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THE WATER TRUST

IMPROVING HYGIENIC MANAGEMENT OF POULTRY IN RURAL UGANDA

Final Report

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OCTOBER 2021

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ACRONYMS AND ABBREVIATIONS

CFU	Colony forming units
COVID-19	Coronavirus Disease 2019
GEE	General Estimating Equation
GLM	Generalized Linear Model
OD	Odds ratio
PPI®	Poverty Probability Index
PR	Prevalence ratio
RCT	Randomized Controlled Trial
USAID	U.S. Agency for International Development
WASH	Water, Sanitation, and Hygiene
WASHPaLS	Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability

EXECUTIVE SUMMARY

Typical poultry management practices in rural Uganda expose children to fecal contamination and increased risk of disease. Yet there is little to no robust evidence on how these behaviors might be changed, and what impact behavior change might have on fecal contamination in the home environment and prevalence of disease. In 2019, The Water Trust developed and implemented a poultry management training intervention across 51 communities in western Uganda. The program was designed in consultation with a rural livelihood training center in Uganda and with inputs from focus group discussions with rural communities in western Uganda. The training intervention integrated behavior change messaging on both health and livelihood risks of current daytime and night-time management practices and included practical group training exercises on low-cost behaviors that households can undertake to reduce these risks. Examples of these behaviors include fencing in chickens with netting and poles and picking up chicken feces for subsequent use as fertilizer. The training consisted of a one-day triggering exercise, three days of practical skill-building, and monthly coaching visits over 6 months.

Training activities began in September 2019 and were completed in August 2020. The intervention was disrupted by COVID-19, which caused a delay between training and follow-on coaching activities of approximately three months. This delay also disrupted the operations of the savings groups, leading many to stop meeting for this period of time and reducing the funds they had available to finance investments, including poultry-related purchases. In response, we offered a small no-interest loan to the treatment savings groups with the zero percent interest contingent on constructing facilities.

The program was evaluated by a randomized controlled trial led by Dr. Ayse Ercumen and Dr. Angela Harris of North Carolina State University. The trial was conducted in areas where The Water Trust had previously formed savings groups within communities to maintain their shared water point. The communities had received hygiene and sanitation promotion (without messaging on poultry feces) prior to this intervention. Villages in these areas were block-randomized by parish into intervention vs. control groups. Among 126 communities within 42 villages, communities with more than 30 households were selected to participate in the trial, resulting in a total of 100 communities (51 intervention, 49 control). Poultry training activities in the 51 intervention communities were open to savings group members as well as non-members. In total, 1,658 people were trained across 51 communities, with women constituting 59 percent of the trainees. In each community, households that were savings group members and had a child under the age of 5 years were enrolled systematically in the randomized controlled trial using The Water Trust membership rosters, for a total of 1305 households (664 intervention, 641 control). Enrolled households were visited approximately 20 months after the initiation of trainings to record poultry management behaviors, infrastructure, observable poultry feces, observed free-roaming poultry and caregiver-reported health outcomes for children under the age of 5 years. Among trial participants that owned poultry, child hand rinse samples were collected to measure *E. coli* as an indicator of fecal contamination.

The randomized controlled trial and microbial hand rinse sample analysis found no impact of the intervention on poultry management practices, contamination of child hands, and child health. This study's findings suggest that a training intervention is inadequate to change household management of poultry. The intervention also offered a no-interest group loan to savings groups to which the training participants belonged. Loan recipients had a higher rate of poultry enclosures than participants who did not take the loan, but the study was not powered to detect the statistical significance of this relationship. Ultimately, the intervention of training plus group loan offer had no statistical impact on enclosures in the study population one year later. One explanation for this lack of impact was that despite training messages emphasizing that several key poultry management practices (such as an outdoor chicken run made of poles and netting) could be done at very little cost, there was significant resistance to undertaking these changes in the absence of a chicken house, which is a dedicated

enclosure with walls, a door, and a roof that requires more financial investment. In addition to this obstacle, our study suggests that even households that have dedicated spaces for poultry only, including chicken houses, fenced in outdoor spaces for poultry coops, and baskets, still have high rates of observable poultry feces, likely connected to traditional poultry feeding practices that allow for free-roaming animals. A key underlying challenge is that rural households are managing poultry at a scale that may be too small to justify investing in appropriate facilities and recurring food and immunization expenses given the significant risks for poultry (i.e., death by predation or disease or theft). Yet free-range small-scale backyard chicken rearing produces contamination that poses a significant health risk for children under five.

1.0 INTRODUCTION

Livestock ownership is an important source of income and nutrition for communities in rural Uganda. Yet typical poultry management practices expose children to fecal contamination and increase their risks of disease. There is a paucity of evidence on how these poultry management practices might be changed, and how such changes would reduce fecal contamination in the home environment and, in turn, transmission of disease. In this USAID WASHPaLS Project Water, Sanitation, and Hygiene (WASH) Behavior Change Innovations grant, The Water Trust developed, implemented, and evaluated a poultry management training intervention across 51 communities in western Uganda. This final report summarizes the completed program activities, adjustments made to the original plans, and research findings.

The intent of the intervention was to help rural poultry owners with children to separate chickens from children by focusing on a set of key motivating factors, including increased risk perception, increased perception of potential livelihood benefits, increased skills, and increased supportive social norms.

Our hypothesis of change identified several barriers to safer domestic poultry management practices in rural Uganda:

- Low awareness of poultry as a risk to child health
- Lack of investment in poultry management, including but not limited to feces management
- Low awareness of both possible health and economic benefits of greater investment in poultry management
- Low practical skill levels in poultry management, including but not limited to management of poultry hygiene

To address these barriers, The Water Trust developed and implemented a series of participatory training exercises designed to improve poultry management practices through three avenues:

1. increase awareness of health risks and lost livelihood benefits of current poultry management practices
2. build practical skills for poultry management that address risks and improve livelihood benefits
3. build supportive community norms for investing in poultry management through facilitating savings group discussions on poultry management.

The intervention itself is described in Section 4.

2.0 ORIGINAL RESEARCH QUESTIONS

The key research questions are:

1. Can the intervention improve the poultry management practices of households?
2. If so, do these improvements translate into reduced fecal contamination of the household environment?
3. If so, do these improvements translate into reduced caregiver-reported diarrhea for children under 5?
4. What are the mechanisms (e.g., knowledge, attitudes, practices, external factors) behind these effects, or their failure?

3.0 METHODS AND APPROACHES

3.1 STUDY DESIGN

The study consists of a randomized controlled trial (RCT) and microbial hand rinse analysis among a subset of the RCT participants:

1. **RCT:** We conducted an RCT in areas where The Water Trust had previously formed savings groups within communities to maintain their shared water point and deliver hygiene and sanitation promotion. We used a random generator to assign villages in each parish within the study area into either an invention group to receive poultry training or a control group with no poultry training. We randomized at the village level because we expected spillover of information among communities within the same village, and we block-randomized villages within parishes to ensure that intervention and control villages were well-balanced on spatial and geographic characteristics. Among 126 communities within a total of 42 villages (21 intervention, 21 control), we selected communities with more than 30 households to participate in the trial, resulting in a total of 100 communities (51 intervention, 49 control). In each community, households that met the eligibility criteria of being savings group members and having a child under the age of 5 years were enrolled systematically in the trial. The Water Trust staff sequentially contacted individuals on their membership rosters to assess eligibility, with the goal of enrolling 10-15 households in each community. We enrolled a total of 1,305 households (664 households in intervention villages and 641 households in control villages). Each enrolled household was visited once before the intervention (baseline) and once after the intervention. At each visit, trained field staff conducted a structured survey to record self-reported poultry management practices and caregiver-reported diarrhea and respiratory illness symptoms for children under the age of 5 years. At each visit, staff also conducted spot check observations to record observed poultry management practices, including the number of any chickens owned, the number of free-roaming chickens, presence of an enclosure for chickens and number of chicken feces in the compound. We compared these outcomes between the intervention and control households at the post-intervention visit to assess the program's impact on poultry management practices, presence of chicken feces in the home environment and reported diarrhea in children <5 years.
2. **Microbial analysis:** In a separate post-intervention visit, we conducted microbial sampling of child hand rinse samples in 218 households that own poultry to assess the program's impact on fecal contamination on child hands, as a proxy for contamination in the home environment.

In addition, formative research for the program design included single-sex focus group discussions and key informant interviews with experts on poultry management and successful local chicken farmers.

Our original approved protocol proposed to enroll a total of 2,000 households for two rounds of data collection (one pre- and one post-intervention). Our originally proposed sample size of 1,000 treatment and 1,000 control households with one round of post-intervention data collection was powered to detect a 36% or greater difference in the reported prevalence of child diarrhea in treatment households compared to households not receiving the intervention, at a two-tailed alpha of 0.05 and a beta of 0.2.[1] However, we were only able to enroll 1,305 households due to the limited number of eligible households in the study areas. We therefore implemented two rounds of post-intervention data collection to achieve the necessary number of observations. However, we chose to discard these post-intervention data due to data integrity concerns that emerged after inspection, and we conducted a

[1] Assuming a one-week diarrhea prevalence of 10% among children <5 years, 1.7 children <5 years per enrolled household, and an intraclass correlation coefficient of 0.005 for children within the same village to account for clustering by village.

third round of post-intervention data collection. We used data from this final round for data analysis to assess the impact of the intervention. We conducted a post-hoc power calculation to estimate the minimum detectable effect, given the smaller than planned number of observations using solely the data from the additional follow-up round. Using the diarrhea prevalence (17%) observed in the control arm in this final round of follow-up, the minimum detectable difference increased slightly to 39% in diarrhea prevalence among children <5 years in the intervention arm compared to controls.

The microbial sampling initially was planned for only 50 households per arm with an exploratory analysis at baseline with 25 households that would have included water, soil, and hand rinse samples. After health and safety concerns around hemorrhagic fever in the operating area, and then COVID-19, made it too risky for NC State faculty to set up a lab in Uganda, the design was altered and the sample size of the endline analysis increased.

The initial and amended study protocol, as well as a risk management plan for COVID-19, were reviewed and approved by the Research and Ethics Committee at Makerere University.

This report presents the program and research design, planned and completed activities, and the results of the randomized controlled trial, microbial sampling, and a descriptive analysis of associations across several indicators of interest.

3.2 POPULATION AND SAMPLE OF THIS STUDY

Our activities take place in rural communities in the districts of Masindi and Kiryandongo in western Uganda, where The Water Trust has been active since 2008. Kiryandongo was formerly a part of Masindi district, before administrative changes in 2010 established it as an independent district. While the districts are similar in that they consist largely of rural farming communities, Kiryandongo is a drier climate, less-resourced, and has an active refugee settlement and accompanying refugees and internally displaced people. Household surveys typically find worse water access and hygiene and sanitation conditions in Kiryandongo.

The study location is the same as the location of previous research undertaken by The Water Trust and the principal investigators, which found that children in households with above-median number (>5) of poultry suffered 83% higher diarrhea prevalence than those with 5 chickens or less, suggesting that higher numbers of domestic poultry is associated with increased risk of enteric illness in young children in this setting.

The study population consists of participants in Self-Help Groups formed by The Water Trust. These groups and communities have received varying amounts of WASH promotion previously from The Water Trust. This promotion included constructing or rehabilitating water points, community-led total sanitation, and encouraging group members to construct and use WASH facilities such as latrines, handwashing facilities, drying racks, and refuse pits. Our evidence suggests that their hygiene and sanitation behaviors as well as water access is better than typical rural communities in this area. For example, an internal evaluation by The Water Trust indicates that in contrast to comparison communities in the same district self-help group members have higher rates of latrine ownership (84% versus 65% and handwashing facility ownership (36% versus 5%).[2] The percentages of households with observed latrines and handwashing facilities with soap in this internal evaluation are similar to those observed in this study (e.g., 12% with handwashing facilities with soap in internal evaluation, and 12% and 14.4% in the treatment and control households at baseline (see able A-1)).

[2] Prottas C, Dioguardi A, Aguti S, 2018. Empowering Rural Communities to Sustain Clean Water and Improve Hygiene through Self-Help Groups. Transformation towards Sustainable and Resilient WASH Services: Proceedings of the 41st WEDC International Conference, July 9–13, 2018, Nakuru, Kenya.

4.0 PROGRAM DESIGN

4.1 OBJECTIVES, ACTIVITIES AND LOGICAL FRAMEWORK

The program we tested is a training intervention that aims to motivate households to adopt new behaviors by increasing the perception of child health risk and economic losses of current practices, as well as building practical skills and supportive community norms. The primary behaviors of interest are physically separating children from chickens during day and night and cleaning up chicken feces from the home and compound.

Activity	Objective
Trigger Awareness (1 day)	• Help communities map (and increase perception of) health risks and livelihood opportunities related to poultry • Foster sense of personal agency and feasible solutions to mitigate risk and leverage opportunities with minimal financial investment • Motivate households to change poultry management behaviors • Increase perception of risk to health and income from poultry feces and poor management practices
Provide Skill Training (3 days)	• Provide training that allows households to improve poultry hygiene while accomplishing higher- salience livelihood goals • Focus on simple, affordable practices that can produce significant health and livelihood benefits • Provide practical, hands-on learning exercises rather than theory or conceptual knowledge • Increase skills to manage poultry hygiene
Leverage Local Institutions (Monthly coaching visits)	• Capitalize on existing high-attendance community group meetings for coaching • Foster a community of poultry practitioners to learn and problem solve together • Build on local, independent institutions that can provide ongoing access to technical, social, and financial capital • Build social norms that support improved poultry hygiene and investment in poultry hygiene

Additional information on changes to this program design is provided in Section 5.1.

The planned intervention was based on the following logical framework:

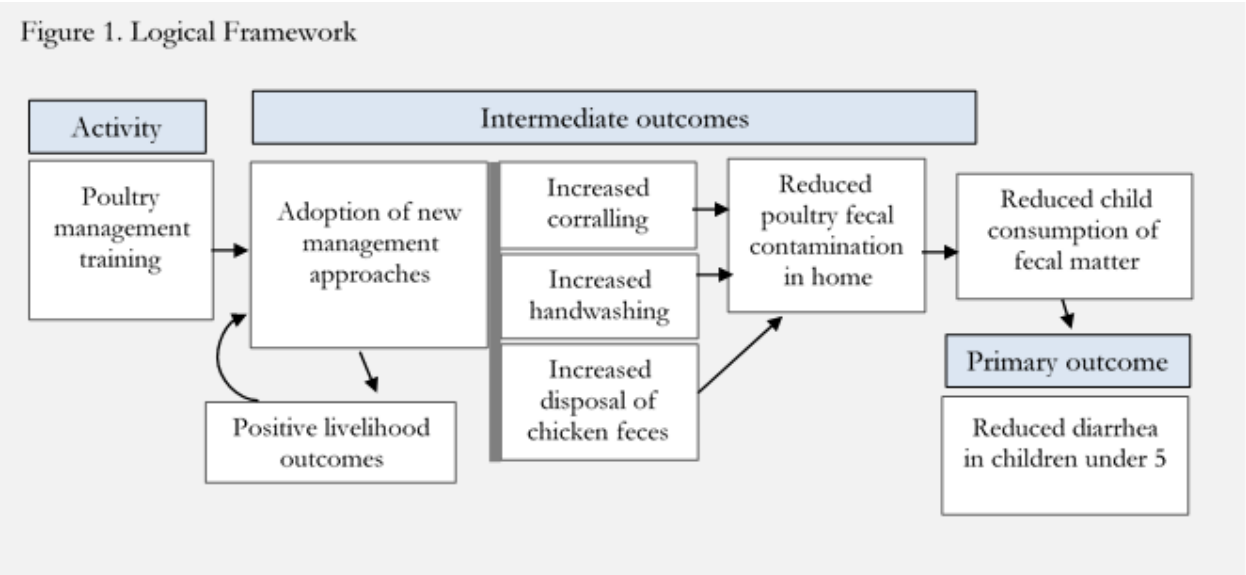

Figure 1. Logical Framework

Key assumptions included the following:

- Households with either capital or willingness to take out loans from their self-help group will be motivated in part by the livelihood benefit as well as the health benefit of the improved practices.
- It is necessary to include livelihood advice on good poultry rearing practices (e.g., immunizations, preparing chicken feed) because in their absence, confining 5-10 chickens (i.e., typical number) to a designated area results in elevated chicken fatality, threatening the profitability raising domestic poultry.
- Even if households lack the capital to invest in new facilities, they can still be motivated to undertake activities such as cleaning and sweeping up chicken feces and this will have a health benefit.
- The intervention will not unintentionally increase child exposure to chicken feces by increasing the rate of chicken ownership, because it is accompanied by measures focused on improving hygiene.

4.2 GENDER EQUALITY AND SOCIAL INCLUSION

Gender equality and social inclusion considerations were incorporated into the program and research design. That backyard chicken rearing is typically managed by women in this context presents both gender equality challenges and opportunities. The primary gender equality concerns were that this program could increase the burden of household work for women. The primary opportunity was that it could increase their asset base and their control or influence over household assets. In addition, we were concerned that gender roles and intra-household decision-making norms might result in resistance to investing more of the household's funds in a livelihood associated with women.

These issues were addressed in the program design by including components in the training sessions on the roles and responsibilities of men, women, and children in poultry management, and encouraging more intentional assignment of tasks across these groups, making the implied tasks more visible and increasingly the likelihood that they would not fall solely to the women in the household. Men were encouraged to play active roles by the facilitators. In addition, both husbands and wives were encouraged to participate in the poultry management training to increase the likelihood of both parties buying into the changes and jointly planning to realize them. However, in many cases this was not

practical due to competing work that had to be done. As discussed later in the report, there was a mix of men and women participants, but often not from the same households. In addition, as 60-70% of self-help group members are typically women, the choice of these groups as a platform for training increased our capacity to engage women in the program.

The household survey was designed to measure the impact of the program on time use by both men and women, input on decision-making about chickens, perception of who owns the poultry, and the management tasks that men, women, and children are responsible for.

The primary social inclusion consideration was the financial cost of improved chicken rearing. Backyard chicken rearing is low-intensity in both the time and money typically invested, but durable facilities and supplies can cost several hundred dollars. We evaluated more feasible alternatives to arrive at small doable actions, defined by FHI 360 as behaviors "that, when practiced consistently and correctly, will lead to personal and public health improvement. It is considered feasible by the householder considering the current practice, the available resources, and the particular social context."[3] With that in mind, we emphasized low-cost facilities that can be constructed and small doable actions (e.g., sweeping up chicken feces), and targeted self-help group members who have access to savings and credit through the group. We focused on how the households could use locally available materials to construct basic facilities, and then later choose to upgrade them if and when they have the resources. For households that would not construct a facility for whatever reason, we emphasize the importance of regular sweeping and the importance of keeping children's play and sleeping areas free of feces.

The focus group discussions and baseline surveys we conducted in August and September 2019 confirmed that current practice involves minimal investment of time and money in poultry management and demonstrated poor livelihood outcomes, such as low investment in facilities, feed, vaccinations, and antibiotics as well as high fatality of poultry, limited selling and consumption of poultry and eggs. These discussions and surveys also demonstrated significant fecal exposure to children. For example, at baseline poultry feces was observed in 27.9% and 33.9% of control and treatment households. In addition, 83.2% and 90.4% of control and treatment households self-reported allowing their poultry to roam free during the day and only 11.8% and 14% kept their poultry in a dedicated space at night (see table A-1 for additional information.) More information is available in our baseline report.

[3] https://www.fhi360.org/sites/default/files/media/documents/resource-washplus-learning-brief-sda.pdf

5.0 PROGRAM REPORT

5.1 ADJUSTMENTS TO PROGRAM PLANS

Shift in coaching visit schedule: The project plan anticipated that The Water Trust would be conducting visits from February 2020 through May 2020, and that households would be constructing new facilities and adopting new practices in this period, which followed the completion of training sessions in January. COVID-19 led to the suspension of coaching activities in March 2020. While self-help group leaders received follow-up by phone, a return to community coaching visits was not possible until the end of June 2020. We amended our project plan to shift the monthly coaching visits to extend to the month of August so that all communities would receive at least six coaching visits.

Addition of interest-free group loan for poultry: Prior to COVID-19, we became concerned that as many of the self-help groups share-out (i.e., pay out accumulated savings and interest to group members) in December, they would not be adequately capitalized by February-May to provide access to capital for improvements in poultry management. After we saw the negative impact of COVID-19 on group meetings and savings in March and April , we discussed this challenge and possible solutions with community members and our staff.

Ultimately, we decided that if self-help groups that meet basic eligibility criteria (that signal engagement in the program and capacity for repayment) would be eligible for a six-month loan of $135 or $270, that the groups would then extend as individual loans to group members to make improvements to poultry management. The loan would bear no interest provided that agreed-upon improvements are made by the group. For example, the group would commit that a certain number of households will construct chicken houses and erect chicken runs. The group would be liable for repayment whether individuals repay or not. We hypothesize that these group loans will allow the group to issue no-interest individual loans to, at a minimum, three (small group loan) to seven (large group loan) households to build chicken houses. As every household's needs and existing resources differ, we are entrusting the self-help groups themselves with reviewing and approving the individual loan requests.

The poultry loans were introduced in June 2020 with 24 of the 51 communities ultimately accepting the loans. Disbursements of the loans were made by The Water Trust to the groups between July 2020 and September 2020, with the groups then disbursing individual loans to group members in the months thereafter.

5.2 ACTIVITY REPORT

5.2.1 Research Activities

The Water Trust and our research partners conducted a baseline assessment of the conditions and practices in the treatment and control communities, administering 1305 household surveys in September 2019. Surveys were administered by 27 enumerators we trained in August 2019. During the final data collection round in August 2021, 868 out of 1305 enrolled households (67%) participated in data collection while the rest were lost to follow-up due to short- and long-term relocation. In addition, in February 2021, hand rinse samples were collected from 218 households that owned poultry.

5.2.2 Program Activities

In July 2019 The Water Trust conducted formative research with rural communities in Masindi and Kiryandongo districts to inform the development of the training intervention. The training curriculum and training aids were developed in August to October 2019. The pictorial training manual is available in the annex.

The Water Trust completed a) poultry management "triggering" (see Section 5.2.3 for more information), b) poultry management training, and c) six coaching visits for 51 communities in rural Uganda from October 2019 to September 2020.

As indicated above, there was a two-to-three-month break in coaching support for the communities due to travel and meeting restrictions from COVID-19. After suspending in-person visits in March 2020, coaching visits were re-initiated in the end of June and continued through August. The chicken loans were extended to the group in this period as well with a payback period of six months.

Each month staff would visit with the groups to monitor progress and provide coaching and support. Group members would both report on whether they had built or purchased a facility or supply (such as a chicken house or footbath) and commit (or not) to doing so in the month ahead. Beyond this self-reported data, five to six randomly selected households received spot-check verification visits to monitor what facilities were present and what evidence there was that substantiated the self-reported data. The monitoring revealed a willingness to make pledges in the moment, followed by limited follow-through in implementing the actions. The most common reasons cited include a lack of money or resources, or too little time.

5.2.3 Poultry "Triggerings"

A total of 1,340 people -- 26 per community -- attended the triggering exercises, of which 61% were women. The one-day exercise consisted of a facilitated community dialogue that covered how chickens and children currently interact, problems they observe with this dynamic, why they raise chickens, the hazards that chickens and children face with current management practices, and doable actions that could reduce the likelihood or impact of these hazards (e.g., sweeping up chicken feces or building a chicken house.) The aim of the activity was to trigger an increase awareness of the child health and livelihood risks posed by current management practices more generally, and increased disgust and concern about the presence of poultry feces in particular. Attendance of the triggerings was high and the exercises were successful in stimulating interest in the poultry management trainings that followed, based on the attendance of those later training sessions. Anecdotally, staff reported that the trainings were successful in raising awareness of the risks chickens posed to children. One challenge was that many people assumed that they would be receiving a chicken or some form of asset, as this is common among livelihood programs in the area.

5.2.4 Poultry Trainings

A total of 1,658 people -- 32.5 per community -- attended at least one day of the three-day poultry-training session, of which 59% were women. Most attendees attended all three days. The three-day training exercise covered practical skill-building on how to manage chickens proactively to improve both child and chicken health. Topics covered included: synchronized incubation, the use of a brooder for chicks, cleaning and disinfection, chicken feed preparation, chicken housing construction, disease control, the use of handwashing and footbath facilities, gender roles in chicken rearing, and action planning to make improvements. Anecdotally, in both focus group discussions informing the program's design and in the training exercises themselves, participants were most interested in technical topics such as synchronized incubation, the use of a brooder, and disease control.

5.2.5 Coaching Visits

Communities received on average two coaching visits prior to the transportation and meeting shutdown in March and four visits from June through August. More than 250 people received remote coaching by phone in June, and we monitored the impact of COVID-19 on the self-help groups themselves. Most groups at the time were still meeting, but 61% of groups had meeting attendance rates lower than 25% of self-help group members. More households reported that COVID-19 had increased (rather than decreased) their interest in chicken-rearing, but a lack of construction materials and money were cited as critical gaps. Our staff's perception of the negative economic impact on households and, in turn, self-

help groups was substantiated by surveys done in the operating area by IDInsight, which found that between March and July 2020 households were impacted by rampant price increases, job losses, businesses closures, and loss of income.[4]

5.2.6 Chicken Loans

In June and July 2020, we evaluated the eligibility of all 51 communities for group chicken loans of 500,000 UGX (approximately $134 as of July 1, 2020) or 1,000,000 UGX (approximately $269). Of these groups, 53% were ineligible or not interested. Eligibility criteria included that the group was actively saving with adequate capital to repay the loan, 30% or more of its members had chickens, and group members were willing to pay back the loan even if individual borrowers did not repay the funds. Ineligibility was generally due to concerns with the self-help group's financial capacity to repay. Uninterested groups had various rationales, such as too few households with a significant number of chickens to make the investment worthwhile, the community is transitory, or a recent poultry disease outbreak. The majority of groups received their loan payments at the end of July. While the community will have six months to put the capital to use to improve their facilities or purchase chicken-rearing supplies, the initial round of end-of-project household surveys were done in September 2020. Ideally, we would have completed the loan approval and disbursal process in June, but we were unable to given challenges with communication, transport, and self-help group deliberation at the time.

[4] https://www.idinsight.org/reports-2/cash-and-covid-19-experiences-from-kiryandongo-1/3

6.0 METHODS

6.1 INDICATOR EVALUATION AT BASELINE

Prior to evaluating the impact of the intervention, indicators of poultry feces management behaviors were rigorously analyzed using scale development methodology.[5] Following Classical Test Theory, inter-item correlations were examined for each poultry feces management indicator of interest to understand their relationships with one another. Pearson's $\chi 2$ Test was used for each pair of indicators to determine statistically significant relationships. Indicators were retained for further evaluation of the intervention's impact if they were significantly related to multiple other poultry feces management indicators ($P < 0.05$) and presented heterogeneity across the study sample based on descriptive characteristics.

6.2 EVALUATION OF INTERVENTION IMPACT

We evaluated the impact of the intervention along the causal chain, including (1) poultry management practices and risk perceptions, (2) fecal contamination of child hands, and (3) caregiver-reported diarrhea and respiratory infections among children under the age of 5 years. Initially, outcome data were collected in two post-intervention rounds, referred to as midline and endline hereinafter. An additional round of post-intervention data collection was completed because of data integrity concerns during midline and endline data collection. We used data from this final round in our data analysis (see Enrollment section under Results).

6.3 POULTRY MANAGEMENT AND RISK PERCEPTION OUTCOMES

We evaluated the impact of the intervention on several key intermediate outcomes including (observed and self-reported) poultry management behaviors, poultry feces risk perceptions and management self-efficacy. Poultry management outcomes included presence/absence relationships of having an observed enclosure for poultry only, having observed poultry feces or free-roaming poultry in the compound, having a handwashing facility next to the enclosure, self-reported hand washing after handling animals or animal feces, and self-reported time spent managing poultry. Questions surrounding risk perceptions asked household members how likely it was that their child would develop diarrheal illness if they kept their poultry in an enclosure, washed their hands after handling poultry feces, swept chicken feces in the compound, and if their child touched chicken feces. Questions surrounding self-efficacy asked households how difficult it was and how sure they were that they could do these tasks or keep children from touching chicken feces. The variability in responses between midline and endline for a respondent's risk perceptions and self-efficacy were further analyzed using paired Wilcoxon Rank Sum tests for the full scale and stratifying based on study assignment to determine if the change was significant.

Unadjusted and adjusted prevalence ratios (PRs) were estimated for the poultry management behaviors using generalized linear models (GLM) with robust standard errors to account for geographical clustering at the village level and multiple visits per household. Similarly, unadjusted and adjusted odds ratios (ORs) were estimated using ordinal logistic regression models for the poultry feces risk perceptions and management self-efficacy indicators, also including robust standard errors to account for clustering. For adjusted PRs and ORs, covariates that were associated with the outcome of interest at the $p<0.2$ level were retained in models.[6] Considered covariates include: gender of household head, literacy of household head, number of household members, number of children currently in school,

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[5] Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. Front Public Heal. 2018;6:149. doi:10.3389/fpubh.2018.00149

[6] Pocock SJ, Assmann SE, Enos LE, Kasten LE. Subgroup analysis, covariate adjustment and baseline comparisons in clinical trial reporting: current practice and problems. Stat Med. 2002;21: 2917–2930. doi:10.1002/sim.1296

primary water source, distance and travel time to primary water source, latrine ownership, type of latrine, presence of handwashing station with water and soap within 5 meters of latrine, and the Poverty Probability Index (PPI®) score.

The PPI has been specifically developed and locally validated for the Ugandan setting based on data from the 2012-2013 National Household Survey conducted by Uganda Bureau of Statistics[7]. The PPI estimates the probability that a household is below the poverty line based on 10 questions on household assets and socio-demographic characteristics, including the number of people living in the household, whether all school-aged children are attending school, whether the female head/spouse can read and write, whether household members own a radio, mobile phone(s) and at least one pair of shoes for every member, the materials of the walls and roof, main fuel type used for cooking, and type of toilet used by the household.

6.4 FECAL CONTAMINATION OF CHILD HANDS

We collected handrinse samples of child hands as part of the final endline survey, though the collection of samples was delayed by approximately one month due to supply chain issues. We collected samples from a subset of 218 households randomly selected from among households that owned poultry at that time. Quality control procedures showed a detection of *E. coli* in one lab blank on one day of sampling, after which samples from that day were removed from analysis, with a total of 187 being retained for analysis. We sampled from children aged 6-18 months old to capture children in the crawling age window; if a child in this age range was not available, another child under 5 years closest to this age range was selected. Following COVID-19 social distancing guidelines, samples were collected by asking respondents to place each of their child's hands into a bag containing 200 mL of sterile water, massaging fingers and fingers for 15 seconds, and massaging the palm, back of hand, and in between fingers for 15 seconds. Fifty (50) mL of the handrinse samples were processed for *E. coli*, a fecal indicator bacterium, using the Wagtech Potakit+ Basic Portable Water Quality Laboratory. Briefly, the 50mL sample was membrane filtered, the filters were placed on growth media and incubated at 44 °C for 18-24 hours. *E. coli* were enumerated by counting colony forming units (CFU). Comparison of fecal contamination on child hands between treatment and control households was conducted using general estimating equation (GEE) models, accounting for geographical clustering of households. We estimated unadjusted beta coefficients, as well as adjusted coefficients that control for relevant enrollment covariates.

6.5 CHILD HEALTH OUTCOMES

We compared the caregiver-reported prevalence of diarrhea, respiratory infections and malaria between the treatment and control arms for a 7-day recall window.[8] Diarrhea was defined as three or more loose stools in a 24-hour period, or one or more bloody stool.[9] Respiratory infection was defined as one of: constant cough, congestion, and wheezing/difficulty breathing.[10] Malaria was used as a negative control outcome that should not be affected by the treatment assignment; any treatment effects on this outcome will therefore signal presence of bias.[11] We estimated PRs using generalized linear models (GLM) with robust standard errors to account for geographical clustering of households within villages

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[7] Microfinance Risk Management. Uganda. In: PPI [Internet]. [cited 11 Oct 2018]. Available: https://www.povertyindex.org/country/uganda

[8] Arnold BF, Galiani S, Ram PK, Hubbard AE, Briceño B, Gertler PJ, et al. Optimal recall period for caregiver-reported illness in risk factor and intervention studies: A multicountry study. Am J Epidemiol. 2013;177: 361–370. doi:10.1093/aje/kws281

[9] Arnold BF, Null C, Luby SP, Unicomb L, Stewart CP, Dewey KG, et al. Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits study design and rationale. BMJ Open. 2013;3: e003476

[10] Ashraf S, Islam M, Unicomb L, Rahman M, Winch PJ, Arnold BF, et al. Effect of Improved Water Quality, Sanitation, Hygiene and Nutrition Interventions on Respiratory Illness in Young Children in Rural Bangladesh: A Multi-Arm Cluster-Randomized Controlled Trial. Am J Trop Med Hyg. 2020;102: 1124–1130. doi:10.4269/ajtmh.19-0769

[11] Arnold BF, Ercumen A. Negative Control Outcomes: A Tool to Detect Bias in Randomized Trials. JAMA. 2016;316: 2597–2598. doi:10.1001/jama.2016.17700

and multiple visits per household. We estimated unadjusted PRs, as well as adjusted PRs that control for relevant enrollment covariates. Any covariates that were associated with the outcomes at the $p<0.2$ level were included in adjusted models. Covariates with insufficient variation in the dataset (>95% or <5% prevalence) were excluded. We considered the following adjustment covariates: child age and sex, gender of household head, literacy of household head, number of household members, primary water source, distance and travel time to primary water source, latrine ownership, type of latrine, presence of handwashing station with water and soap within 5 meters of latrine, PPI®, and household assets. We calculated the total assets of each household by summing up their reported savings, the reported value of any businesses owned by the household, and the estimated value of any owned land and domestic animals.

7.0 RESULTS

7.1 ENROLLMENT

We enrolled 1305 households (664 treatment and 641 control) and conducted a pre-intervention baseline survey between August and October 2019. While we conducted a total of three rounds of post-intervention data collection, we only report findings for the third and final round due to data integrity concerns during the first and second rounds. The final follow-up survey was implemented in August 2021, where 868 households (67%) participated in data collection, while 437 (33%) were lost to follow-up. Loss to follow-up was similar across study arms, with 443 households in the control arm and 425 households in the intervention arm participating in the final follow-up round. Households that were lost were overall similar in their baseline characteristics to households that were retained, except that they had a slightly smaller number of household members and were less wealthy (See Appendix, Table A6). No other systematic differences were detected between households that were retained and those that dropped out.

7.2 EVALUATION OF INTERVENTION IMPACT

The study finds no overall impact of the training program one year after the training program ended, with the exception of an increase in the perceived difficulty of corralling chickens. These findings are consistent with the findings from the previous two rounds of post-intervention data collection omitted from this analysis due to data integrity concerns.

7.2.1 Poultry Management and Risk Perception Outcomes

Table 1 includes prevalence ratios (PRs) for the poultry management outcomes, Table 2 includes PRs for poultry livelihood outcomes, and Table 3 includes odds ratios (ORs) for the poultry feces risk perception and management self-efficacy outcomes.

Table 1. Poultry management practices

	Prevalence (%)		Unadjusted		Adjusted	
	Treatment	Control	PR (95% CI)	p-value	PR (95% CI)	p-value
Observed poultry enclosure	30.9	26.1	1.18 (0.77, 1.81)	0.45	1.13 (0.75, 1.71)	0.56
Observed poultry feces in compound (yes/no)	63.3	58.7	1.08 (0.8, 1.46)	0.60	1.06 (0.80, 1.40)	0.71
Observed free-roaming poultry (yes/no)	69.9	72.0	0.97 (0.84, 1.13)	0.69	0.97 (0.84, 1.13)	0.72
Reported hand washing after handling animals or animal feces	16.9	11.1	1.53 (0.81, 2.9)	0.19	1.47 (0.77, 2.78)	0.24

	Prevalence (%)		Unadjusted		Adjusted	
Reported any amount of time spent managing poultry the day prior	79.4	73.1	1.09 (0.89, 1.33)	0.43	1.10 (0.90, 1.34)	0.35

PR: Prevalence ratio; CI: Confidence interval

Table 2. Poultry livelihood outcomes

	Prevalence (%)		Unadjusted		Adjusted	
	Treat	Control	PR (95% CI)	p-value	PR (95% CI)	p-value
Eggs sold in last week	5.3	3.0	1.79 (0.82, 3.87)	0.14	1.82 (0.84, 3.94)	0.13
Eggs consumed in household in last week	36.2	33.0	1.10 (0.83, 1.46)	0.51	1.09 (0.83, 1.45)	0.53
Eggs consumed by children in last week	38.6	31.2	1.24 (0.94, 1.63)	0.12	1.22 (0.92, 1.62)	0.17
Chicken consumed in household in last week	22.8	23.3	0.98 (0.73, 1.33)	0.90	0.93 (0.69, 1.26)	0.64

PR: Prevalence ratio; CI: Confidence interval

Table 3. Poultry feces risk perceptions and management self-efficacy

	Prevalence (%)		Unadjusted		Adjusted	
	Treat	Control	OR (95% CI)	p-value	OR (95% CI)	p-value
Likely That Ingestion of Chicken Feces by Children Results in Diarrhea	76.9	80.5	0.81 (0.35, 1.88)	0.63	0.82 (0.44, 1.54)	0.54
No Difficulty in Corralling Poultry	30.1	43.7	0.56 (0.33, 0.96)	0.04	0.56 (0.29, 1.10)	0.09
No Difficulty in Washing Hands After Handling Poultry Feces	74.9	75.4	0.78 (0.39, 1.57)	0.49	0.80 (0.35, 1.85)	0.60
No Difficulty in Cleaning Up Feces	74.2	75.4	0.73 (0.36, 1.47)	0.38	0.75 (0.31, 1.81)	0.52
No Difficulty in Keeping Children from Touching Poultry Feces	63.3	64.5	0.75 (0.31, 1.82)	0.52	0.76 (0.31, 1.87)	0.54
Efficacy in Corralling Poultry	64.6	72.7	0.69 (0.38, 1.25)	0.22	0.69 (0.38, 1.25)	0.22

	Prevalence (%)		Unadjusted		Adjusted	
Efficacy in Washing Hands After Handling Chicken Feces	79.7	78.7	0.86 (0.46, 1.60)	0.64	0.89 (0.37, 2.11)	0.79
Efficacy in Cleaning Up Feces	81.3	84.1	0.75 (0.35, 1.60)	0.46	0.76 (0.32, 1.85)	0.55
Efficacy in Keeping Children from Touching Poultry Feces	73.7	79.2	0.55 (0.27, 1.12)	0.10	0.58 (0.25, 1.34)	0.20
Perceived Corralling Poultry Prevents Diarrhea	78.0	87.1	0.69 (0.28, 1.73)	0.43	0.71 (0.32, 1.57)	0.40
Perceived Washing Hands Prevents Diarrhea	80.3	88.6	0.50 (0.17, 1.45)	0.20	0.53 (0.25, 1.13)	0.10
Perceived Cleaning Up Poultry Feces Prevents Diarrhea	81.5	88.8	0.49 (0.19, 1.30)	0.15	0.52 (0.23, 1.17)	0.11
Perceived Keeping Children From Touching Poultry Feces Prevents Diarrhea	81.3	89.8	0.44 (0.16, 1.21)	0.11	0.47 (0.22, 1.00)	0.05

OR: Odds ratio; CI: Confidence interval; Prevalence ratios displayed represent respondents that responded with 'very' or 'somewhat likely,' 'very' or 'somewhat easy,' and 'very' or 'somewhat sure' to each question type.

Households in the intervention arm were more likely to report washing their hands after handling animals or animal feces than households in the control arm (adjusted PR=1.47 (0.77, 2.78), p-value=0.24). They were also more likely to have sold an egg in the past week (adjusted PR=1.82 (0.84, 3.94), p-value=0.13), and children in intervention households were more likely to have consumed an egg in the past week (adjusted PR=1.22 (0.92, 1.62), p-value=0.17). However, we could not rule out chance as an explanation of these findings as the 95% confidence intervals included the null. When asked about the difficulty of keeping poultry in a designated area, households in the control arm were more likely to report it was an easy task as compared to households in the intervention arm (adjusted OR=0.56 (0.29,1.10), p-value=0.09). When asked about their confidence that they could always perform a task, households in the control arm were more likely to be confident in keeping poultry in a designated area (adjusted OR=0.69 (0.38, 1.25), p-value=0.22) and keeping children from touching poultry feces (adjusted OR=0.58 (0.25, 1.34), p-value=0.20) than households in the intervention arm. They were also more likely to perceive that certain behaviors prevented diarrhea in their children, including washing hands after handling poultry feces (adjusted OR=0.53 (0.25, 1.13), p-value=0.10), cleaning up poultry feces (adjusted OR=0.52 (0.23 1.17), p-value=0.11, and keeping children from touching poultry (adjusted OR=0.47 (0.22, 1.00), p-value=0.05) than households in the treatment arm. We could not rule out chance in explaining all of these findings, though, since the null was included in the 95% confidence intervals in several relationships.

7.2.2 Child Hand Rinse Fecal Contamination

PRs for the detection of *E. coli* in child hand rinse samples across study arms are presented in Table 4.

Table 4. Detection of E. coli in child hand rinse samples by study arm

	Prevalence (%)		Unadjusted		Adjusted	
	Treat	Control	PR (95% CI)	p-value	PR (95% CI)	p-value
Detection of *E. coli* in hand rinse sample	57.1	49.4	1.16 (0.82, 1.64)	0.42	1.25 (0.91, 1.71)	0.17

PR: Prevalence ratio; CI: Confidence interval

E. coli was detected in 57.1% of child hand rinse samples for households in the treatment group, whereas it was detected in 49.4% of samples from the control group (adjusted PR=1.25 (0.91, 1.71), p-value=0.17).

7.2.3 Health Outcomes

Among children in the control arm, the caregiver-reported seven-day prevalence was 17.8% for diarrhea, 44.8% for respiratory infections and 30.2% for malaria. There were no differences in the prevalence of any health outcome between the treatment and control groups in unadjusted or adjusted analyses (Table 5).

Table 5. Seven-day reported prevalence of diarrhea, respiratory infection and malaria by study arm (using data from final data collection round)

	Prevalence (%)		Unadjusted		Adjusted	
	Treat	Control	PR (95% CI)	p-value	PR (95% CI)	p-value
Diarrhea	19.3	17.8	1.08 (0.73, 1.60)	0.69	1.10 (0.75, 1.61)	0.63
Respiratory infection	48.4	44.8	1.08 (0.85, 1.37)	0.52	1.03 (0.84, 1.27)	0.78
Malaria	32.2	30.2	1.07 (0.73, 1.57)	0.74	0.93 (0.69, 1.26)	0.66

PR: Prevalence ratio; CI: Confidence interval

8.0 DISCUSSION

8.1 BEHAVIOR CHANGE FINDINGS

Statistical analysis did not identify any changes in the treatment population with the exception of an association with an increased perceived difficulty of appropriately corralling chicken. These findings generally align with observations from community monitoring visits conducted by staff, though qualitative discussions between staff and with treatment communities during these visits suggests there may have been increased awareness of health risks of chicken feces and improvements in separating chickens from children at nighttime (i.e., keeping chickens in a separate room or dedicated space) and cleaning up of chicken feces. Observations made by staff during their community visits agree with the results in the household surveys that there was little to no change in the construction or use of a standalone chicken house, chicken run (or fenced in outdoor area), footbath, chicken feed, handwashing facility, synchronized hatching, chicken brooder, treatment for sick chickens, vaccination of most or all chickens, or separation of sick chickens. Staff perceptions of behavior change in communities they support are subject to bias, however, since they aligned in most cases with the household surveys it is possible they may speak to behavior and perception changes not captured in the household surveys.

While our messaging emphasized that several key hygiene behaviors (such as an outdoor chicken run made of poles and netting), could be done at very little cost, households resisted these changes without the presence of a chicken house. While a chicken run might not require a chicken house in the middle of it, study participants did not view an enclosed area lacking a physical corralling structure as logical. We also received feedback that it was much more difficult than anticipated for households to freely source local materials (notably wood), and so affordability constraints on building a chicken house became a central obstacle to behavior change.

Focus group discussions suggest that the trainings increased knowledge of poultry management best practices, but that it also actually increased the sense that implementing them was beyond their capacity. Other justifications for not implementing best practices were a worry of increased theft of chickens when corralled in a separate structure and high costs. For example, one person who took out a loan to invest in poultry corralling abandoned the practice, stating, "I picked the poultry loan last year to improve on my poultry management, but this requires a lot of time and resources like food, medicine which became very expensive for us. At the moment, our chickens are moving freely in the compound without any cost."

Roughly half of communities were either ineligible (due to inadequate capital to be a reliable debtor) or uninterested in interest-free loans to make poultry improvements. The reasons why provide insight into some of the additional barriers for households in this period:

- Households did not have confidence the financial returns to greater poultry investment would outweigh the costs. This may be because households had too few chickens to merit investment or because the risk of poultry death or theft created too much uncertainty about financial returns.
- Transitory households afraid of eviction or uncertain whether they would be living in the homes in near future did not want to invest in permanent structures.
- Not saving due to COVID-19 or already taking loans for other household needs.

Land tenancy issues includes both renters unsure of their future plans as well as communities at risk of large-scale evictions taking place after gazetted government land was sold to private firms[12].

[12] https://www.monitor.co.ug/uganda/news/national/35-000-left-homeless-as-private-firms-share-kiryandongo-land-1877156

8.2 SURVEY DESIGN LEARNINGS

The survey covered a wide range of behaviors (observable and self-reported), facilities, and caregiver-reported outcomes related to water, sanitation, hygiene, and poultry management, and child health. Upon review of our baseline data, we made several adjustments to our survey tool to address technical challenges as well as to provide additional insight in the endline analysis. These challenges and changes included:

- **Inconsistent responses on chicken corralling:** We asked several questions for self-reported corralling practices during the day and night as well as observed what facilities exist and the extent to which chickens were corralled. Self-reported corralling practices do not appear to be reliable, and even the existence of facilities does not seem a reliable proxy for the extent to which chickens are observed corralled during the visit or the extent of observable chicken feces. Both in the household surveys and monitoring visits observed enclosures, observed chickens inside and outside the enclosures, and self-reported corralling practices varied considerably.
- **Capturing chicken ownership over time**: In the baseline survey we constructed a poultry management section of questions contingent on owning chickens at that moment. However, due to the variance of chicken ownership across a year we have found that this will exclude households who had poultry six months prior and/or who will have poultry six months in the future given the high fatality rate of chickens from contagious disease. With that in mind, the poultry management section was asked of households who have chickens at present or self-report having owned chickens in the past during the endline survey.
- **Measuring risk-perceptions relating to chicken fecal contamination:** During the final follow-up survey we asked a series of questions that provided new insight into the relative risk of disease people associate with poultry management or child behaviors (e.g., keeping chickens in the same space as children or when children ingest soil.)
- **Measuring self-efficacy of specific household poultry feces management practices**: During the final follow-up survey, we added a series of questions that provide new insight into the degree to which people feel capable of performing these practices (e.g., always keep chickens corralled in a designated area) and the self-reported barriers that prevent practices from being performed.

This project has produced a novel dataset on knowledge, attitudes, practices, and health outcomes related to poultry management. Initial insights from these data were presented by Jeremy Lowe (North Carolina State University) in his poster presentation on "Exploring the Determinants and Indicators of Poultry Feces Management Behaviors in Rural Western Uganda" the University of North Carolina 2020 Water and Health Conference. Findings included:

- Self-reported indicators can have discrepancies with observational indicators. For instance, households that reported corralling poultry in the day still had free-roaming poultry visible at the time of survey and most households that had an observed poultry enclosure did not report using it for day and night corralling.
- Indicators representing poultry feces occurrences and free roaming could be subject to temporal variation. Future research could explore this nature and the validation of more robust, consistent indicators like poultry infrastructure.

These findings point to the complexity of measuring poultry management practices. Further analysis of the data may generate new insights on the relationships between these indicators to inform future program design.

8.3 GENDER EQUALITY AND SOCIAL INCLUSION FINDINGS

The gender balance of the triggering (61%) and training (59%) activities suggest we engaged women in the program, while also being inclusive of men. Based on community discussions in the training and coaching visits, staff believe that the potential concerns and benefits identified in the design phase are accurate. Specifically, community members perceive that increased investment in poultry management is likely to disproportionately require time of women, and that increased poultry assets will disproportionately benefit them. This additional benefit to women is perceived as positive or neutral, though it may reduce men's preference to invest in it versus livelihoods that they manage. With regards to the gender equality impact of the actual program, many of the gender equality considerations presumed not only participation, but a profound change in management practices. Given the lack of a statistically significant change in management practices, it is unlikely that there were changes to the time spent on poultry by women, nor changes to the asset base women control or influence. Household survey results indicate that there was not a dramatic change in time use.

With regards to social inclusion, the financial constraints to constructing facilities were greater than we anticipated. These constraints were not specific to the poorest households, but rather affected virtually all households as they navigated the COVID-19 crisis. Internal monitoring and third-party studies of the impact COVID-19 suggests that the pandemic and attendant shutdown did depress the local economy. In addition, while self-help groups did increase the resilience of communities to the shock (in the form of an accumulated savings to withdraw from or borrow against), the self-help groups were only partially capitalized at the time of the pandemic (they typically share out and restart their savings cycle in January).

Finally, our program design did not adequately account for the impact that land insecurity would have on household willingness to make improvements. Land insecurity affected at least 10% of the treatment households and this vulnerability dramatically reduced if not eliminated interest in medium- to long-term investments in chicken rearing facilities.

8.4 CONCLUSIONS ON PROGRAM DESIGN ASSUMPTIONS

These results suggest that a short-term training and coaching intervention with a small, short-term group loan offered is inadequate for poor rural households to improve their poultry management infrastructure and practices. We believe that the high cost of intensive chicken rearing (e.g., construction of chicken house, ongoing feeding), related risks such as predation, theft, and disease, and access to capital were likely binding constraints on poultry corralling and housing during the coaching period. While COVID-19 and the accompanying recession certainly reduced the household and self-help group capital available for infrastructure improvements, it is plausible that these constraints would have been binding in any event.

The ongoing, recurring cost of time and money to feed and maintain corralled chickens was a repeating concern among households. Community members framed many behavior changes as contingent upon the existence of the chicken house, which is the most expensive component to construct, and yet even among households with such enclosures, they are not consistently used, and free-range poultry management remains high. The relatively small group loans offered to the savings groups to which training participants belonged were inadequate to address the recurring costs (e.g., feed) of intensive chicken rearing. It is unknown if a larger capital infusion in grant or loan form, or if smaller allowances to pay for recurring costs for a period of time, might catalyze sustained adoption of intensive management.

Even with access to capital it is possible that households might simply prefer to invest in other livelihood activities, as they do currently. Some households voiced that they would not prioritize poultry investments due to their low number of poultry. It is plausible that without adequate capital for both the house and an adequate number of chickens at the same time, the investment of both money and time (e.g., preparing chicken feed) may appear too distant or speculative, especially given the economic

environment. These results suggest alternative program strategies that either provide significantly more support to transform poultry livelihood management (i.e., converting practices from free-range chicken-rearing to enclosed poultry rearing), or, conversely, aim to improve hygiene while minimally affecting general poultry management, may be more effective.

It is worth noting that we do not yet have evidence on whether increasing the presence or use of a chicken house will actually reduce chicken feces in the compound area. Observed enclosure presence was not associated with the presence of free-roaming poultry, for example, with 86.7% of households with an enclosure having free-roaming poultry observed (see Figure A-1). To the extent day-time corralling *is* an effective means of minimizing fecal exposure, our results suggest that capital in the form of grant would be needed.

We are considering alternative programmatic approaches to these challenges, including purchasing poultry feces from the groups as a more reliable financial incentive to change poultry feces management practices, as well as improved flooring which might reduce exposure within the households. If the former approach were effective in reducing child exposure to feces, there may be scope for a market-based approach for self-help groups or local entrepreneurs to sell feces as fertilizer. However, there remain open questions about whether the approach would catalyze behavior change and the impact of this collection on the magnitude of pathogens in the soil. We see potential in low-cost improved earthen floors to potentially mitigate child exposure to poultry feces, and a financial and institutional capacity of the savings groups created by The Water Trust to finance floor installations, possibly creating a higher adoption rate as well as serving as a platform for complementary hygiene and sanitation coaching and support. While it is not yet clear to what extent interior flooring improvements versus exterior courtyard hygiene will reduce child exposure to poultry feces, it is a worthwhile alternative program strategy to test and explore.

9.0 DISSEMINATION

In October 2019, The Water Trust had a poster presentation on the "Improving Hygienic Management of Poultry in Rural Uganda" project at University of North Carolina's Water and Health Conference. The Water Trust also planned an in-person stakeholder meeting with peer organizations and government officials in Uganda in spring 2020, which was instead shifted to a webinar due to COVID-19. The Water Trust participated in side-sessions on poultry and WASH at University of North Carolina's 2020 and 2021 conferences, and Jeremy Lowe, a student assisting Dr. Harris and Dr. Ercumen, presented an exploration of the baseline results in a poster presentation at the 2020 conference as well as a verbal presentation at the 2021 conference regarding risk perceptions and self-efficacy beliefs in poultry feces management.

Final results were shared in March 2021 at a virtual stakeholder meeting with Ugandan NGO and government officials as well as academic researchers. Awareness among government and NGO officials of chicken feces as an important health risk remains very low, and we aim to stimulate interest in addressing this challenge, as well as sharing what learnings we have from this project. To that end, we produced three videos to highlight the challenges around chicken feces in rural Uganda and feasible behavioral changes that would allow households to reduce their children's health risks while improving livelihoods outcomes. The Water Trust also published an article, "Chickens Are an Overlooked Risk to Child Health: Here's Why We Have to Get Poultry Promotion Right," on the Next Billion website.[13]

[13] https://nextbillion.net/chickens-are-overlooked-risk-child-health/

10.0 ATTACHMENTS

With the exception of the videos (which are linked in footnote), annexes are included in the folder: https://drive.google.com/drive/folders/14liWxJBo9tC21OdtOlaI_ERNAI8tAHPP?usp=sharing

- Poultry management training guide
- Poultry management situation analysis and program videos[14]
- Sample Poultry Training report
- Sample Poultry Triggering report
- Sample monitoring form
- Revised approved IRB application to Makerere University
- De-identified survey data and codebook

[14] https://www.youtube.com/playlist?list=PLDpl9u7QskZ7F22-It171yehMIPVvrYWW

APPENDIX A

INDICATOR EVALUATION AT BASELINE

Prior to evaluating the impact of the intervention, analysis was conducted on key poultry management outcomes at baseline. Descriptive characteristics of household demographics, wealth, WASH access, and general poultry management behaviors at the time of the baseline survey can be seen in Table A1. Characteristics are representative of all households interviewed at baseline (N =1305), though some questions pertaining to poultry management were only asked of households owning poultry.

Table A-1. Characteristics of demographics, wealth, WASH access, and poultry management behaviors (N = 1305)

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Number of Household Members				
Mean (SD)	6.2 (2.44)	641	6.59 (3.19)	663
Number of Children Under 5				
Mean (SD)	1.48 (0.74)	641	1.67 (0.87)	664
Female-Headed Household	11.4%	641	13.4%	664
Child Schooling				
No Child Aged 6-12	18.9%	641	18.1%	664
All Children Aged 6-12 in School	67.7%	641	72%	664
Not All Children Aged 6-12 in School	13.4%	641	9.9%	664
Material Used in the Walls of the House				
Unburnt bricks with mud, mud and poles, or other	70.7%	641	68.8%	664
Unburnt bricks with cement, burnt stabilized bricks	29.3%	641	31.2%	664
Material Used in the Roof of the Household				
Thatch, banana leaves/fibres, grass papyrus, tin	70%	641	66.3%	664

	Control		Treatment	
	Summary Statistic	Total Responses	Summary Statistic	Total Responses
Iron sheets, concrete, tiles, asbestos, or other	30%	641	33.7%	664
Primary Cooking Energy Source				
Firewood, cow dung, or grass	97.3%	641	98.3%	664
Charcoal, paraffin stove, gas, biogas, electricity, or other	2.7%	641	1.7%	664
Radio Owned	75.8%	641	67.3%	664
Phones Owned				
0	35.9%	641	35.5%	664
1-3	64.1%	641	64.5%	664
All Household Members Own Shoes	80.5%	641	80.1%	664
Type of Latrine Owned				
Uncovered pit latrine without a superstructure. Hole is not covered and no structure.	15.1%	557	12.7%	632
Uncovered pit latrine with a super structure. Hole is not covered but with a super structure	68.2%	557	70.3%	632
Covered pit latrine without a super structure	6.3%	557	6.6%	632
Covered pit latrine with a superstructure	8.4%	557	7.9%	632
VIP Latrine	2%	557	2.5%	632
Handwashing Facility with Adequate Water and Soap	14.4%	641	12.0%	644
Number of Human Feces Occurrences				
0	98%	641	98.6%	664
1-4	1.9%	641	1.2%	664

	Control		Treatment	
	Summary Statistic	Total Responses	Summary Statistic	Total Responses
5+	0.2%	641	0.2%	664
Number of Animal Feces Occurrences				
0	72.1%	641	77.7%	664
1-4	20.7%	641	19%	664
5+	7.2%	641	3.3%	664
Number of Poultry Feces Occurrences				
0	70.2%	641	66.1%	664
1-4	21.7%	641	27.4%	664
5+	8.1%	641	6.5%	664
Self-Reported Number of Poultry Owned				
Median [Min, Max]	6.00 [1, 900]	298	7.00 [1, 65]	311
Observed Number of Free-roaming Poultry				
Median [Min, Max]	2.00 [0, 22]	306	2.00 [0, 22]	316
Observed Poultry Enclosure	37.9%	309	41.6%	315
Self-Reported Chicken Corralling Practices in the Day				
Free roam	83.2%	304	90.4%	314
Use of corral or enclosure	10.2%	304	4.5%	314
Keep in home	6.6%	304	5.1%	314
Self-Reported Chicken Corralling Practices at Night				
Free roam	7.9%	304	6.7%	315

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Use of corral or enclosure	11.8%	304	14%	315
Keep in home	80.3%	304	79.4%	315
Time Spent Managing Chickens the Day Prior				
Self-reported any amount of time spent	72.6%	310	82%	316
Unprompted Reporting of Key Handwashing Practices				
Handwashing after handling animals or animal feces	7.5%	641	5.7%	664

A correlation matrix of indicators of interest is also shown below in Figure A1. The matrix represents significant associations ($P < 0.05$) found after conducting a series of Pearson's $\chi 2$ Tests. As the indicators of interest only pertain to households owning poultry, the following results are representative of the subset of households owning poultry at baseline ($N = 609$).

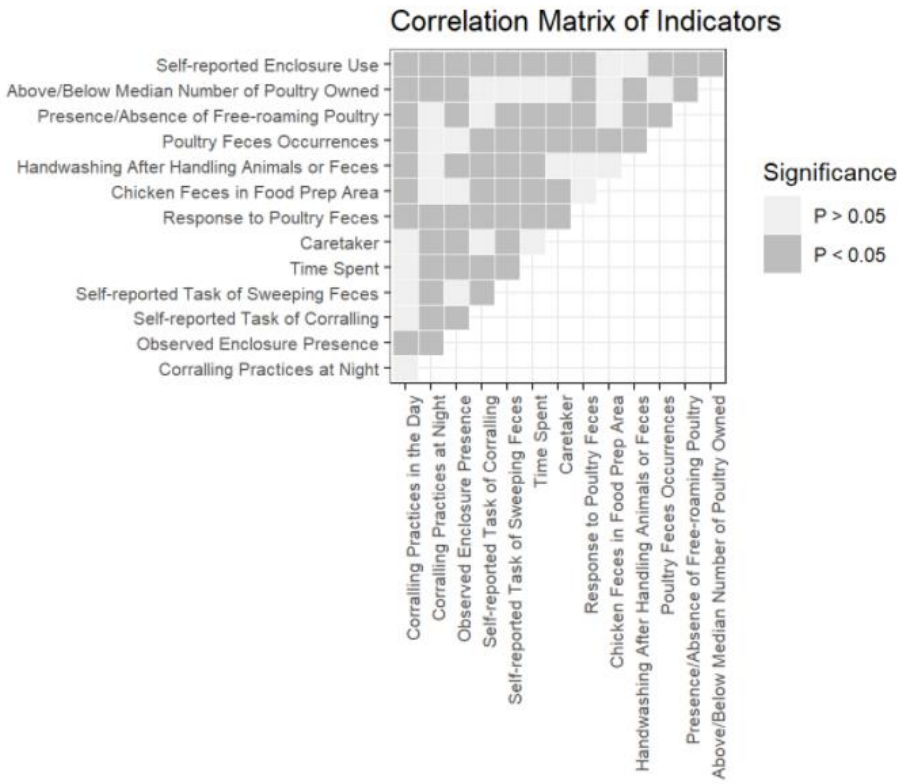

Figure A-1. Bivariate correlation matrix of poultry management indicators

Relationships displayed in Figure A1 are explained in detail below. For key relationships, results are further stratified to gain insight and to display the direction and magnitude of each effect.

Common infrastructure for households to invest in the enclosure of poultry and their feces include chicken 'runs' (fenced in areas), 'houses' (walled enclosures with roofs), baskets, and more. Households commonly have different corralling practices between the day and night; At baseline, 88% of households report letting their chickens roam freely during the day while 81% report keeping their poultry in their home at night.

Overall, 71% of households allow their chickens to roam freely during the day, while keeping them in their homes, including kitchen areas, and bedrooms at night, making it the most common practice in the study area. Further, 41% of households had an observed enclosure of some kind for poultry only. However, there are contradictions between households' self-reported corralling practices and what is observed by enumerators. Particularly, 83% of households that reported corralling chickens in the day still had chickens observed free roaming (N = 34) the compound at the time of the survey.

Observed enclosure presence was associated with corralling practices in the day ($\chi 2$, $P < 0.001$) and night ($\chi 2$, $P = 0.006$). A greater proportion of households with observed enclosures reported corralling chickens in their homes at night (85.5%, N = 212) and in an enclosure in the day (13.8%, N = 34), as compared with households with no enclosures corralling chickens in their homes at night (77.2%, N = 277) and in an enclosure in the day (1.7%, N = 6). Observed enclosure presence was not associated with the presence of free-roaming poultry ($\chi 2$, $P = 0.23$, 86.7% of households with an enclosure had free-roaming poultry as compared to 82.7% of households without an enclosure having free-roaming poultry). However, observed enclosure presence had a negative association with poultry feces occurrences (categories include: 0, 1-4, 5+, $\chi 2$, $P = 0.03$), in which 50% of households with an enclosure had 0 feces occurrences, whereas 39% of households without an enclosure had 0 feces occurrences. This relationship is nuanced however, as only 23% (N = 58) of households with an observed enclosure reported using it in the day or night.

Overall, 78.0% of households report spending time managing their chickens the day prior to the survey, indicating that it is mostly daily that households are spending time interacting with their poultry. Typical tasks include sweeping, feeding chickens, or maintaining enclosures. A household reporting spending time managing chickens the day prior had no association with a specific household member serving as caretaker (categories include: children aged 2-15, adults over 15 years, and a combination of adults and children, $\chi 2$, $P = 0.127$). Time spent was also positively associated with chicken feces occurrences ($\chi 2$, $P < 0.001$) and the presence of free-roaming chickens ($\chi 2$, $P = 0.001$). Of households that did not spend time managing chickens, 42% (N = 56) had an observed presence of feces, whereas 61% (N = 289) of households that did spend time managing chickens had an observed presence of chicken feces. A similar increase is seen in the number of free-roaming chickens, in which 75% (N = 100) of households that did not spend time managing chickens and 87% (N = 413) of households that did spend time managing poultry had an observed presence of free-roaming chickens ($\chi 2$, $P = 0.001$). An association was also found between time spent and a respondent's self-report of what they do with poultry feces found in their household or compound (categories include: Nothing, Place it in a rubbish pit, Use it as fertilizer, or Other, $\chi 2$, $P < 0.001$). Households that report time spent most often placed poultry feces in a rubbish pit (47%, N = 222).

A small proportion of households (9.4%, N = 57) owning poultry reported washing their hands after handling animals or animal feces when asked the unprompted question: "When do you wash your hands?" As shown in Figure A1, handwashing after handling animals or animal feces was not associated with either chicken feces occurrences ($\chi 2$, $P = 0.71$) or the presence of free-roaming chickens ($\chi 2$, $P = 0.09$). However, handwashing after handling animals or animal feces was positively associated with having an observed enclosure ($\chi 2$, $P = 0.009$). For households reporting handwashing at this key time, 58% have

an observed enclosure (N = 33), whereas only 39% (N = 215) of households that do not report handwashing also have an observed enclosure. Further, 89% (N = 51) of households that report handwashing after handling animals or animal feces also report spending time managing poultry, with slightly less (77%, N = 424) that do not report handwashing also report time spent ($\chi 2$, P = 0.04).

DESCRIPTIVE CHARACTERISTICS FROM ADDITIONAL ENDLINE DATA

Table A-2. General poultry management practices (N = 868)

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Percentage of households with any chickens	79.5%	443	79.3%	425
Owned Chickens Previously Not Currently	55.6%	90	65.1%	86
Number of Roosters, Chickens, and Chicks Owned				
Mean (SD)	13.8 (12.6)	353	13.3 (10.4)	339
Median [Min, Max]	11 [0, 87]		11 [0, 80]	
Above/Below Median Number of Chickens Owned				
No chickens owned	20.3%	443	20.2%	425
Above Median	42%	443	40.2%	425
Below Median	37.7%	443	39.5%	425
Number of Chickens Owned by Type				
Roosters Owned, Mean (SD)	2.02 (2.46)	353	1.92 (2.37)	339
Adult Chickens Owned, Mean (SD)	4.75 (4.81)	353	5.17 (4.53)	339
Chicks Owned, Mean (SD)	7.06 (7.87)	353	6.26 (6.49)	339
Observed Free Roaming Poultry Presence	72%	443	69.9%	425
Number of Free Roaming Poultry				
Mean (SD)	4.36 (5.59)	443	3.96 (4.59)	425
Number of Observed Corralled Poultry				

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Mean (SD)	0.482 (2.45)	353	1.26 (4.59)	339
Poultry Are Clean	92.6%	324	88.9%	307
Observable Hatching Coop	17%	353	25.4%	339
Observed Poultry Enclosure	26.1%	402	30.9%	395
Enclosure is Clean	77.1%	262	57.8%	225
Handwashing Facility at Enclosure	2.7%	113	3.1%	130
Footwashing Station at Enclosure	0.9%	113	3.1%	130
Poultry Vaccinated				
All	20.3%	403	14.9%	395
Most	2.2%	403	3.8%	395
Some	2.5%	403	3%	395
Few	1%	403	0.8%	395
None	73.9%	403	77.5%	395
Use of Antibiotics for Poultry	19.4%	403	13.9%	395
Use of Feed				
Do not use feed, chickens forage for food	82.6%	403	77.7%	395
Purchase feed	7.2%	403	13.9%	395
Make feed	10.2%	403	8.4%	395
Time Spent Managing Poultry Yesterday				
0 minutes	26.9%	353	20.6%	339
0-30 minutes	71.1%	353	77.3%	339

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
30-60 minutes	1.1%	353	1.5%	339
Over 1 hour	0.8%	353	0.6%	339
Caretaker of Poultry				
Adult	65.8%	403	71.8%	394
Adult and Child	31.8%	403	26.1%	394
Child	2.5%	403	2%	394

Table A-3. Poultry feces management behaviors (N = 868)

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Household with Some Visible Feces Instances in Home or Compound				
Human Feces	8.8%	443	9.9%	425
Other Animal Feces	32.5%	443	31.1%	425
Poultry Feces	58.7%	443	63.3%	425
Food Area Raised	26.9%	443	25.6%	425
Child Interaction with Chicken Feces				
Touched Chicken Feces	2.5%	443	3.3%	425
Put Feces in Mouth	1.6%	443	2.4%	425
Neither	88.7%	443	74.8%	425
Don't Know	7.2%	443	19.5%	425
Observed Child Put Soil in Mouth	10.8%	443	12.2%	425

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Corralled Chicken in Home at Night in Last Week	36.5%	353	45.4%	339
Poultry Corralling at Night				
Use a Poultry-only Enclosure For Any Amount of Time	38.2%	343	45.5%	352
No Reported Use of an Enclosure	61.8%	343	54.5%	352
Poultry Corralling during the Day				
Use a Poultry-only Enclosure For Any Amount of Time	11.3%	362	14.2%	351
No Reported Use of an Enclosure	88.7%	362	85.8%	351
Response to Poultry Feces in the Compound				
Nothing	13.1%	419	24.9%	418
Use it to make fertilizer	25.3%	419	29.7%	418
Place it in a rubbish pit	60.4%	419	42.3%	418
No chicken feces in compound	1.2%	419	3.1%	418
Value of Fertilizer				
Very Significant	68.9%	106	70.2%	121
Significant	28.3%	106	28.9%	121
Unsure	0.9%	106	0%	121
Insignificant	0%	106	0.8%	121
Very Insignificant	1.9%	106	0%	121

Table A-4. Poultry Livelihood Outcomes (N = 868)

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Eggs Sold				
Mean (SD)	0.54 (5.49)	403	0.68 (3.85)	395
Eggs Price				
Mean (SD) (UGX)	475 (62.2)	12	369 (183)	21
Eggs Eaten in Household in Last Week				
Mean (SD)	2.1 (3.9)	443	2.6 (4.8)	425
Eggs Eaten by Children in Last Week				
Mean (SD)	1.1 (2.2)	443	1.4 (2.4)	425
Chicken Eaten in Household in Last Week				
Mean (SD)	0.4 (1.1)	443	0.4 (1.0)	425
Chicken Eaten by Children in Last Week				
Mean (SD)	1.2 (1.2)	103	1.0 (0.7)	97
Used loan for Poultry Management	6.7	403	19.2	395

Table A-5. Poultry Risk Perceptions and Self-Efficacy in Management Practices (N = 868)

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
If your child puts chicken feces in their mouth, how likely is it they will get sick?				
Very likely	77.7%	443	73.9%	425
Likely	14.9%	443	16.9%	425

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Neither likely nor unlikely	2.9%	443	3.8%	425
Unlikely	1.6%	443	2.4%	425
Very unlikely	2.9%	443	3.1%	425
How difficult is it to keep your chickens in a designated area?				
Very difficult	32%	403	44.3%	395
Somewhat difficult	15.6%	403	15.7%	395
Neither difficult nor easy	8.7%	403	9.9%	395
Somewhat easy	15.9%	403	14.7%	395
Very easy	27.8%	403	15.4%	395
How sure/confident are you that you could always keep your chickens in a designated area?				
Very sure	48.6%	403	40.5%	395
Somewhat sure	24.1%	403	24.1%	395
Neither sure nor unsure	14.1%	403	14.9%	395
Somewhat unsure	8.2%	403	12.4%	395
Very unsure	5%	403	8.1%	395
How likely is it that your child will have fewer episodes of diarrhea if you keep your chickens in a designated area?				
Very likely	70%	403	63.8%	395
Somewhat likely	17.1%	403	14.2%	395
Neither likely nor unlikely	5%	403	5.8%	395

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Somewhat unlikely	5.7%	403	10.9%	395
Very unlikely	2.2%	403	5.3%	395
How difficult is it to clean up chicken feces in your home or compound?				
Very difficult	3.7%	403	7.8%	395
Somewhat difficult	6%	403	6.3%	395
Neither difficult nor easy	14.9%	403	11.6%	395
Somewhat easy	26.6%	403	34.9%	395
Very easy	48.9%	403	39.2%	395
How sure/confident are you that you could always clean up chicken feces in your home or compound?				
Very sure	66.5%	403	60%	395
Somewhat sure	17.6%	403	21.3%	395
Neither sure nor unsure	13.6%	403	11.9%	395
Somewhat unsure	1.7%	403	5.1%	395
Very unsure	0.5%	403	1.8%	395
How likely is it that your child will have fewer episodes of diarrhea if you clean up chicken feces in your home or compound?				
Very likely	79.4%	403	65.1%	395
Somewhat likely	9.4%	403	16.5%	395
Neither likely nor unlikely	4%	403	4.8%	395
Somewhat unlikely	5.7%	403	10.4%	395

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
Very unlikely	1.5%	403	3.3%	395
How difficult is it to keep your child from touching chicken feces?				
Very difficult	14.1%	403	12.4%	395
Somewhat difficult	6%	403	12.4%	395
Neither difficult nor easy	15.4%	403	11.9%	395
Somewhat easy	22.8%	403	33.7%	395
Very easy	41.7%	403	29.6%	395
How sure/confident are you that you could always keep your child from touching chicken feces?				
Very sure	61%	403	44.6%	395
Somewhat sure	18.1%	403	29.1%	395
Neither sure nor unsure	15.9%	403	13.9%	395
Somewhat unsure	4.5%	403	9.1%	395
Very unsure	0.5%	403	3.3%	395
How likely is it that your child will have fewer episodes of diarrhea if you keep your child from touching chicken feces?				
Very likely	80.1%	403	63.3%	395
Somewhat likely	9.7%	403	18%	395
Neither likely nor unlikely	3.2%	403	6.3%	395
Somewhat unlikely	6.5%	403	9.1%	395
Very unlikely	0.5%	403	3.3%	395

	Control		Treatment	
	Summary Statistic	**Total Responses**	**Summary Statistic**	**Total Responses**
How difficult is it to wash your hands with soap after handling chicken feces?				
Very difficult	1.7%	403	3.5%	395
Somewhat difficult	5.5%	403	9.6%	395
Neither difficult nor easy	17.4%	403	11.9%	395
Somewhat easy	32.3%	403	39.2%	395
Very easy	43.2%	403	35.7%	395
How sure/confident are you that you could always wash your hands with soap after handling chicken feces?				
Very sure	57.3%	403	53.2%	395
Somewhat sure	21.3%	403	26.6%	395
Neither sure nor unsure	17.9%	403	11.6%	395
Somewhat unsure	3%	403	5.6%	395
Very unsure	0.5%	403	3%	395
How likely is it that your child will have fewer episodes of diarrhea if you wash your hands with soap after handling chicken feces?				
Very likely	76.2%	403	62%	395
Somewhat likely	12.4%	403	18.2%	395
Neither likely nor unlikely	5%	403	3.8%	395
Somewhat unlikely	6%	403	11.9%	395
Very unlikely	0.5%	403	4.1%	395

DESCRIPTION OF CHARACTERISTICS OF PARTICIPANTS LOST TO FOLLOW-UP VS. RETAINED IN STUDY

Table A-6. Characteristics of participants lost to follow-up vs. retained in study

	Captured at final round (N=868)	Missed at final round (N=437)	p-value *
Number of household members, mean (SD)	6.6 (2.9)	6.0 (2.7)	0.0001
Female headed household, %	13.0	11.2	0.35
Oldest female can read and write, %	64.2	62.5	0.55
Obtains drinking water from tubewell, %	70.1	68.0	0.44
Roundtrip time to water source, %			0.78
<30 min	51.5	49.4	
30-60 min	40.3	42.1	
>60 min	8.2	8.5	
Latrine access, %			0.53
No latrine	9.3	8.0	
Uncovered pit without superstructure	12.9	11.9	
Uncovered pit with superstructure	63.5	62.5	
Covered pit without superstructure	5.7	6.4	
Covered pit with superstructure	8.6	11.2	
Water and soap within 5 m of latrine, %	6.1	8.0	0.20
Poverty probability index quartile, %			0.02
Bottom quartile	24.2	26.8	
Second quartile	28.0	20.6	
Third quartile	27.7	27.5	
Top quartile	20.2	25.2	
Asset quartile, %			0.01
Bottom quartile	23.9	28.4	
Second quartile	24.4	25.5	
Third quartile	23.9	26.8	
Top quartile	27.9	19.3	

* p-value obtained from t-test for continuous variables and from chi-square test for binary and categorical variables.

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