Multiple-Use Water Services in Rural Burkina Faso

An Impact Evaluation

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Summary

Multiple-use water services (MUS) is an integrated water service delivery approach that takes into account rural households’ range of needs as a starting point when planning, financing, and managing water services for domestic and productive uses. In Burkina Faso, the MUS component of the West Africa Water Supply, Sanitation and Hygiene Program (WA-WASH) provides rural dwellers with an investment option in support of their domestic (drinking, cooking, washing, bathing) and productive (e.g., livestock rearing, gardening) needs with water. Through a modified self-supply approach, households are given the chance to invest in an upgraded water point, which is installed and maintained by the private sector. Drillers and repair technicians receive technical and business development services training from Winrock.

The aim of this study is to systematically and rigorously evaluate a wide range of impacts (livelihoods, health, and water service quality) associated with upgraded domestic and productive water supply within the WA-WASH program area. Key outcome measures include: water-based income, livelihood diversification, water availability in the dry season (resilience), nutritional status, food security, drinking water quality, and child health.

The preliminary findings presented in this report are limited in that they do not account for additional factors which may also influence outcomes of interest. Follow up analyses will control for confounders, such as wealth, access to markets, credit, etc. Nonetheless, the findings presented here show a strong and consist trend linking MUS to positive outcomes, including:

- Undertaking more diverse water-based income earning activities
- Earning more income in the driest months of the year
- Vegetable cultivation in the driest months of the year
- Lower incidence of food insecurity
- More consumption of protein- and micronutrient-rich foods essential for women’s reproductive health
- Slightly fewer incidences of diarrhea and respiratory illness among children under age five and injuries among those fetching water
- Drinking water that is free of fecal contamination at the point of collection
- Less time spent waiting for water in situations where the well must recharge
- Fewer full-day interruptions in water service and less time spent waiting for repairs

Abbreviations

CBT - compartment bag test
MUS – multiple-use water services
ODK – open data kit
WA-WASH – West Africa Water Supply, Sanitation and Hygiene Program
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**Introduction**

Multiple-use water services (MUS) is an integrated water service delivery approach that takes into account rural households’ range of needs as a starting point when planning, financing, and managing water services for domestic and productive uses. In Burkina Faso, the MUS component of the West Africa Water Supply, Sanitation and Hygiene Program (WA-WASH) provides rural dwellers with a modified self-supply investment option in support of their domestic (drinking, cooking, washing, bathing) and productive (e.g., livestock rearing, gardening) needs with water. Recent studies have shown the powerful benefits of MUS in terms of water-based income generation and women’s empowerment (Davis, Hope, & Marks, 2011; Hall, Vance, & van Houweling, 2014; van Houweling, Hall, Diop, & Davis, 2012). However, little is known about additional potential impacts of MUS at scale, especially pertaining to households’ health, resilience through the dry season, and livelihoods diversification.

The aim of this study is to systematically and rigorously evaluate a wide range of impacts associated with upgraded domestic and productive water services within the WA-WASH program area. Specifically, the study will quantify the influence of MUS on rural households’ livelihoods, health, and water service quality as a direct result of their participation in the WA-WASH project. Key outcome measures include: water-based income, livelihoods diversification, water availability in the dry season (resilience), nutritional status, food security, drinking water quality, and child health.

**WA-WASH in Burkina Faso**

Burkina Faso is a landlocked country in West Africa, bordered by Mali, Niger, Benin, Togo, Ghana, and Cote d’Ivoire (Figure 1). There are nearly 16 million people in Burkina Faso, with three quarters of the population living in rural areas. Water resources are scarce and characterized by significant seasonal variability. Most rural residents access water using hand-dug private wells, which are highly susceptible to shortages, especially during the driest months (March-June). An estimated one third of public water points and piped water systems are non-functional at any given time (World Bank, 2009).

![Figure 1. Study area](image-url)
Winrock International, through the USAID-funded WA-WASH program in Burkina Faso, used a demand-responsive, modified self-supply approach to deliver MUS to rural households across the study area. The overall goal of the MUS component is to introduce economically and technically viable water services that enable sustainable and equitable access to water, health, hygiene, food security and income. Water for domestic (drinking, cooking, washing, bathing) and for productive (gardening, livestock rearing, and small water-based enterprises) activities is provided through installation of low-cost boreholes and enhanced traditional wells (Figure 2). Through a modified self-supply approach, households are given the option to invest in an upgraded water point, which is installed and maintained by the private sector. Drillers and repair technicians receive technical and business development services training from Winrock.

Winrock’s primary MUS-related objectives are to: (1) Identify promising locations for implementing MUS; (2) Provide reliable access to MUS for sustainably meeting domestic and productive water needs; (3) Improve health for poor rural households by providing access to safe drinking water and promoting improved hygiene practices at the household level; (4) Increase annual incomes, enhance food security, and diversify livelihoods of poor rural households through locally appropriate strategies that support and sustain incomes from productive water use activities, focusing on horticulture and livestock; and (5) Catalyze a supportive environment for MUS learning, replication, and scale-up through outreach, education, and multi-stakeholder MUS learning workshops.

**Figure 2: Before and After - Upgraded dug-well in Weglega**

!(Photo: Winrock International)

**Impact Study Methodology**

*Village and household selection.* All villages located within the Winrock WA-WASH program area qualified for enrollment to the study. Any village that was visited by Winrock staff and offered the opportunity to invested in upgraded water services through the modified self-supply option are considered “treatment villages,” henceforth referred to as MUS villages. Villages that had not been “touched” by the Winrock WA-WASH project are considered “control villages” and henceforth referred to as non-MUS villages. Within MUS villages, households are further categorized as being investors, neighbors of investors (i.e., those who report using an investor’s upgraded well), or non-neighbors (i.e.,
those who did not invest in nor use an investor’s upgraded well). Within non-MUS villages, all households are categorized as control households (Figure 3). Table 1 describes village and household categorizations, sample sizes, and sampling strategies.

**Figure 3. Household types found in MUS and non-MUS villages**

![Figure 3. Household types found in MUS and non-MUS villages](image)

**Table 1. Village and household sample sizes and strategy**

<table>
<thead>
<tr>
<th>Village type</th>
<th>Household type</th>
<th>Sampling strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUS (n = 19)</td>
<td>Investor (n = 146)</td>
<td><strong>Census</strong>: All households are offered chance to enroll.</td>
</tr>
<tr>
<td></td>
<td>Neighbor (n = 292)</td>
<td><strong>Snowball sampling</strong>: Neighbors identified by each investor, 2-3 are randomly chosen and offered the chance to enroll.</td>
</tr>
<tr>
<td></td>
<td>Non-neighbor (n = 451)</td>
<td><strong>Stratified random sampling</strong>: Households are mapped and clusters identified, with every n&lt;sup&gt;th&lt;/sup&gt; household offered the chance to enroll.</td>
</tr>
<tr>
<td>Non-MUS (n = 9)</td>
<td>Control (n = 438)</td>
<td><strong>Stratified random sampling</strong>: Households are mapped and clusters identified, with every n&lt;sup&gt;th&lt;/sup&gt; household offered the chance to enroll.</td>
</tr>
<tr>
<td></td>
<td><strong>Total household sample = 1,327</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Data sources.** A total of 1,327 household surveys were conducted using smartphones loaded with Open Data Kit (ODK) (Table 1). Survey instruments collected information on household composition (concession or single family home, family size, etc.), socio-economic status, water sources used, water-based activities undertaken, water service features, and nutritional status. Prior to the start of household survey data collection, a short village-level survey and mapping activity was undertaken in each village in cooperation with a village representative (n = 28). In addition, focus group discussions were conducted in 6 villages with women and men together and separately to better understand gender dynamics of MUS.

Water quality testing was conducted using compartment bag test (CBT) kits, indicating the microbial quality (*E. coli* concentration). Sampling took place in two of the Winrock program areas. In the Koudougou region, samples were taken in Doudou, Tialgo, Koukouldi and Balévalése. In the
Ouagadougou region, samples were taken in Oueglega, Nabélin and Tensouka. Three groups of people were targeted: investors that use upgraded wells installed by the private sector which received technical and business development services training from Winrock, the “non-neighbors” group (households within MUS village but who did not invest or access upgraded water points), and the “control” group (households within non-MUS villages). In total, 59 investors, 59 non-neighbors and 63 controls were sampled.

Results

In this section we present preliminary findings regarding the impacts of upgraded water services on participating households within MUS villages. The analysis presented in this report focuses on direct comparisons of key outcome measures across MUS and non-MUS villages. The sample strategy described above was designed to reduce potential sources of bias to the extent possible. However, since treatment households chose themselves whether or not to participate in the program through the self-supply scheme (i.e., households assigned themselves to the treatment group), follow up analyses will use a propensity score matching technique to control for confounding factors. For further details on the findings presented in this section, please refer to Appendices A-C.

Household characteristics. The typical household survey respondent was 49 (male) and 39 (female) years old. Sixty-one percent of survey respondents were men, 31% were women, and in 8% of cases both a man and woman were interviewed. Survey respondents lived in either a single-family household (56%) or an extended family concession (44%). When asked an open-ended question about the main challenge faced by their village, the most common response was overwhelmingly water supply services (76%), followed by health and healthcare services (10%) and support for agriculture (7%).

Water-based income and activities. The most common productive water-based activities undertaken were livestock rearing, gardening, and dolo brewing (Table 2). The diversity of productive water-based activities undertaken by households in MUS villages was slightly greater (M = 1.49, SD = 0.73) as compared to non-MUS villages (M = 1.40, SD = 0.66) (t (1,325) = 2.23, p<0.05). The median monthly income (fCFA 30,000 or USD $51.26) earned by households in MUS villages in the dry season was significantly greater than in non-MUS villages (fCFA 20,000 or USD $34.17) (U = 25,000, p<0.001).

Table 2. Percentage of households in MUS and non-MUS villages undertaking various productive activities with water.

<table>
<thead>
<tr>
<th>Activity</th>
<th>MUS</th>
<th>non-MUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence crop</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Cash crop</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Gardening*</td>
<td>47.5</td>
<td>38.6</td>
</tr>
<tr>
<td>Livestock*</td>
<td>83.8</td>
<td>88.4</td>
</tr>
<tr>
<td>dolo</td>
<td>14.6</td>
<td>12.3</td>
</tr>
<tr>
<td>shea butter*</td>
<td>1.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Chi-square test indicates statistically significant difference between MUS and non-MUS group.

In terms of women’s contribution to household income, there was no meaningful difference, when comparing households within MUS and non-MUS, between the number of women engaged in income earning activities or the share of income earned. These findings are consistent with previous research which reports that whereas water improves the overall livelihoods portfolio for rural households, the contribution of women to total income is relatively small.
Nutrition and food security. In all villages a minority of households are cultivating vegetables in the warm-dry season (March-June). However, in MUS villages a significantly greater share of households (45%) are able to cultivate vegetables in this critical time as compared to households within non-MUS villages (23%) \( (X^2 (1) = 56.04, p<0.001, \text{Figure} \ 4a) \). In terms of self-reported food security throughout the year, results show that whereas both MUS and non-MUS groups experience some level of food insecurity at some point during the past year, the proportion of households in the insecure category is significantly higher among non-MUS households as compared to MUS households \( (X^2 (2) = 27.71, p<0.001) \) (Figure 4b). Finally, in terms of the number of different food types consumed within the past week (FAO & FANTA, 2014), results show that overall dietary diversity did not differ significantly between MUS and non-MUS households. However, households living in MUS villages were more likely to have consumed foods rich in protein and micronutrients (critical for the women’s reproductive health and child growth) such as leafy greens \( (X^2 (1) = 6.82, p<0.01) \) and animal products \( (X^2 (1) = 4.69, p<0.05) \), as compared to households in non-MUS villages (Fig. 4c).

**Figure 4. Comparison of (a) vegetable cultivation in the dry season, (b) self-reported food security, and (c) consumption of leafy green vegetables and animal products.**
**Illness and injuries.** Within MUS villages there were fewer incidences of diarrhea, respiratory illness, and injury while fetching water as compared to non-MUS villages (Table 3). However, variation in these measures is low (less than 6% of households reporting any illness or injury) and none of the observed differences were found to be statistically significant in the Chi-square test of independence. Further research is needed to understand whether the observed trend is meaningfully explained by the MUS intervention or simply due to random chance.

**Table 3. Incidence of diarrhea and respiratory illness in the past week, and injuries at or near the well at any time in the past.**

<table>
<thead>
<tr>
<th></th>
<th>MUS</th>
<th>non-MUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>diarrhea (&lt;5 yrs)</td>
<td>3.9%</td>
<td>4.5%</td>
</tr>
<tr>
<td>respiratory illness</td>
<td>0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>injury</td>
<td>4.2%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

**Drinking water quality.** Water quality analysis revealed two trends. First, the vast majority of upgraded wells with rope pumps provided water that is categorized as low risk / safe at the time of sampling. By contrast, nearly all traditional wells were highly contaminated with E. coli and categorized as very high risk / unsafe (Table 4). When examining the quality of the main drinking water source for each household type (investor, non-neighbor, control), we find that most investors (75%) are accessing a source categorized as safe or probably safe. About half of non-neighbors and controls are using very unsafe drinking water sources.

**Table 4. Health risk categorization based on World Health Organization Drinking Water Quality Guidelines (2011) for E. coli concentrations.**

<table>
<thead>
<tr>
<th>Health risk category</th>
<th>CFU/100mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk/safe</td>
<td>0</td>
</tr>
<tr>
<td>Intermediate risk/probably safe</td>
<td>1-9</td>
</tr>
<tr>
<td>High risk/Probably Unsafe</td>
<td>10 – 99</td>
</tr>
<tr>
<td>Very High risk/unsafe</td>
<td>&gt;100</td>
</tr>
</tbody>
</table>

**Resilience.** We assessed resilience by probing the availability of the households’ main drinking water source throughout the year, as well as the duration of recent interruptions. Results show that a greater proportion of MUS households (34%) report waiting at some point during the year for their main drinking water source to recharge as compared to non-MUS households (19%). However, MUS households typically waited for half the time as compared to non-MUS households, with a median of 60 minutes and 120 minutes, respectively ($U = 8,884$, $p<0.001$). Further, over 20% of non-MUS households waited for 24 hours or longer, as compared to only 5% of MUS households (Figure 5).
In terms of water service availability, results show that a full-day interruption in water service within the past 6 months was a relatively rare occurrence for both groups of households. MUS households experienced fewer (16%) interruptions in water service as compared to non-MUS households (23%) ($X^2$ (1) = 8.06, p<0.01). Further, less than a quarter of the MUS households experiencing interruptions had to wait more than 10 days for repairs, whereas over 40% of non-MUS households had to wait longer than 10 days (Figure 6).

**Figure 5. Queue times for main drinking water source recharge**

**Figure 6. Duration of service interruptions (n=273)**
Summary

This preliminary findings regarding the impact of MUS on the health and well-being of rural households in Burkina Faso are limited in that we have not yet examined additional factors which may also influence the key outcomes examined here. Follow up analyses will control for factors which may influence households’ likelihood of investing in the MUS self-supply option, such as wealth, access to markets and capital, etc. Nonetheless, the findings presented here show a strong and consist trend linking MUS to positive outcomes, including:

- Undertaking more diverse water-based income earning activities
- Earning more income in the driest months of the year
- Vegetable cultivation in the driest months of the year
- Lower incidence of food insecurity
- More consumption of protein- and micronutrient-rich foods essential for women’s reproductive health
- Slightly fewer incidences of diarrhea and respiratory illness among children under age five and injuries among those fetching water
- Drinking water that is free of fecal contamination at the point of collection
- Less time spent waiting for water in situations where the well must recharge
- Fewer full-day interruptions in water service and less time spent waiting for repairs
References


Appendix A: Livelihoods

A-1. Livelihoods Activities

To assess the impacts of MUS on households’ livelihoods activities, we examined the following survey questions:

Do you use source X for any of the following activities? (Subsistence crops, cash crops, gardening, livestock, dolo brewing, shea butter production)

We find that the most common productive activities undertaken with domestic water supply were livestock rearing, gardening, and dolo brewing (Table A-1.1). The total number of productive water-based activities undertaken by households in MUS villages was slightly higher (M = 1.49, SD = 0.73) than the number of activities within non-MUS villages (M = 1.40, SD = 0.66) (Figure A-1.1). A Student’s t-test revealed a small but statistically meaningful difference (t (1,325) = 2.23, p<0.05).

Table A-1.1. Percentage of households in MUS and non-MUS villages undertaking various productive activities with domestic water supply.

<table>
<thead>
<tr>
<th>Activity</th>
<th>MUS</th>
<th>non-MUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence crop*</td>
<td>0.0</td>
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<tr>
<td>dolo</td>
<td>14.6</td>
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</tr>
<tr>
<td>shea butter*</td>
<td>1.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Chi-square test indicates statistically significant difference between MUS and non-MUS group.

Figure A-1.1. Number of productive activities undertaken by households with MUS and non-MUS villages.
A-2. Income

To assess the impacts of MUS on income generation at the household level, we examined the following survey questions:

*In the DRY months, about how much total income is earned each month by members of your household?*

*How many women in your household earn some income?*

*About what share of your household income is earned by women in your household? (very little, less than half, half, more than half, all)*

We find that the median monthly income (fCFA 30,000) earned by households in MUS villages in the dry season was significantly greater than in non-MUS villages (fCFA 20,000) (U = 25,000, p<0.001). In terms of women’s contribution to household income, there was no meaningful difference between the number of women engaged in income earning activities or the share of overall income earned when comparing households within MUS and non-MUS (Figure A-2.1).

**Figure A-2.1. Share of overall household income earned by women within MUS and non-MUS villages**
**A-3. Agriculture and Livestock**

To assess the impacts of MUS on agricultural and livestock activities, we assessed the following key survey questions:

*How much land do you use to cultivate vegetables in the warm-dry months? (converted to a binary cultivate/did not cultivate variable)*

*How many of each of these animals does your household currently own? (Large stock, small stock, poultry)*

We find that in all villages a minority of households are cultivating vegetables in the warm-dry season (March-June). However, in MUS villages a significantly greater share of households (45%) are able to cultivate vegetables in this critical time as compared to households within non-MUS villages (23%) ($X^2$ (1) = 56.04, p<0.001, Figure A-3.1).

Further, the median number of livestock ($U=199,234$, p<0.01) and poultry ($U=196,618$, p<0.05) owned by households was significantly greater within MUS villages as compared to non-MUS villages.

**Figure A-3.1. Cultivation of vegetables during the warm-dry season in MUS and non-MUS villages.**
Appendix B: Health

B-1. Food Security

To assess food security the household survey asked: *How would you describe your households’ situation with food security in the past year?* Answer choices: Very secure, somewhat secure, insecure, don’t know/no answer.

This question was carefully developed with local enumerators and translated into the local language to meaningfully capture the concept of food security. Results show that whereas both MUS and non-MUS groups experience food insecurity at some point during the past year, the proportion of households in the insecure category is significantly higher among non-MUS households as compared to MUS households ($\chi^2 (2) = 27.71, p<0.001$) (Figure B-1.1).

![Figure B-1.1. Self-reported food security among MUS and non-MUS households](image)

<table>
<thead>
<tr>
<th></th>
<th>MUS</th>
<th>non-MUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>very secure</td>
<td>39%</td>
<td>27%</td>
</tr>
<tr>
<td>somewhat secure</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>insecure</td>
<td>31%</td>
<td>44%</td>
</tr>
</tbody>
</table>
B-2. Nutrition

To assess nutritional status the household survey asked the follow question: In the past week, did your family consume any of the following types of foods? Answer choices: starchy foods, beans, nuts, dairy, meat, eggs, leafy greens, vegetables, fruits.

This question draws on the FAO’s recommended nutrition matrix for assessing nutritional status of women of reproductive age. We focused on three key outcomes:

- The total number of food types that were consumed within the past week.
- Consumption of animal products such as meat, milk, and eggs, which provide iron, calcium, zinc, vitamin A, DHA, and choline (essential nutrients for pregnant women and young children).
- Consumption of leafy green vegetables which provide iron and folic acid, common micronutrient deficiencies in rural sub-Saharan Africa, especially among pregnant women.

Results show that the total number of food types consumed by households did not differ significantly between MUS and non-MUS households. However, households living in MUS villages were more likely to have consumed leafy greens ($X^2 (1) = 6.82, p<0.01$) and animal products ($X^2 (1) = 4.69, p<0.05$) within the past week, as compared to households in non-MUS villages (Fig. B-2.1).

**Fig. B-2.1. Consumption of leafy green vegetables and animal products among MUS and non-MUS households**

<table>
<thead>
<tr>
<th></th>
<th>MUS: leafy greens</th>
<th>non-MUS: leafy greens</th>
<th>MUS: animal products</th>
<th>non-MUS: animal products</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes, consumed</td>
<td>86%</td>
<td>17%</td>
<td>86%</td>
<td>16%</td>
</tr>
<tr>
<td>no, did not consume</td>
<td>14%</td>
<td>83%</td>
<td>14%</td>
<td>84%</td>
</tr>
</tbody>
</table>
B-3. Illness and Injury

To assess the impacts of MUS on illness and injury rates among households, we included the following survey questions:

(Among families with at least one child under the age of 5): Has your child(ren) been sick with diarrheal or respiratory illness within the past week?

In the past year, has anyone of any age in your home been hurt while collecting water or on the path to collect water?

The graph below shows that among MUS villages, there are fewer incidences of diarrhea, respiratory illness, and injury while fetching water as compared to non-MUS villages (Figure B-3.1). However, variation in these measures is low (less than 6% of households reporting any illness or injury) and none of the observed differences were found to be statistically significant in Chi-square tests (all p-values are greater than 0.2). Further research is needed to understand whether the observed trend is meaningfully explained by the MUS intervention or simply due to random chance.

**Figure B-3.1. Percentage of households reporting (a) diarrheal disease and (b) respiratory illness incidence among children under age 5, and (c) injury while fetching water among all age groups.**

<table>
<thead>
<tr>
<th></th>
<th>MUS</th>
<th>non-MUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>diarrheal (&lt;5 yrs)</td>
<td>3.9%</td>
<td>4.5%</td>
</tr>
<tr>
<td>respiratory illness (&lt;5 yrs)</td>
<td>0.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>injury</td>
<td>4.2%</td>
<td>5.5%</td>
</tr>
</tbody>
</table>
Appendix C: Water

C-1. Fecal Contamination

Water quality testing was conducted using compartment bag test kits (CBT kits), indicating the microbial quality (level of *E. Coli*). The sampling took place in two of the Winrock program areas. In the Koudougou region, samples were taken in Doudou, Tialgo, Koukouldi and Balévalsé. In the Ouagadougou region, samples were taken in Ouelega, Nabilin and Tensouka. Three groups of people were targeted: investors that use upgraded wells installed by Winrock, the “non-neighbors” group (households within MUS village but who did not access upgraded water points), and the “control” group (households within non-MUS villages). In total, 59 investors, 59 non-neighbors and 63 controls were sampled.

Results indicate two trends:

- **The vast majority of upgraded wells with rope pumps provided water that is categorized as low risk / safe at the time of sampling.** By contrast, nearly all traditional wells were highly contaminated with *E. coli* and categorized as very high risk / unsafe. (Fig. C-1.1)
- **When examining the quality of the main drinking water source reported by households, we find that most investors are accessing a source categorized as safe or probably safe (Figure C-1.2).** However, non-neighbors and controls are roughly evenly split across the categories of safe and very unsafe drinking water sources.

![Figure C-1.1: Water quality risk categories for wells of different designs (traditional, traditional-reinforced, and upgraded with rope pump)](image-url)
Figure C-1.2: Risk categories for the main drinking water source for study households (investor, non-neighbor, control)
C-2. Satisfaction

To assess the relationship between MUS and households’ satisfaction with their water supplies services, we analyzed survey data from the following question:

*Overall, how satisfied would you say you are with your current water supply situation?*

<table>
<thead>
<tr>
<th></th>
<th>generally satisfied</th>
<th>somehow unsatisfied</th>
<th>very unsatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUS</td>
<td>47%</td>
<td>47%</td>
<td>5%</td>
</tr>
<tr>
<td>non MUS</td>
<td>26%</td>
<td>58%</td>
<td>16%</td>
</tr>
</tbody>
</table>
C-3. Availability

We assess resilience by probing the availability of the household’s main drinking water source throughout the year. The relevant questions within the household survey are:

*In the months when you use your main drinking water source, do you ever have to wait for the water due to slow recharge? (If yes) How long do you typically wait?*

Results show that a greater proportion of MUS households (34%) reporting waiting at some point during the year for their main drinking water source to recharge as compared to non-MUS households (19%) (figure 1). **However, MUS households typically waited for half the time as compared to non-MUS households**, with a median of 60 minutes and 120 minutes, respectively ($U = 8,884, p<0.001$). Further, over 20% of non-MUS households waited for 24 hours or longer, as compared to only 5% of MUS households.

**Figure C-3.1. Share of MUS and non-MUS households waiting for their main drinking water source to recharge**

**Figure C-3.2. Distribution of waiting times for main drinking water source recharge**
C-4. Service Interruptions

We assess resilience by probing whether there were any recent major interruptions in water service. The household survey asks:

_In the last 6 months, were there any times when water from your main drinking water source was not available for more than one day? How long did the last interruption in service last?_

Results show that a full-day interruption in water service within the past 6 months was a relatively rare occurrence for both groups of households. **MUS households experienced fewer (16 interruptions in water service as compared to non-MUS households (23%) ($X^2 (1) = 8.06, p<0.01$) (Figure C-4.1).** Further, less than a quarter of the MUS households experiencing interruptions had to wait more than 10 days for repairs, whereas over 40% of non-MUS households had to wait longer than 10 days (Figure C-4.2).

**Figure C-4.1. Recent interruptions in water service among MUS and non-MUS households**

![Figure C-4.1](image1)

**Figure C-4.2. Duration of service interruption among MUS and non-MUS households (n=273)**

![Figure C-4.2](image2)