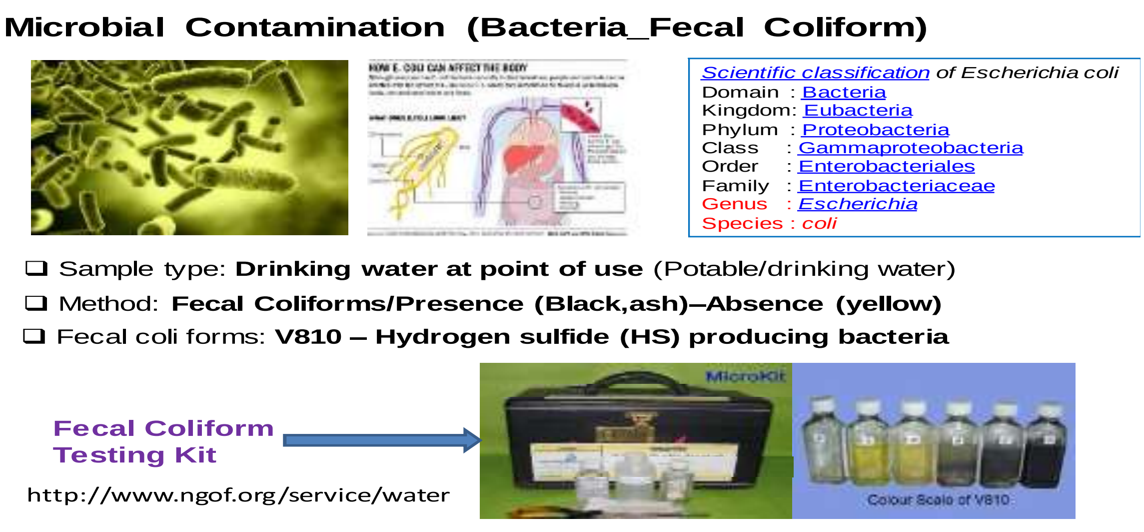


Figure 3 Water testing kits used for the treatment

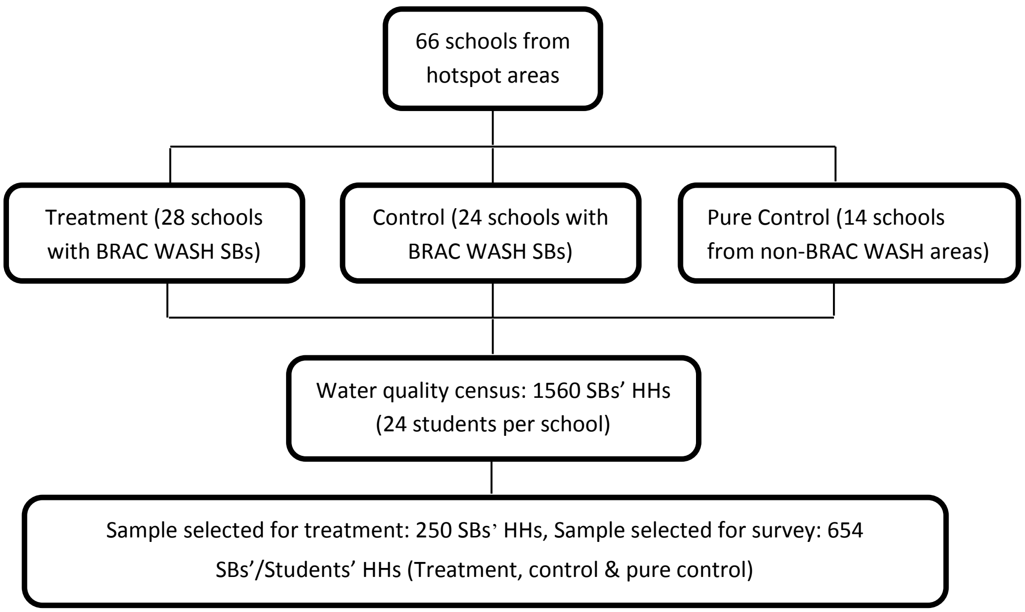


Figure 4: Sampling frame at a glance

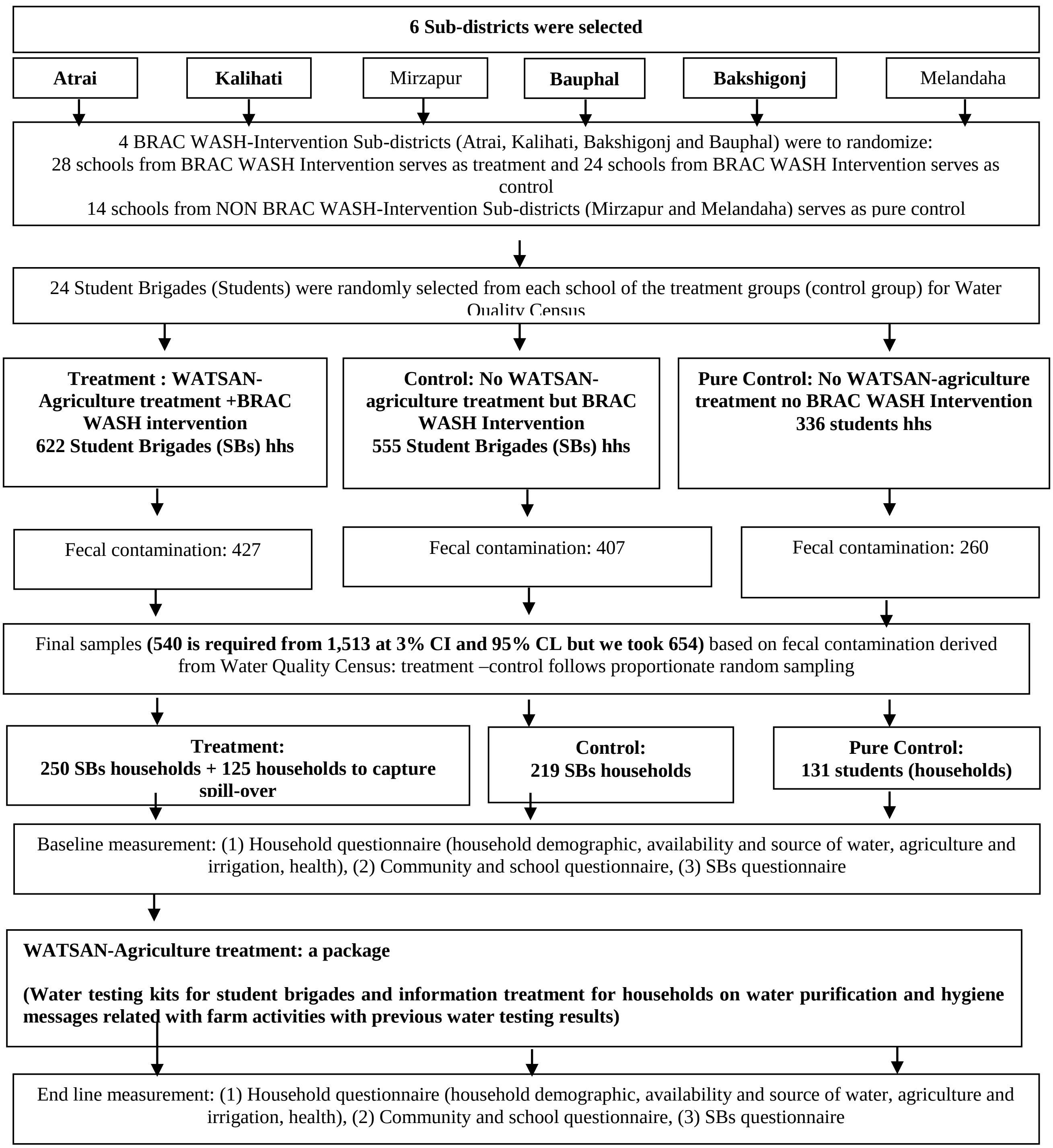


Figure 5: Sampling frame in details

Annex 1 Letter treatment

……March 2015

Name and Address…………………………

Dear Madam/Sir,

Assalamu Alaikum.

Probably you can recall that we took drinking water sample to test the water quality from your home during the survey conducted in August 2014. Thank you for your cooperation. Unfortunately, we found the sample of your household fecal contaminated (pathogen). But we are not very sure of that this contamination might make you sick.

You may wish to take the following preventive measures:

1. You may please get your water at POU tested again through your kid to confirm whether the water is still contaminated. The water testing kit is kept at your kids' school and your kid is already taught about how to use it. You may also like to test the water at source of your household at second time. You will get maximum three times to get the water sample to be tested from your kids' school at free of cost within next 12 weeks.
2. If your drinking water is still contaminated, we recommend you to take actions that could make it clean prior to drinking. We also suggest you to maintain cleanliness regarding farm activities both at home and at farm fields. We request you to set the posters at your dwelling wall and follow the messages given at the posters-your kids are also taught about these messages at the school.

We will appreciate your cooperation to follow these guidelines to make your environment clean.

With warm regards,

……………………..

(Dr. Mohammad Abdul Malek)
Senior Research Fellow and Co-coordinator, Agricultural Economics Unit
BRAC Research and Evaluation Division (RED)
BRAC Center
75 Mohakhali, Dhaka

Phone:
Cell:
Email:

Annex 2 Poster


Ensuring hygiene and use of safe drinking water in the crop field and at the household
In the crop field
In the household
Carry safe drinking water in a covered clean jar/bottle to the field
Treat water by current standard practices and preserve treated water
Protect drinking water and food from wastes/latrine
Use hygienic latrine
Wash your hands with soap/detergent after farming handling animals/wastes and defecation
Wash your hands with soap/detergent before cooking and eating
After
Before
Soap
Be clean, drink safe water, live a healthy life.
brac

Table 1 Prevalence of diarrhea in the hotspot areas in Bangladesh (1 if yes) : Results from logit regression

Diarrhea	**Coef.**	**Std. Err.**	**P-values**
Income	0.000	0.000	0.958
Agri_work (1 if yes)	**0.460**	**0.211**	**0.029**
ChildU5 (1 if yes)	-0.263	0.202	0.193
Latrine_imprvd (1 if yes)	0.007	0.211	0.972
Soap/ash use for handwash (1 if yes)	**-0.663**	**0.206**	**0.001**
Advanced areas (1 if yes)	-0.030	0.190	0.874
Impvd_toilet (1 if yes)	-0.424	0.389	0.276
Ss2 (1 if control)	**0.600**	**0.251**	**0.017**
Ss3 (1 if treatment)	-0.004	0.255	0.986
Inc2	**-0.533**	**0.256**	**0.038**
inc3	-0.167	0.298	0.574
inc4	-0.121	0.464	0.795
_cons	-0.031	0.814	0.970
		Number of obs	**600**
		LR chi2(12)	**43.33**
		Prob > chi2	**0**

Table 2 Baseline characteristics

Location/Distance Characteristics														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Household distance from the school (km)	1.01	0.91	0.92	0.73	1.15	1.08	0.79	0.54	0.22	0.02	-0.35	0.001	-0.13	0.62
Distance from nearest pacca road (km)	0.59	0.82	0.6	0.95	0.66	0.86	0.4	0.38	0.06	1	-0.26	0.01	-0.2	0.09
Distance from the nearest market/bazar (km)	1.12	1.2	0.97	1.02	1.24	1.22	1.05	1.37	0.27	0.04	-0.18	0.43	0.08	1
Distance from the hospital (km)	1.77	1.9	1.44	1.57	1.9	2.01	1.94	2.01	0.46	0.02	0.04	1	0.5	0.07
Household characteristics														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Household/family size (no.)	5.55	2.01	5.74	2.06	5.34	1.96	5.81	2.01	-0.403	0.08	0.47	0.072	0.07	1
Number of children under 5 years	0.5	0.63	0.57	0.64	0.42	0.62	0.6	0.63	-0.15	0.032	0.17	0.026	0.028	1
Head is a male (male==1) (%)	94%	23%	97%	17%	93%	26%	94%	24%	-4%	0.21	1%	1	-3%	0.68
Head's age (Years)	46.68	9.74	47.44	10.001	46	9.57	47.31	9.75	-1.44	0.31	1.31	0.6	-1.28	1
Head is married (married==1) (%)	98%	15%	98%	12%	97%	18%	99%	9%	-2%	0.59	3%	0.32	1%	1
Head's education (years of schooling)	5.41	7.27	5.38	7.18	5.41	7.26	5.48	7.49	0.034	1	0.0671	1	0.101	1
Annual household expenditure (BDT)	274353.77	274264.2	307251.98	392181.33	255912.7	220943.28	272521.2	152578.6	-51339.3	0.118	16609	1	-34731	0.807
Value of household assets (BDT)	2630463.5	5772579	2885585.6	6089897.8	2416397	6243065.9	2802357	3601970.1	-469189	1	385960	1	-83229	1
Farm size (decimal)	88.45	140.69	94.35	168.87	93.58	140.85	65.99	77.61	-0.77	1	-27.59	0.183	-28.36	0.236

Sanitation and hygiene profile														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Water, sanitation and hygiene expenditure (last 4 weeks) (BDT)	398.304	482.31	390.34	450.39	388.26	556.7	436.75	276.67	-2.089	1	48.5	1	46.41	1
Presence of toilet in the house or dwelling (% HHs)	93%	26%	91%	28%	91%	29%	99%	9%	-0.0024	1	0.083	0.007	0.081	0.021
Improved sanitation (yes==1) (%)	33%	47%	33%	47%	33%	47%	33%	47%	0.0052	1	0%	1	0.0052	1
Toilet facility in the field (open defecation==1) (%)	45%	50%	45%	50%	51%	50%	30%	46%	0.61	0.52	-0.21	0	-0.15	0.029
Hand-washing with soap or detergent (yes==1) (%)	92%	27%	93%	25%	90%	30%	97%	18%	-0.035	0.44	0.071	0.034	0.036	0.73
Soap observed in the hand washing station (yes==1) (%)	52%	50%	58%	50%	57%	50%	33%	47%	-0.012	1	0.24	0	-0.25	0
Courtyard free from animal/human waste (yes==1) (%)	45%	50%	53%	50%	41%	49%	44%	50%	-0.12	0.024	0.03	1	0.09	0.35
Household types of water sources														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Improved main drinking water source at households (%)	99.85%	4%	99.48%	7%	100%	0%	100%	0%	1%	0.43	0%	1	1%	0.74
Improved Drinking water sources in the field (%) [3]	98.44%	12%	100%	0%	98.28%	13%	96.51%	18%	-2%	0.62	-2%	0.78	-3%	0.13
Households that used other than own STW source for drinking water (%)	41.98%	49%	43.75%	50%	44.55%	50%	32.54%	47%	1%	1	-12%	0.06	-11%	0.14

[3] Only for farm households (Sample size, n=449)

Household Water Treatment Behavior														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Treated water to make it safer to drink (%)	2.93%	17%	3.13%	17%	3.03%	17%	2.38%	15%	0%	1	-1%	1	-1%	1
Stocked drinking water in the house (%)	100%	0%	100%	0%	100%	0%	100%	0%	0%	.	0%	.	0%	.
Storage container is closed by lid or cork (%)	80.25%	40%	82.29%	38%	83.03%	38%	69.84%	46%	1%	1	-13%	0.01	-12%	0.02
Used soap or detergent to wash storage container (the last time) (%)	79.63%	40%	81.25%	39%	77.27%	42%	83.33%	37%	-4%	0.83	6%	0.45	2%	1
Child Health and Nutrition Outcomes														
Variables	**All (=648)**		**Control (1)=192**		**Treatment (2)=330**		**Pure control (3)=126**		**(1vs2)**		**(2vs3)**		**(3vs1)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Diff**	**p-value**	**Diff**	**p-value**	**Diff**	**P-value**
Child age (months)	34.09	16.69	34.8	16.75	32.82	16.16	35.26	17.56	-1.98	1	2.44	1	0.46	1
Child is a male (%)	47.39%	50%	50%	50%	46.22%	50%	45.71%	50%	-4%	1	-1%	1	-4%	1
Member had diarrhea in the past 2 weeks (%)	9.26%	29%	10.42%	31%	9.10%	29%	7.94%	27%	-1%	1	-1%	1	-2%	1
Child height (cm)	65.3	43.1	65.61	43.38	63.51	42.66	67.9	43.93	-2.1	1	4.39	1	2.29	1
Child weight (kg)	11.11	3.72	11.04	3.53	10.82	3.7	11.69	4.01	-0.22	1	0.87	0.36	0.65	0.79

Source: BRAC AG-WATSAN Baseline Survey Dec 14-Janu 15