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HOUSEHOLD PROBLEM-SOLVING TO REDUCE CHILDREN'S EXPOSURE TO POULTRY FECES

Phase II Final Report

PHOTO CREDIT: ICDDR,B.

AUGUST 2021

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ACRONYMS AND ABBREVIATIONS

BDT	Bangladeshi Taka
CHP	Community Hygiene Promoter
CI	Confidence Interval
COVID-19	Coronavirus Disease 2019
DiD	Difference in Difference
icddr,b	International Centre for Diarrhoeal Disease Research, Bangladesh
IBM-WASH	Integrated Behavioral Model for Water, Sanitation, and Hygiene
NEAP	Neighborhood-Based Environmental Assessment and Planning
p.p.	Percentage Point
SD	Standard Deviation
USAID	United States Agency for International Development
USD	United States Dollars
WASH	Water, Sanitation, and Hygiene
WASHPaLS	Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability Project

EXECUTIVE SUMMARY

Backyard poultry raising is common in low- and middle-income countries like Bangladesh. Exposure to poultry feces is a risk factor for *Campylobacter* spp. infections, which are associated with diarrhea and malnutrition among young children. Children's risk of exposure to poultry feces is likely higher when poultry are kept inside the sleeping space/household dwelling at night. Little is known about acceptable and feasible enabling technologies (hardware) or other strategies that could effectively separate children from poultry and poultry feces to reduce risks of infection. Thus, we designed this study to:

1. Identify and improve upon existing behaviors and strategies to separate children and poultry and explore feasibility, acceptability, effectiveness, difficulties, benefits, and costs associated with said behaviors and strategies;
2. Investigate the effectiveness of a behavior change communication and counseling intervention, with and without monetary support, to encourage backyard poultry-raising households to confine poultry in a shed in the courtyard at night (i.e., outside of the household dwelling); and,
3. Develop households' problem-solving capacities as they work to adopt behavioral recommendations to separate young children from poultry and poultry feces.

We undertook this study in two phases. In Phase I, we conducted formative research to identify and refine existing local strategies that could separate children from poultry feces. A complete description of the formative research methodology and findings is available in our Phase I report. In brief, our formative research identified several barriers to building nighttime poultry housing, including availability and access to material, labor, and financial resources. To respond to these barriers, we designed a neighborhood-based behavior change intervention promoting improved nighttime poultry housing practices and poultry feces management. In Phase 11 we then conducted a pilot study of the intervention to encourage backyard poultry-raising households to (a) build an improved poultry shed and (b) confine all poultry outside the household dwelling in the shed at night. We defined an improved poultry shed as one located outside, raised from the ground, equipped with multiple compartments and having cross-ventilation. This report covers the methods and findings of the pilot study.

Previous formative research suggested that material and labor costs were a major constraint to building improved poultry housing, so our pilot study tests the effect of a household subsidy of approximately 23 United States Dollars (USD), amounting to roughly 43% of the average cost of a multi-compartment shed with ventilation. The pilot study sample was 80 households, with 38 households in the subsidy arm and 42 in the non-subsidy arm. Households in both arms participated in a behavior change and counseling intervention that we developed named Neighborhood-based Environmental Assessment and Planning (NEAP). The NEAP intervention is a novel participatory intervention package that incorporates principles of household-based assessments and an ecological model approach to behavioral determinants, considering a multi-level perspective of factors likely to influence behavioral outcomes in the development of intervention content and delivery. Our NEAP intervention included group meetings and household visits with poultry raisers (all of whom were women in this setting), group meetings with male members of enrolled households, and a training session with local masons. NEAP intervention activities were delivered by community hygiene promoters (CHPs) recruited from the study site.

At baseline, no households had an improved poultry shed. By endline, 87 percent of subsidy households (32/37; one household of the original 38 migrated out) and 33 percent of non-subsidy households (14/42) had built a multi-compartment, ventilated poultry shed.

The NEAP intervention significantly altered poultry-raising practices among study households. After the intervention, households were more likely to confine all poultry outside, have an improved poultry shed, have no feces inside the household dwelling, and have a specific place for disposing of poultry feces.

Among all study households, we found that the proportion of households reporting that they confined all poultry outside the household dwelling the previous night was significantly higher at endline (33%) than at baseline (2.5%) (prevalence difference: 30 percentage points (p.p.), 95% CI: 19 p.p. to 41 p.p.). Again, after intervention, of those study households that built an improved poultry shed, 47 percent (21/45[1]) still confined some poultry inside during endline. The common types of poultry kept inside by these households were egg-laying or brooding hens (52%, 11/21), healthy adult chickens (43%, 9/21), healthy chicks (38%, 8/21), healthy ducklings (29%, 6/21), and healthy adult ducks (14%, 3/21). A considerably higher proportion of study households (81%) had no visible poultry feces inside the household dwelling at endline than at baseline (54%; prevalence difference: 26 percentage points, 95% CI: 12p.p. to 41p.p.). Similarly, the fraction of primary poultry raisers who reported washing hands with soap after handling poultry feces increased from baseline to endline (prevalence difference: 51 percentage points, 95% CI: 38 p.p. to 64 p.p.). A higher fraction also reported handwashing after feeding poultry or handling poultry or poultry products (prevalence difference: 43 percentage points, 95% CI: 32 p.p. to 54 p.p.), and after handling other animal feces (prevalence difference: 15 percentage points, 95% CI: 1.5 p.p. to 29 p.p.). At endline, a higher proportion of households (combining both arms) reported using a specific place for disposing poultry feces compared to baseline (prevalence difference: 44 percentage points, 95% CI: 30 p.p. to 58 p.p.).

Households in both study arms built improved sheds, but accelerating improved poultry housing outside of the household dwelling may require monetary support. We found that households receiving a monetary subsidy were more likely to build an improved poultry shed within the intervention period (three months) than those households that did not receive a subsidy.

As part of the pilot study, we also explored whether having an improved shed enabled poultry raisers to house their poultry outside the household dwelling. Our data suggests that having an improved poultry shed does serve as an enabling technology for confining poultry separate from people at night. We also explored if having an improved poultry shed would reduce the presence of poultry feces in the household dwelling and courtyard. Households with improved poultry sheds had fewer poultry feces piles inside the household dwelling, although the difference was small and not significant.. These findings suggest that ownership of improved shed was not enabling in reducing presence of open feces in the environment.

Through this pilot, we conclude that the NEAP intervention was successful at encouraging poultry-raising households to build an improved poultry shed, confine poultry outside of the household dwelling at night, reduce/prevent poultry feces in the household dwelling, and dispose of poultry feces in a dedicated location away from the reach of children. Additional research is needed to explore sustained uptake of behavioral recommendations and opportunities to improve intervention content and delivery to make the intervention more impactful. Future investigation should assess whether changes to poultry raising practices result in reduced fecal contamination of the domestic environment (as measured by the concentration of *E. coli* present in dirt and on surfaces), improved child health outcomes, and improved poultry health outcomes.

[1] One household with improved poultry shed did not have any poultry during endline. Therefore, one missing value recorded here.

1.0 INTRODUCTION

Campylobacter spp. infections are the most common bacterial cause of gastroenteritis (Murray et al., 2012). In children under two years of age, *Campylobacter* spp. infections have been associated with poor linear growth, increased intestinal permeability, and increased intestinal and systemic inflammation (Amour et al., 2016). Causes of campylobacteriosis in humans include consuming contaminated water and food; person-to-person transmission; and exposure to domestic animals, especially poultry, and poultry feces (Kaakoush et al., 2015; Zambrano et al., 2014).

In Bangladesh, 80 percent of rural households raise backyard poultry (Dolberg, 2008). In one study among poultry-raising households, 98 percent reported poultry scavenging in the yard, 93 percent reported poultry roaming freely inside homes during the day, and 37 percent reported children touching, carrying, or playing with poultry in the past two weeks (Shanta et al., 2017). Little is known about acceptable and feasible enabling technologies (hardware) or other strategies that could effectively separate children from poultry and poultry feces. Through a grant from the United States Agency for International Development (USAID) Water, Sanitation, and Hygiene Partnerships and Learning for Sustainability (WASHPaLS) project, a team led by the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) designed this study to:

1. Identify and improve upon existing behaviors and strategies to separate children and poultry and explore feasibility, acceptability, effectiveness, difficulties, benefits, and costs associated with said behaviors and strategies;
2. Investigate the effectiveness of a behavior change communication and counseling intervention, with and without monetary support, to encourage backyard poultry-raising households to confine poultry in a shed in the courtyard at night (i.e., outside of the household dwelling); and,
3. Develop households' problem-solving capacities as they work to adopt behavioral recommendations to separate young children from poultry/poultry feces.

We undertook this study in two phases. In Phase I, we conducted formative research to identify and refine existing local strategies intended to separate children from poultry feces (Objective 1). The Phase I report contains a description of the formative research methodology and findings. To respond to Phase I findings, we designed a neighborhood-based behavior change and counseling intervention promoting improved nighttime poultry housing practices and poultry feces management, and in Phase II, we conducted a pilot study to investigate the intervention's effectiveness, with and without monetary support. Objectives of the intervention were to encourage backyard poultry-raising households to (a) build a night shed for poultry confinement (Objective 2) and (b) confine all poultry separately from the household dwelling at night (Objective 3). We hypothesized that an improved poultry shed would enable households to keep all of their poultry outside of the household dwelling at night and thereby reduce fecal contamination inside the household dwelling. We also hypothesized that monetary support would increase the likelihood of a household building, using, and maintaining an improved poultry shed. The midline reports present a description of the intervention development and methods of the pilot study. This report provides an overview of the Phase II pilot study methods and presents the main findings.

2.0 MATERIALS AND METHODS

2.1 STUDY SETTING

We conducted the Phase II pilot study in the Fulbaria sub-district of Mymensingh district in north-central Bangladesh. We selected Mymensingh district based on its convenient location, the willingness of households to participate, and the Phase I finding suggesting that approximately half of poultry-raising households in this area house birds inside their household dwelling at night. Additionally, we selected Fulbaria sub-district because it represents a typical rural sub-district in Bangladesh and is conveniently located to Mymensingh city center, which facilitated project logistics. Fulbaria sub-district comprises 13 unions, which are the smallest rural administrative and local government units in Bangladesh. Each union has several villages; in each village, the households are clustered as compounds, usually a cluster of two to eight households surrounding a shared courtyard. Households of each compound are usually part of the same extended family.

2.2 STUDY DESIGN

This study was a two-arm pilot study, with each arm receiving the behavior change communication and counseling intervention and one arm additionally receiving a monetary subsidy for constructing a poultry night shed. The subsidy arm was included to assess the degree to which affordability constrains adoption of a poultry shed. The subsidy support provided was 2,000 Bangladeshi takas (BDT, roughly 23 United States dollars [USD]) for labor and/or material costs, which is roughly 43% of the average cost faced by households. The subsidy amount was decided based on our experience of supporting households to build poultry sheds during Phase I formative research. The amount was roughly equivalent to the cost of hiring a carpenter to build a poultry shed.

We randomly selected two unions from seven eligible unions out of 13 total unions of Fulbaria sub-district (see Figure 3.1). The selected unions had similar characteristics based on the 2011 national census (e.g., literacy rate, household ownership, population density, male to female ratio, sanitation coverage, safe drinking water provision at the household level, and electricity supply). The selected unions were then randomized into non-subsidy and subsidy arms. Unions were considered as the randomization unit to avoid spillover of the information related to monetary support within the unions. We selected two villages from each union based on convenience, poultry raising practices, and distance from Fulbaria city center. In each village, trained enumerators identified the village center. Enumerators went door-to-door to identify compounds[2] in which each of the households had at least one adult chicken (at least two months old), at least one household was practicing housing of poultry inside their household dwelling at night, and at least one household had a child 6–59 months old. Enumerators visited 30–40 compounds to list 30–35 eligible households. They then prepared a hand-drawn map with landmarks of the village, the relative position of the compounds, the number of households in each compound, and the presence of poultry and children in those households. Using the maps, the study team selected compounds in the same vicinity or adjacent to each other to facilitate neighborhood-level intervention delivery and engagement. We excluded compounds with households raising poultry commercially (50+ birds) and compounds with a single household that was not adjacent to other compounds; 19–21 households were enrolled from each village. The enumerators collected informed written consent from the primary poultry-raiser in the household at enrollment. The primary poultry-raiser was defined as the household member who owned and cared for the poultry and was the primary decision-maker for the poultry. In rural Bangladesh, primary poultry-raisers are most often female (Shanta et al., 2017). In our study setting, all primary poultry-raisers enrolled were female. The target children in our study were children of the selected compounds ages 6–59 months old during enrollment,

[2] Usually a cluster of two to eight households surrounding a shared courtyard

or those ages 6–59 months during endline for the households that did not have a child in this age group during enrollment.

The total sample size for the pilot study was 80 households. Prior pilot studies in similar settings (Desi et al., 2015; Paul et al., 2012) suggest that the inclusion of 50 households per arm allows for exploring trends in behavioral uptake and the NEAP intervention encourages four behavioral recommendations. However, based on budgetary constraints, we were limited to enroll 40 households per arm.

2.3 INTERVENTION DESIGN AND DELIVERY

We developed an intervention package based on formative research findings, considering contextual, psychosocial, and technological factors at multiple levels as outlined by the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH) (Dreibelbis et al., 2013). We also incorporated guidance from research on self-assessment of health hazards in the domestic environment, which can be a helpful tool for both identifying hazards and possible solutions (Morgan et al., 2005; Tomita et al., 2014). The resulting approach, which we named "Neighborhood-based Environmental Assessment and Planning" (NEAP), incorporates principles of household-based assessments and an ecological model approach to behavioral determinants, considering a multi-level perspective of factors likely to influence behavioral outcomes in the development of intervention content and delivery. Our NEAP intervention activities included a community engagement meeting, masons' training, group meetings and household visits with the primary poultry raisers, and male engagement meetings with male household members. Enrolled households were organized into neighborhoods (groups) with adjacent households for intervention delivery to create a supportive environment for adopting recommended behaviors and creating new poultry raising norms. The NEAP intervention promoted four key behavioral recommendations:

1. confinement of all poultry out of the household dwelling at night;
2. handwashing with soap and water after contact with poultry, poultry products, or poultry feces;
3. removal of poultry feces as soon as they are seen; and
4. disposal of poultry feces in a specific site away from the reach of children.

We introduced each behavioral recommendation over the course of six group meetings with the primary poultry raisers. We developed three corresponding NEAP posters for key behavioral recommendations to serve as visual aids during group meetings. In the first poster, illustrations of common behaviors with negative consequences were depicted. In the second poster, photographs of target behaviors with a positive outcome were shown. The final poster presented enabling technology to facilitate the adoption of target behaviors. The promoted enabling technology included an improved poultry shed, a handwashing station (bucket with lid, tap, and basin), a soapy water bottle (water mixed with detergent powder), and a hoe or spade for poultry feces removal. Models of enabling technology were presented during the meetings.

In addition to the NEAP posters, an overview poster with illustrations of the four key behavioral recommendations was provided to households at the first group meeting (Figure 2.1). Participants were asked to sign the poster to show commitment to the intervention recommendations and were then asked to display the overview poster in their homes.

Finally, to track their progress toward each recommended behavior, participants were provided a progress book with illustrations and photographs of small, doable actions to take to reach project recommendations.

In addition to all these NEAP activities, the subsidy arm received financial support from the project. In the subsidy arm, each household that demonstrated to the CHP that it was prepared to build an improved shed received the money to complete building the improved poultry shed.

Figure 2.1: Phase II poster promoting the four key behavioral recommendations

We hired community hygiene promoters (CHPs) (four women and two men) from the study site to facilitate group meetings and household visits. CHPs were more than 18 years old and had at least eight years of formal education. CHPs received rigorous training and were supervised by project staff. We also trained local masons from each study village to orient them with the project, noting the characteristics of an improved shed and the anticipated role of masons in the project.

We formed three neighborhoods (groups) of 6–8 primary poultry raisers from adjacent households and compounds in each enrolled village. Primary poultry raisers in each neighborhood attended bi-weekly group meetings led by female CHPs. The day before the scheduled date of group meetings, each CHP reminded participants by phone or in person. Group meetings were conducted in a convenient place for the households (e.g., courtyard, off-compound location, common room, or veranda). CHPs also conducted individual household visits in each study household following each group meeting during which CHPs recorded the household's progress and challenges toward adopting the recommended behaviors from the previous group meeting. CHPs recorded progress and challenges in a separate pictorial progress book, similar to those kept by participants. During household visits, CHPs also shared possible solutions to the difficulties reported. Female CHPs led all group meetings and household visits with primary female poultry raisers.

Male CHPs conducted two male engagement meetings with the male members of the study households. During these meetings, CHPs provided male household members with an overview of the project's behavioral recommendations, highlighted the important contributions of poultry raising to the household, and emphasized the critical role that men play in achieving the goal of having both healthy children and healthy poultry.

Due to the Coronavirus Disease 2019 (COVID-19) pandemic, CHPs and participants wore face masks and maintained a physical distance from each other to the extent possible during group meetings. Before each meeting, both as part of the intervention and to follow COVID-19 handwashing recommendations,

CHPs and participants washed their hands using the promoted handwashing station and soapy water bottle.

2.3.1 Data Collection

Primary and Secondary Outcomes. The primary outcome of the pilot study was the proportion of households confining poultry separately from the household dwelling at night. We defined the household dwelling as the main standing structure of the household, where the household members usually sleep. The secondary outcomes of the pilot study were the number of poultry feces in the household and courtyard and ownership of an improved night shed. We defined an improved poultry night shed as one located outside (i.e., separate from the household dwelling), with cross-ventilation and two or more compartments to confine different poultry types separately. While sturdy walls to prevent predation and a lock on the door to prevent theft were also important, households were already motivated to ensure these attributes of the shed, so we did not include them in the definition of an improved shed.

Quantitative Assessment. We conducted a baseline and endline quantitative assessment in all households. The baseline assessment was completed after enrollment in February 2020. Due to the COVID-19 pandemic, the implementation of intervention activities was delayed to September 2020. The endline quantitative assessment was conducted from January to February 2021, after three months of intervention implementation (mid-September to mid-December 2020). In Table 2.1, we present the timeline of Phase II activities.

Table 2.1: Phase II Pilot Activity Timeline

Activities	2020												2021	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Baseline survey		*												
Community engagement meeting			*											
Field activity on hold due to COVID-19 pandemic														
Mason training									*					
CHPs' training; convening of group meetings, household visits, and male meetings by CHPs									*	*	*	*		
Process monitoring and qualitative assessments									*	*	*	*	*	*
Endline survey													*	*

During baseline and endline quantitative assessments, an independent team of two enumerators (one male and one female) conducted spot-checks (see Appendices 1A and 1B) followed by a survey questionnaire (see Appendices 2A and 2B) in all study households. The enumerators used the Commcare platform on tablet computers to record the data.

Spot-Check. Trained enumerators visited different locations in the household and compound (e.g., household dwelling, courtyard, veranda, and others) to record signs of poultry (e.g., feathers) and to count visible poultry feces piles. Enumerators counted each pile of poultry feces in each of the household sites until reaching 25 piles. If more than 25 piles were present, the number recorded was 26 piles. Enumerators also checked for the presence of different types of poultry housing (e.g., shed[3], shelter[4], bamboo cage[5], corral[6], and other confinement strategies). Structural elements (e.g., windows)

[3] A poultry confinement structure that is house-like with features that include walls, roof, and door. The structure may or may not be independent of other structures, but it must either be a) on the veranda, in the courtyard, or off the compound, or b) moveable to the veranda, courtyard, or off the compound.

[4] A poultry confinement structure that involves built or put-together components that may or may not be joined together. Simple shelters may have walls, roof, or doors, but these are not required. A confinement structure is considered a "simple shelter" if it cannot be moved to the veranda, courtyard, or off the compound.

[5] A freely movable basket-like poultry confinement strategy that is typically placed over poultry to confine them.

[6] An area that is surrounded by a fence made by any type of material (e.g., plastic, metal, jute-based rope, mosquito net, or fishing net) and that is used for holding poultry (such as chickens or ducks).

and signs of use (e.g., poultry feces piles) were assessed. Enumerators also observed handwashing stations[7], poultry feces disposal sites, any free-roaming poultry in the households, and presence of poultry feces.

Survey Questionnaire. At baseline and endline, enumerators administered a structured questionnaire to the primary poultry raiser in each enrolled household. The questionnaire included questions on demographics and socioeconomic status (baseline only), poultry raising practices (day and nighttime poultry confinement, the involvement of other household members in poultry raising, and decision-making related to poultry and poultry products), poultry health, and children's exposure to poultry and poultry feces. Psychosocial factors likely to influence poultry raising practices (e.g., risk perceptions and social cohesion), and information on preferences for poultry housing and available resources and anticipated challenges for building improved poultry shed were also assessed.

Qualitative Assessment. From November 2020 to February 2021, members of the study team experienced in qualitative data collection conducted qualitative interviews (N=30) with primary poultry raisers (n=21) and male household members (n=9). Interviewers used a semi-structured guide and the participants' narratives to explore experiences with the intervention as well as barriers and facilitators to the four behavioral recommendations. Participants were intentionally selected from both subsidy and non-subsidy arms from "doer" and "non-doer" households. Doers were households who had completed the construction of an improved poultry shed and non-doers were households who had not completed construction. Households were selected for interviews based on pictorial progress book data and CHP reports.

Process Monitoring and Documentation. We documented intervention activities throughout implementation (see Supplementary Table 1, page 353). After each training session, CHPs evaluated the session using a semi-structured evaluation form and trainers (CHP supervisors) noted any challenges with intervention content or delivery. For each group meeting and household visit, CHPs recorded meeting attendance, duration, and challenges related to intervention delivery in a semi-structured daily record form. In addition, icddr,b supervisors observed at least one bi-weekly group meeting and two household visits facilitated by each CHP to assess performance, recording their observations in the supervisor monitoring form.

2.3.2 Data Analysis

Statistical Analysis of Quantitative Data. We summarized socio-demographic characteristics and animal ownership across the intervention arms at baseline. Initially, to assess the impact of the intervention, we assessed the change in primary and secondary outcomes from baseline to endline for both study arms combined. We calculated the prevalence difference from baseline to endline for each of the outcomes. We then compared the changes in primary and secondary outcomes from baseline to endline between non-subsidy and subsidy arms. We conducted all analyses based on intention-to-treat, without considering session attendance. We measured the intervention's effect size with difference-in-differences (DiD), i.e., $[\text{endline - baseline}]_{\text{subsidy}}$ minus $[\text{endline - baseline}]_{\text{non-subsidy}}$. We used Stata-13 to conduct this analysis.

Qualitative Data Analysis. Field notes from all interviews were expanded into a descriptive narrative and revised into a final summary after debriefing sessions with the study team on Zoom. At least two study team members reviewed interview summaries and organized them into a matrix according to predefined and emergent themes.

Process Monitoring. We conducted descriptive quantitative data analysis of the process monitoring data and presented the attendance of participants in each meeting (group meetings, household visits, and

[7] A specific place reported by the respondent where the household members usually wash their hands.

male engagement meetings) as a percentage of the total study participants. We also summarized and presented the CHPs' performance as frequency distribution.

3.0 FINDINGS

In February 2020, the study team enrolled 80 households from four villages of two unions in the Fulbaria sub-district of Mymensingh district. At the endline visit (January–February 2021), one household had migrated out of the study area, resulting in endline data collection for 79 households (Figure 3.1).

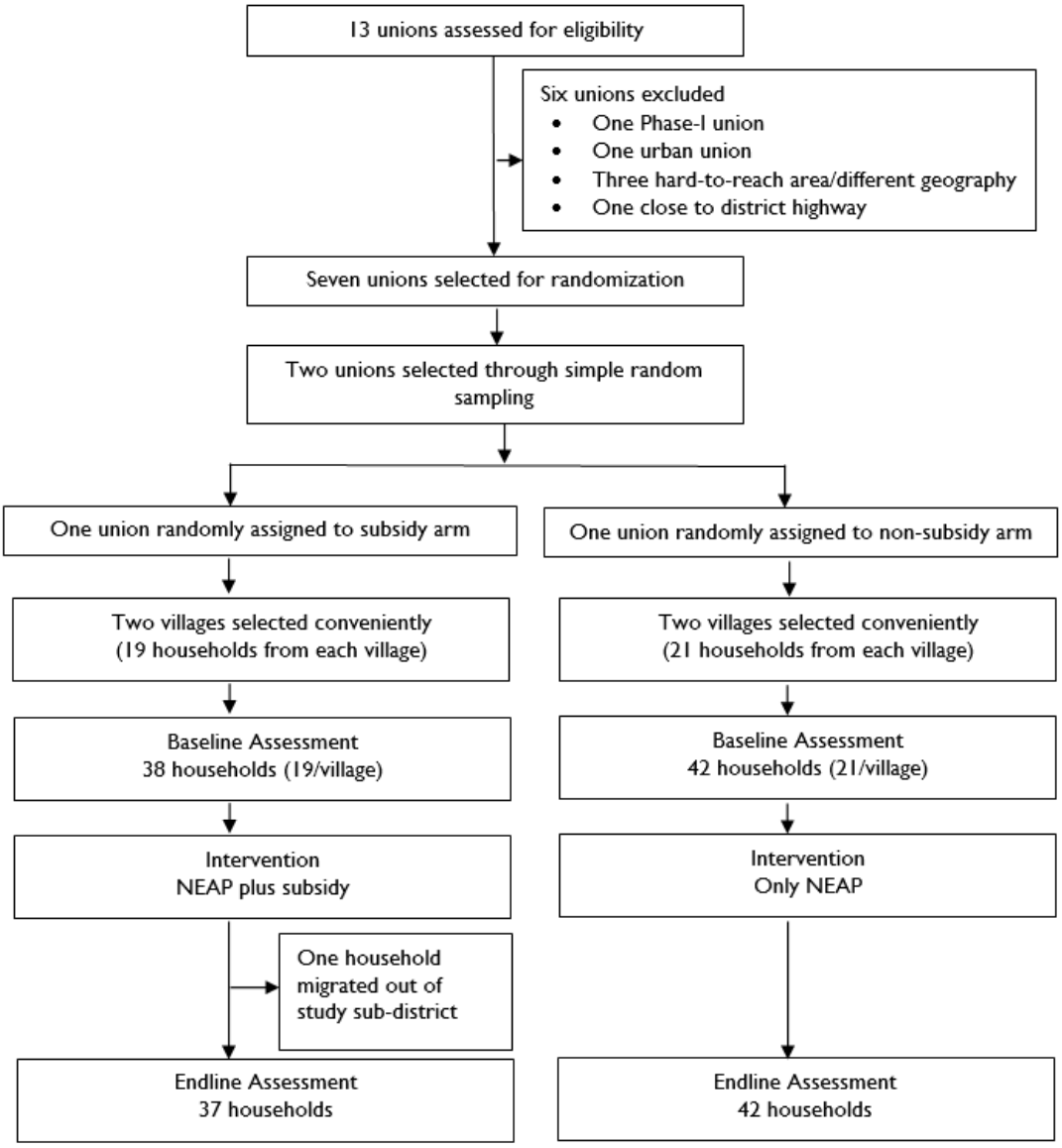


Figure 3.1: Participant Flow Chart of Phase II Pilot Study

3.1 CHARACTERISTICS OF THE STUDY POPULATION AT BASELINE

The primary poultry raisers were the main respondents from the study households and all were female. During baseline, most primary poultry raisers and their households had similar characteristics across arms (Tables 3.1 and 3.2). However, there were significant differences between arms with respect to ownership of some animals (including ducks, pigeons, cows/buffaloes) and other household assets (including televisions and smart phones).

Table 3.1: Characteristics of the Study Population at Baseline (February 2020)

Indicators	Non Subsidy Arm (N 42) % or Mean ±SD	Subsidy Arm (N 38) % or Mean ±SD	Total (N=80) % or Mean ±SD
Status of the respondent			
Female	100%	100%	100%
Has child 6–59 months of age	50%	58%	54%
Average number of individuals in the household	4.0 ± 1.4	4.3 ± 1.4	4.1 ± 1.4
Average number of households in the compound	3.9 ± 1.6	3.0 ± 1.1	3.5 ± 1.4
Survey respondent's mean age (years)	37 ± 14	35 ± 12	36 ± 13
Survey respondent's formal education (years)			
No formal education	43%	42%	43%
1–5 years	36%	34%	35%
6–10 years	19%	24%	21%
More than 10 years	2.4%	0%	1.3%
Primary occupation of the main earning member of the household (top 6)			
Day/unskilled laborer (domestic, agricultural, or migrant work within the country)	33%	26%	30%
Work on own farm or as a sharecropper	24%	24%	24%
Rickshaw/van puller/boat driver	21%	5.3%	14%
Skilled worker other than mason/carpenter (long term contracted laborer)	0%	18%	8.8%
Business owner	9.5%	7.9%	8.8%
Mason/carpenter	2.4%	7.9%	5.0%
Has access to an improved latrine[8]	67%	55%	61%
Household assets			
Has electricity (including solar)	100%	95%	98%
Television (functional)	4.8%	21%	13%
Refrigerator (functional)	2.4%	7.9%	5.0%
Mobile phone	88%	95%	91%
Smartphone	36%	16%	26%

Table 3.2: Animal Ownership among Study Households at Baseline (February 2020)

Indicators	Non Subsidy Arm (N 42) % or Mean±SD	Subsidy Arm (N 38) % or Mean±SD	Total (N=80) % or Mean±SD
Household poultry ownership			
Chickens (any age)	100%	100%	100%
Average number of chickens (any age) per household	8.8 ± 7.0	8.5 ± 7.9	8.6 ± 7.4
Healthy[9] adult chickens (>2 months age)	86%	92%	89%
Sick[10] adult chickens (>2 months age)	0%	5.3%	2.5%
Egg-laying chickens	50%	55%	53%
Healthy chicks (<2 months age)	64%	50%	58%
Sick chicks (<2 months age)	14%	11%	13%
Ducks (any age)	21%	63%	41%

[8] Improved toilet according to WHO/UNICEF Joint Monitoring Program: Flush or pour-flush to piped sewer system, septic tank, pit toilet, ventilated improved pit (VIP) toilet, pit toilet with slab, composting toilet, pit latrine with slab, no bucket, and/or hanging toilet.

[9] Self-reported by the respondent: Poultry (adult chicken/chick/adult duck/duckling) with no sign symptom of a disease.

[10] Self-reported by the respondent: Poultry (adult chicken/chick/adult duck/duckling) with sign symptom of a disease (e.g., fever, convulsion, pox, diarrhea, vomiting, etc.).

Indicators	Non Subsidy Arm (N 42) % or Mean±SD	Subsidy Arm (N 38) % or Mean±SD	Total (N=80) % or Mean±SD
Average number of ducks (any age) per household	0.48 ± 1.1	3.0 ± 3.8	1.7 ± 3.0
Household ruminant ownership			
Pigeons	0%	11%	5%
Bulls/milk cows/buffaloes	26%	61%	43%
Goats/sheep	29%	34%	31%

3.2 ATTENDANCE AT GROUP AND HOUSEHOLD MEETINGS

CHPs conducted a total of 72 group meetings with primary poultry raisers and 22 meetings with male household members across both arms and among all groups throughout the intervention period. Group meeting attendance for primary poultry raisers was 93 percent on average for both the subsidy and non-subsidy arms, respectively (Figure 3.2). Of primary poultry raisers, 70 percent (n=56) attended all six meetings and 93 percent (n=74) attended at least four meetings. For male engagement meetings, attendance at the first meeting was 89 percent in the subsidy arm and 85 percent in the non-subsidy arm, but by the second meeting dropped to 76 percent in the subsidy arm and 39 percent in the non-subsidy arm. CHPs reported that the lack of monetary support was the major factor contributing to lower male household member attendance in the non-subsidy arm. Male household members' work schedules and lack of prioritization of raising poultry were other factors mentioned for lower attendance at male engagement meetings than at meetings with primary poultry raisers.

In both study arms, CHPs visited each household until they contacted the primary poultry raiser to complete the household visit. In this way, there were no missed household visits.

Due to lower-than-anticipated attendance of male household members at male engagement meetings, male CHPs completed individual visits with male household members who were absent from either of the male engagement meetings (11 in subsidy arm and 29 in non-subsidy arm). These personal visits were done in a convenient place and time recommended by the male household members.

3.3 PRIMARY OUTCOME

3.3.1 Confining All Poultry Outside the Household Dwelling.

The proportion of households that reported confining all poultry outside the household dwelling the previous night was significantly higher at endline than at baseline (prevalence difference: 30 percentage points, 95% CI: 19 p.p. to 41 p.p.) (Table 15.3). In both study arms, the reported practice increased significantly from baseline to endline (prevalence difference: non-subsidy arm 25 p.p., 95% CI: 10 p.p. to 39 p.p.; subsidy arm 36 p.p., 95% CI: 19 p.p. to 53 p.p.). The effect size was not significant between the subsidy and non-subsidy arms (DiD: 12 p.p., 95% CI: -10 p.p. to 34 p.p.) (Table 3.4)

At endline, two of the 79 households did not have any poultry and 68 percent (52/77) of households still reported keeping some or all poultry inside the household dwelling at night. The types of poultry kept inside were healthy adult chickens[11] (69%, 36/52), healthy chicks[12] (54%, 28/52), egg-laying or brooding hens (37%, 19/52), healthy adult ducks[13] (17%, 9/52), sick chickens or chicks[14] (14%, 7/52), healthy

[11] More than two months or eight weeks old chicken without any sign symptom of diseases reported by the primary poultry raisers.

[12] Chicks without any sign symptoms of diseases reported by the primary poultry raisers.

[13] More than two months or eight weeks old ducks without any sign symptom of diseases reported by the primary poultry raisers.

[14] Adult chicken or chick with sign symptom of any disease reported by the primary poultry raisers.

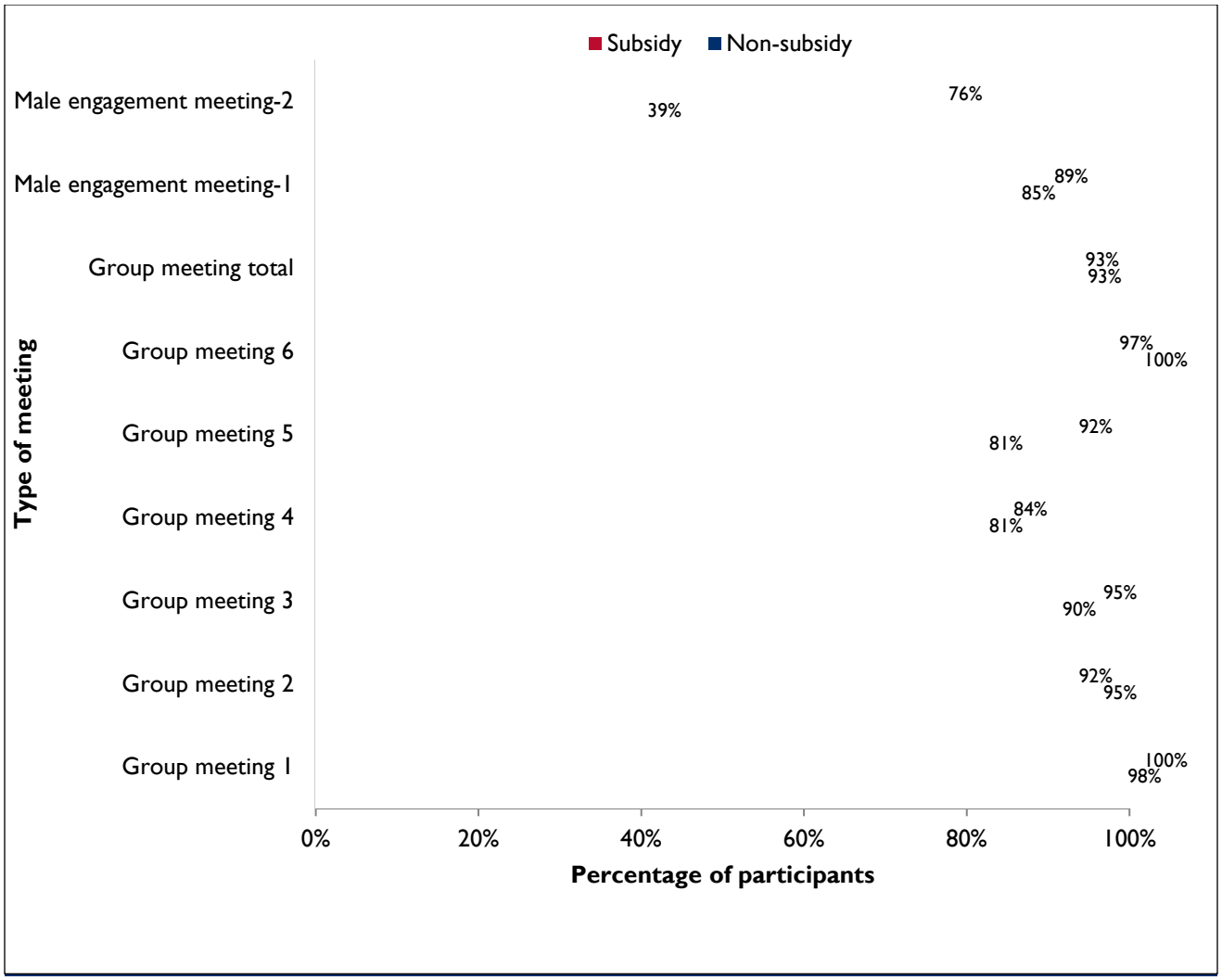


Figure 3.2: Attendance at Group Meetings and Male Engagement Meetings

ducklings[15] (14%, 7/52), and egg-laying or brooding ducks (12%, 6/52) (see Supplementary Table 3, page 36). For households with poultry at endline, 58 percent (45[16]/77) had an improved shed and 47 percent (21/45) of those with an improved shed still kept some poultry inside the household dwelling. The poultry still being housed inside the household dwelling at night were healthy adult chickens (43%, 9/21), healthy chicks (38%, 8/21), egg-laying or brooding hen (52%, 11/21), healthy adult ducks (14%, 3/21), and healthy ducklings (29%, 6/21) (see Supplementary Table 3). Twenty-seven households had a shed (i.e., either an improved or unimproved shed) and confined poultry inside. In the households that had poultry shed and still confined poultry inside, 22 percent (6/27) sheds had one, 30 percent (8/27) had two, 30 percent (8/27) had three, and 19 percent (5/27) had four compartments.

[15] Ducklings without any sign symptoms of diseases reported by the primary poultry raisers.

[16] One household with improved poultry shed did not have any poultry, so one missing value recorded.

3.4 SECONDARY OUTCOMES

3.4.1 Building an Improved Poultry Shed

When the intervention started, none of the study households in either arm had an improved poultry shed. At baseline, 17 percent (13/79) of households had an unimproved shed, whereas at endline, 58 percent of households (46/79) of households had built an improved poultry shed. At endline, combining arms, the proportion of households with an improved poultry shed was significantly higher than at baseline (Prevalence difference: 58 p.p., 95% CI: 47 p.p. to 69 p.p.) (Table 3.3). When we compared the changes in study arms, this significant increase was observed in both study arms (prevalence difference: non-subsidy arm 33 p.p., 95% CI: 19 p.p. to 48 p.p.; subsidy arm 87 p.p., 95% CI: 75 p.p. to 98 p.p.). Subsidy households were more likely to have built an improved poultry shed during the intervention period than non-subsidy ones (DiD: 53 p.p., 95% CI: 35 p.p. to 72 p.p.) (Table 3.4).

Building an improved shed requires labor, materials, and money. Of the forty-six households that had an improved poultry shed at endline, 44 reported on labor, that is, on how the shed was constructed. The improved sheds built by study households were made by a mason from the same village or other village (27/44[17], 59%), a household member (10/44, 23%), a compound member (4/44, 9.1%), or a relative outside the compound (3/44, 6.8%) (Supplementary Table 4, page 36). No primary poultry raiser built a shed by themselves. Hiring of masons from the same village or nearby villages was higher in the non-subsidy arm (10/13, 77%) than in households in the subsidy arm (17/31, 55%). Most households who used a mason to build an improved shed (23/27, 85%) reported that they faced no problems with the mason. Four households, all in the non-subsidy arm, reported problems hiring a mason (e.g., masons were busy, charged high price).

Regarding the required material for building the improved shed, 30/46 (65%) of households used at least some material they already owned, including wood, corrugated tin, brick, and other items, such as nails and plastic fruit crates. All but one non-subsidy household reported needing to buy materials to build their shed. Thirty-five percent of households (16/46) reported that they had to buy all the materials from the market and 94 percent (43/46) bought at least some material. The materials bought included wood, corrugated tin, brick, and other items (metal screws, nails, hinges, plastic sheets, plastic/metal nets, and flat wooden boards) (Supplementary Table 4).

Among the 38 poultry raisers who had an improved shed and could recall the costs of materials and installation, the average total cost was 4,520 BDT (53.35 USD) (38/46; SD: 1,440); eight respondents did not report costs. For households who hired a mason, the average labor cost was 1,331 BDT (SD: 423; 16 USD). The average cost of materials purchased from the market was 3,500 BDT (35/46 poultry raisers; SD: 1,254) (41 USD) (Supplementary Table 4).

Examples of improved sheds built by study participants are depicted in Picture 3.1.

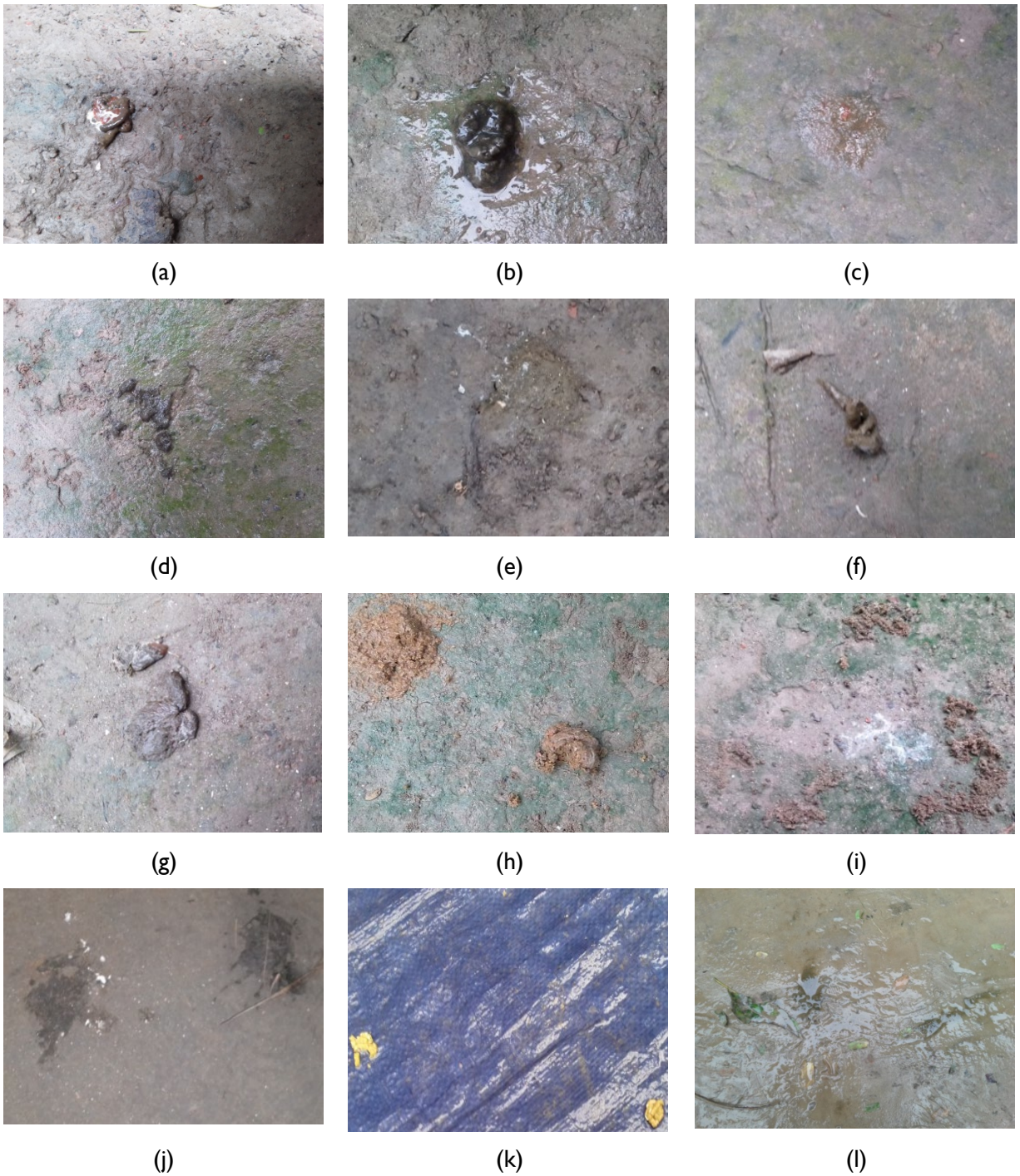
[17] Two missing values (one subsidy and one non-subsidy arm).

Picture 3.1: Improved Sheds Built by the Study Households

3.4.2 Presence of Poultry Feces

Among all the study households, significantly more households had no visible poultry feces piles inside the household dwelling (Picture 3.2) at endline than at baseline (prevalence difference: 26 p.p., 95% CI: 12 p.p. to 41 p.p.), and fewer households had 1–25 piles of feces (prevalence difference: -25 p.p., 95% CI: -39 p.p. to -11 p.p.). The presence of more than 25 piles also decreased, but the 95% CI included the null value (Table 3.3). There were no significant differences in the number of poultry feces piles in the courtyard or veranda at endline compared to baseline (Table 3.3).

Overall, comparing changes from baseline to endline, households in the non-subsidy arm had a similar level of change in the number of observed feces piles inside the household dwelling as the subsidy arm (DiD: no feces piles: -19 p.p., 95% CI: -48 p.p. to 9.2 p.p.; 1–25 feces piles: 17 p.p., 95% CI: -11 p.p. to 45 p.p.) (Table 3.4).



Picture 3.2: Poultry feces piles: Single poultry feces piles (a-f); Multiple poultry feces piles (g-l)

3.5 OTHER BEHAVIORAL OUTCOMES

3.5.1 Handwashing

Between baseline and endline, a significantly higher proportion of primary poultry raisers reported washing their hands with soap before eating (prevalence difference: 28 p.p., 95% CI: 14 p.p. to 42 p.p.), before preparing food (prevalence difference: 54 p.p., 95% CI: 43 p.p. to 66 p.p.), after handling poultry

feces (prevalence difference: 51 p.p., 95% CI: 38 p.p. to 64), after feeding poultry or handling poultry or poultry products (prevalence difference: 43 p.p., 95% CI: 32 p.p. to 54 p.p.), and after handling other animal feces (prevalence difference: 15 p.p., 95% CI: 1.5 p.p. to 29 p.p.) (Table 3.3). When we compared the changes from baseline to end line across study arms, significantly more primary poultry raisers in the subsidy arm reported washing hands after feeding or handling poultry or poultry products compared to those in the non-subsidy arm (DiD: 26 p.p., 95% CI: 3.6 p.p. to 48 p.p.) (Table 3.4).

Combining arms, the proportion of study households with access to a handwashing station with soap and water at endline compared to baseline did not significantly increase (prevalence difference: 10 p.p., 95% CI: -5.2 p.p. to 26 p.p.) (Table 3.3). When we compared the changes from baseline to endline between study arms, there was no statistically significant difference (DiD: 22 p.p., 95% CI: -9.1 p.p. to 52 p.p.) (Table 3.4).

3.5.2 Feces Disposal Pit

At endline, significantly more households had a specific pit or trash pile for disposal of poultry feces compared to baseline (prevalence difference: 44 p.p., 95% CI: 30 p.p. to 58 p.p.) (Table 3.3). A higher increase in the proportion of households were observed with a specific pit or trash pile for disposal of the poultry feces from baseline to endline occurred in the subsidy arm as compared to the non-subsidy arm (DiD: 34 p.p., 95% CI: 6.4 p.p. to 61 p.p.) (Table 3.4). Although we recommended covering pits, no pits were found covered during spot-checks conducted at the endline.

Table 3.3: Impact of NEAP intervention on primary and secondary outcomes among all the study households (Prevalence Difference from Baseline to Endline)

Indicators	Baseline (N 79) %	Endline (N 79) %	Prevalence Difference (Baseline to Endline) p.p. (95% CI))
Proportion of households that confined all poultry outside the living space at night	N=79	N=77	
	2.5%	33%	30 (19, 41)
Proportion of households with an improved[18] night shed	0	58%	58 (47, 69)
Proportion of households with any shed	17%	67%	51 (37, 64)
Poultry feces piles observed inside the household dwelling	N=79	N=78	
No feces pile	54%	81%	26 (12, 41)
1–25 feces piles	42%	17%	-25 (-39, -11)
>25 feces piles	3.8%	2.7%	-1.2 (-6.8, 4.3)
Poultry feces piles observed in the courtyard[19]	N=79	N=77	
No feces pile	0	1.3%	1.3 (-1.2, 3.8)
1–25 feces piles	15%	13%	-2.2 (-13, 8.8)
>25 feces pile	85%	86%	0.90 (-10, 12)
Poultry feces piles observed in the veranda	N=60	N=61	
No feces pile	33%	39%	6.0 (-11, 23)
1–25 feces piles	58%	54%	-4.2 (-22, 14)
>25 feces pile	8.3%	6.6%	-1.8 (-11, 7.7)
Proportion of households has access to handwashing station with water and soap/soapy water	35%	46%	10 (-5.2, 26)
Proportion of primary poultry raisers mentioned washing hands with soap and water after the following events	N=78	N=79	
After defecation	77%	66%	-10 (-24, 4.0)
After cleaning child feces	9.0%	11%	2.5 (-6.9, 12)

[18] Multi-compartmented poultry night-shed with ventilation facility located outside the living space and higher from the ground.

[19] During endline, in two households of the non-subsidy arm, the enumerators were not able to access to the courtyard to observe and count the poultry feces.

Indicators	Baseline (N 79) %	Endline (N 79) %	Prevalence Difference (Baseline to Endline) p.p. (95% CI))
Before eating	21%	48%	28 (14, 42)
Before serving food	0%	3.8%	3.8 (-0.44, 8.0)
Before preparing food	5.1%	60%	54 (43, 66)
After handling poultry feces	14%	65%	51 (38, 64)
After feeding/handling poultry or poultry product	1.3%	44%	43 (32, 54)
After handling other animal feces	19%	34%	15 (1.5, 29)
Poultry feces disposal sites (spot-check confirmed)			
Specific place	20%	65%	44 (30, 58)
Used as a fertilizer in crop field or garden	47%	20%	-27 (-41, -12)
Bush or jungle	35%	6.3%	-29 (-41, -17)
Drain or ditch	18%	3.8%	-14 (-23, -4.5)
Area beyond the courtyard	1.3%	7.6%	6.3 (-0.05, 13)
Water bodies (pond/bill)	0%	1.3%	1.3 (-1.2, 3.8)

Table 3.4: Impact of subsidy on primary and secondary outcomes among the subsidy households compared to the non-subsidy ones (Direct Comparison and Difference-in-Differences)

Indicators	Baseline %		Endline %		Prevalence Difference (Baseline to Endline)		Effect Size (Difference in Differences) p.p. (95% CI)
	Non Subsidy (n=42)	Subsidy (N=37)	Non Subsidy (N=42)	Subsidy (N=37)	Non Subsidy (N=42) p.p. (95% CI)	Subsidy (N=37) p.p. (95% CI)	
Proportion of households that confined all poultry outside the living space at night			N=41	N=36			
	2.4%	2.6%	27%	39%	25 (10, 39)	36 (19, 53)	12% (-10, 34)
Proportion of households with an improved[20] night shed	0	0	33%	87%	33 (19, 48)	87 (75, 98)	53% (35, 72)
Poultry feces piles observed in the household dwelling							
No feces pile	50%	60%	85%	77%	35 (17, 55)	16 (-5.1, 38)	-19 (-48, 9.2)
1–25 feces piles	45%	38%	12%	22%	-33 (-51, -15)	-16 (-37, 4.6)	17 (-11, 45)
>25 feces piles	4.8%	2.7%	2.4%	2.7%	-2.3 (-10, 5.8)	0.0 (-7.5, 7.5)	2.3 (-8.8, 14)
Poultry feces piles observed in the courtyard[21]			N=40	N=37			
No feces pile	0	0	0	2.7%	-	2.7 (-2.6, 8.0)	2.7% (-2.3, 7.7)
1–25 feces piles	21%	8.1%	13%	14%	-8.9 (-25, 7.5)	5.4 (-8.9, 20)	14% (-7.6, 36)
>25 feces piles	79%	92%	88%	84%	8.9 (-7.5, 25)	-8.1 (-23, 6.9)	-17% (-39, 5.3)
Poultry feces piles observed in the veranda	N=35	N=25	N=35	N=26			
No feces pile	43%	20%	46%	31%	2.9 (-21, 27)	11 (-13, 35)	7.9 (-27, 43)
1–25 feces piles	57%	60%	54%	54%	-2.9 (-27, 21)	-6.2 (-34, 22)	-3.3 (-40, 33)
>25 feces piles	0	20%	0	15%	-	-4.6 (-26, 17)	-4.6 (-23, 14)
Proportion of households that have access to handwashing station with water and soap/soapy water	41%	30%	41%	51%	0.0 (-21 - 21)	22 (-0.50, 44)	22 (-9.1, 52)
Proportion of primary poultry raisers who mentioned washing hands with soap and water after the following events	N=42	N=36					
After defecation	83%	69%	79%	51%	-4.8 (-22, 12)	-16 (-39, 6.2)	-12 (-39, 16)
After cleaning child feces	12%	5.6%	12%	11%	0.0 (-14, 14)	5.4 (-7.1, 18)	5.4 (-14, 24)

[20] Multi-compartmented poultry night-shed with ventilation facility located outside and higher from the ground.

[21] During endline, in two households of the non-subsidy arm, the enumerators were not able to access to the courtyard to observe and count the poultry feces.

Indicators	Baseline %		Endline %		Prevalence Difference (Baseline to Endline)		Effect Size (Difference in Differences) p.p. (95% CI)
	Non Subsidy (n=42)	Subsidy (N=37)	Non Subsidy (N=42)	Subsidy (N=37)	Non Subsidy (N=42) p.p. (95% CI)	Subsidy (N=37) p.p. (95% CI)	
Before eating	26%	14%	55%	41%	29 (8.2, 49)	27 (7.5, 47)	-1.5 (-30, 27%)
Before serving food	0	0	2.4%	5.4%	2.4 (-2.3, 7.1)	5.4 (-2.0, 13)	3.0 (-5.5, 12)
Before preparing food	7.1%	2.8%	67%	51%	60 (43, 76)	49 (32, 66)	-11 (-35, 13)
After handling poultry feces	12%	17%	55%	76%	43 (25, 61)	60 (41, 78)	17 (-9.4, 43)
After feeding/handling poultry or poultry product	2.4%	0	33%	57%	31 (16, 46)	57 (41, 73)	26 (3.6, 48)
After handling other animal feces	7.1%	33%	19%	51%	12 (-2.5, 26)	19 (-3.5, 41)	7.0 (-19, 33%
Proportion of households that dispose of poultry feces in a specific pit/trash	33%	5.4%	62%	68%	29 (7.9, 49)	62 (45, 79)	34 (6.4, 61)

3.6 IMPACT OF OWNERSHIP OF SHED ON SELECTED STUDY OUTCOMES

We assessed the impact of having an improved shed or any shed on the study outcomes during endline. Combining arms, during endline, 53 households had any shed., of which 46 were improved sheds and 7 were unimproved. Twenty-six households had no shed at endline. Significantly more households with an improved shed or any shed confined all poultry outside at night (prevalence difference: 50 p.p., 95% CI: 32 p.p. to 69 p.p. and 48 p.p., 95% CI: 28 p.p. to 68 p.p., respectively). Households with improved poultry sheds had less poultry feces inside their household dwelling; however, with small sample size, the difference was small and was not statistically significant (Table 3.5).

Table 3.5: Impact of Improved Shed and Any Shed on Study Outcomes at Endline

Outcomes[22]	Has Improved Shed			Has Any Shed		
	Yes	No	Prevalence Difference (95% CI)	Yes	No	Prevalence Difference p.p. (95% CI)
Reported confining all poultry outside the household dwelling at night	N=45	N=32		N=52	N=25	
	53%	3.1%	50% (32%, 69%)	48%	0%	48 (28, 68)
No poultry feces observed inside the household dwelling	N=45	N=33		N=52	N=26	
	82%	79%	3.4% (-15%, 21%)	85%	73%	12 (-7.1, 30)
No poultry feces on veranda	N=33	N=28		N=40	N=21	
	33%	46%	-13% (-38%, 12%)	38%	43%	-5.4 (-32, 21)
≤25 poultry feces piles in the courtyard	N=44	N=33		N=51	N=26	
	14%	15%	-1.5% (-18%, 15%)	12%	19%	-7.5 (-24, 9.2)
Disposed of poultry feces in a specific place	N=46	N=33		N=53	N=26	
	72%	55%	17% (-4.1%, 39%)	68%	58%	10 (-12, 33)

3.7 IMPACT OF POULTRY CONFINEMENT AT NIGHT ON POULTRY FECES PRESENCE IN THE HOUSEHOLDS

We also explored if confining all poultry outside at night impacted the presence of poultry feces in the household premises. We found that households that confined all poultry outside at night had less feces inside the household dwelling and courtyard; but this may be due to small sample size. The impact was not statistically significant (Table 3.6).

Table 3.6: Impact of Poultry Confinement at Night on Poultry Feces Presence in the Households

Outcomes	Confined All Poultry Outside		
	No (N=52)	Yes (N=25)	Prevalence Difference p.p. (95% CI)
Poultry feces piles observed inside the household dwelling	N=51[23]	N=25	
No feces pile	75%	92%	18 (-1.4, 36)
1–25 feces piles	22%	8.0%	-14 (-32, 4.4)
>25 feces piles	3.9%	0%	-3.9 (-12, 3.8)
Poultry feces piles observed in the courtyard	N=51	N=24[24]	
No feces pile	0%	0%	-
1–25 feces piles	12%	13%	0.74 (-15, 17)
>25 feces piles	88%	88%	-0.74 (-17, 15)

[22] Due to missing values, there are different N for different outcomes.

[23] One household dwelling could not be accessed during endline.

[24] Courtyard of one household could not be accessed during endline.

Outcomes	Confined All Poultry Outside		
	No (N=52)	Yes (N=25)	Prevalence Difference p.p. (95% CI)
Poultry feces piles observed on the veranda[25]	N=40	N=19	
No feces pile	38%	37%	-0.66 (-28, 26)
1–25 feces piles	58%	53%	-4.9 (-32, 23)
>25 feces piles	5.0%	11%	5.5 (-8.4%, 19)

3.8 MALE HOUSEHOLD MEMBERS' ENGAGEMENT IN POULTRY-RAISING ACTIVITIES

Given that our intervention specifically aimed to engage men more in poultry housing improvement and poultry feces management, Figure 3.3 presents male household members' engagement in poultry-raising activities at both baseline and endline, as per the primary poultry raiser's (female) report. Adult men were often involved in slaughtering poultry; building or repairing sheds or other housing; and buying medicines, vaccines, or feed. At the endline, we found a slight increase in participation of adult male household members in feces management practices and a marginal increase in construction/repairing of poultry night sheds. Between baseline and endline, male household member involvement in other poultry-raising activities also changed; these changes may be due to differences in seasons, flock composition, or other factors not fully explored in this study.

3.9 CHANGES IN FEMALES' INVOLVEMENT IN POULTRY-RELATED DECISION MAKING AND CONSUMPTION OF POULTRY AND POULTRY PRODUCTS FROM BASELINE TO ENDLINE

We explored changes in female household members' (both primary poultry raisers and other adult female members) involvement in poultry-related decision making and control over earned money and consumption of poultry and poultry products from baseline to endline.

Compared to baseline, a higher number of female household members during endline were reported to make decisions regarding selling of poultry eggs during the previous two weeks (prevalence difference: 60 p.p., 95% CI: 23 p.p. to 97 p.p.) and control of earnings from selling poultry eggs (prevalence difference: 46 p.p., 95% CI: 9.1 p.p. to 83 p.p.) (see Supplementary Table 5, page 38). As we did not have any control arm to compare the intervention's effect on those indicators, we cannot conclude if observed changes were due to our intervention or not.

We did not find any significant changes in prevalence of household produced egg consumption by females, females' decision to sell poultry, females' control over earnings from selling poultry, females' decision making power to slaughter household's poultry, or consumption of slaughtered poultry by females (Supplementary Table 5). Our intervention did not result in any loss of poultry-related decision-making or control of earnings among female household members.

[25] All households did not have a veranda.

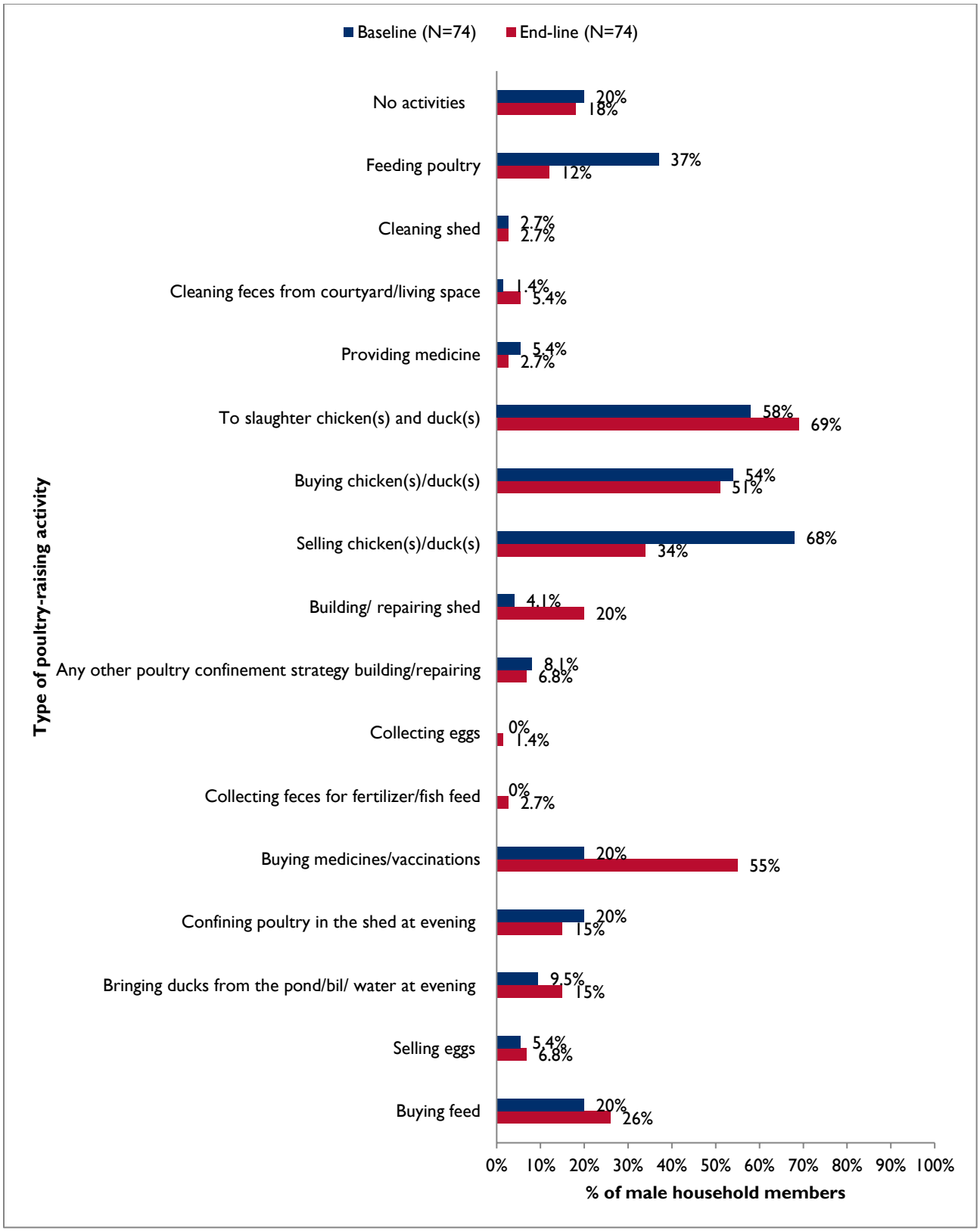


Figure 3.3: Changes in the Male Household Member's Involvement in Different Poultry-Raising Activities from Baseline to Endline

3.10 CHILDREN'S EXPOSURE TO POULTRY AND POULTRY FECES

There were changes in only a few of the indicators related to caregiver reports of children's exposure to poultry and poultry feces from baseline to endline. At endline, significantly fewer respondents reported seeing the target child entering into poultry housing or touching poultry feces in the previous week, compared to baseline. Significantly fewer poultry raisers reported seeing poultry feces inside the household dwelling (Table 3.7).

Table 3.7: Changes in Children's Exposure to Poultry or Poultry Feces from Baseline to Endline

Indicators	Baseline (N 79) %	Endline (N 79) %	Prevalence difference p.p. (95% CI)
Proportion of respondents reported seeing target children play with or grab poultry	N=42	N=44	
Never	26%	21%	-5.7 (-24, 12)
Within one week	50%	34%	-16 (-37, 4.9)
Proportion of respondents reported seeing target children entering into the shed or other poultry confinement areas	N=42	N=44	
Never	29%	36%	7.8 (-12, 28)
Within one week	55%	23%	-32 (-52, -12)
Proportion of respondents reported seeing target children touch poultry feces	N=42	N=44	
Never	21%	32%	10 (-8.4, 29)
Within one week	31%	9.1%	-22 (-38, -5.5)
Proportion of respondents reported seeing target children put poultry feces in mouth	N=42	N=44	
Never	62%	66%	4.0 (-17, 25)
Within one week	2.4%	0	-2.4 (-6.9, 2.2)
Proportion of respondents reported seeing target children step on poultry feces	N=42	N=44	
Never	9.5%	16%	6.4 (-7.8, 21)
Within one week	71%	61%	-10 (-30, 10)
Proportion of respondents reported seeing poultry eating food from the main serving dish or person's plate			
Never	8.9%	15%	6.3 (-3.8, 17)
Within one week	53%	43%	-10 (-26, 5.5)
Proportion of respondents reported seeing poultry entering the child's sleeping room	N=42	N=44	
Never	7.1%	4.6%	-2.6 (-13, 7.4)
Within one week	88%	84%	-4.0 (-19, 11)
Proportion of respondents reported seeing open poultry feces in the household dwelling			
Never	6.3%	8.9%	2.5 (-5.8, 11)
Within one week	89%	72%	-17 (-29, -4.3)

3.11 SELF-EFFICACY

We explored primary poultry raisers' perceptions of the ease/difficulty of poultry raising and certain poultry raising practices and the primary poultry raisers' assessments of their capability to maintain and continue the use of poultry sheds (Table 3.8). At endline, primary poultry raisers considered poultry raising easier than they had at baseline. Despite the lack of an observed reduction of poultry feces in courtyards, significantly more primary poultry raisers rated keeping their courtyard free from poultry feces as "very easy" at endline, compared to baseline. At endline, most participants were not confident in their own ability to repair a damaged shed but were confident in their ability to find someone to

repair it. This finding was not surprising, given that primary poultry raisers in this setting were all women and it is usually male household members who have the skills and tools for repair and maintenance of structures like sheds. Most poultry raisers were confident that they would continue using their shed for housing poultry during the rainy season.

Table 3.8: Primary Poultry Raiser's Self-Efficacy Related to Raising Poultry, Cleaning Poultry Feces from the Courtyard, Repairing the Shed, and Using the Shed

Indicators	Baseline (N 79) %	Endline (N 79) %	Prevalence Difference (Baseline to Endline) p.p. (95% CI)
Respondent considers raising poultry:			
Very difficult	2.5% (2)	2.5% (2)	0 (-4.9, 4.9)
Difficult	28% (22)	18% (14)	-10 (-23, 2.9)
Not easy nor difficult	8.9% (7)	7.6% (6)	-1.3 (-9.9, 7.4%
Easy	53% (42)	37% (29)	-17 (-32, -1.1)
Very easy	7.6% (6)	35% (28)	28 (16, 40)
Respondent consider keeping courtyard free from poultry feces:			
Very difficult	30% (24)	27% (21)	-3.8 (-18, 10)
Difficult	43% (34)	33% (26)	-10 (-25, 5.0)
Not easy nor difficult	8.9% (7)	12% (9)	2.5 (-6.9, 12)
Easy	17% (13)	20% (16)	3.8 (-8.3, 16)
Very easy	1.3% (1)	8.9% (7)	7.6 (0.82, 14)
Respondent's confidence in the ability to repair the damaged poultry shed by themself:		N=44[26]	
Not at all confident	N/A	61% (27)	N/A
A little bit less confident	N/A	4.6% (2)	N/A
Neutral	N/A	-	N/A
A little bit more confident	N/A	23% (10)	N/A
Very confident	N/A	11% (5)	N/A
Respondent's confidence in the ability to find someone to repair the damaged poultry shed:		N=44	
Not at all confident	N/A	9.1% (4)	N/A
A little bit less confident	N/A	2.3% (1)	N/A
Neutral	N/A	6.8% (3)	N/A
A little bit more confident	N/A	2.3% (1)	N/A

[26] Two missing values

Indicators	Baseline (N 79) %	Endline (N 79) %	Prevalence Difference (Baseline to Endline) p.p. (95% CI)
Very confident	N/A	80% (35)	N/A
Respondent's confidence to continue using the poultry shed during rainy season:		N=44	
Not at all confident	N/A	-	N/A
A little bit less confident	N/A	4.6% (2)	N/A
Neutral	N/A	4.6% (2)	N/A
A little bit more confident	N/A	14% (6)	N/A
Very confident	N/A	77% (34)	N/A

3.12 SHARING THE INTERVENTION BEYOND ENROLLED PARTICIPANTS

Sixty-six percent (52/79) of primary poultry raisers reported that they discussed the intervention with people who were not enrolled or otherwise part of the project, including neighbors (42/52, 81%), parental relatives (24/52, 46%), in-laws (19/52, 37%), other people from the same village (17/52, 33%), and friends or other people from another village (2/52, 3.9%). Thirteen primary poultry-raisers reported that the persons with whom they discussed the project had since built poultry sheds, even though they were not part of the project.

3.13 ECONOMIC IMPACT OF COVID-19 ON THE STUDY HOUSEHOLDS

We conducted our study amid the COVID-19 pandemic. As our study required that households allocate valuable resources to build improved poultry sheds and follow other recommendations, we explored the self-reported economic impact of COVID-19 among our study households. One-fourth (19/79) of the study households reported that, since the COVID-19 pandemic, at least one household member had to change employment; in slightly more than half of these cases (11/19, 58%), the main earning member of the household had become unemployed. More than half of study households (46/79, 58%) reported that their income had been reduced or zeroed, while 33/79 (42%) said income was static or had increased (Table 3.9). Reported changes in income were similar across study arms.

To cope with the negative economic impact of COVID-19, households either started consuming cheaper foods, reduced meal portions and frequency, tried to earn additional money from other sources, used previous savings, or had taken a loan from others. The economic impact of COVID-19 is summarized in Table 3.9.

Table 3.9: Self-Reported Economic Impact of COVID-19 on the Study Households (January to February 2021)

Indicator	Non subsidy (N 42)	Subsidy (N 37)	Total (N=79)
Proportion of households' members' employment changed since COVID-19 pandemic	21% (9)	27% (10)	24% (19)
Type of employment changes reported by the households	N=9	N=10	N=19
Main earning member became unemployed	67% (6)	50% (5)	58% (11)
The main earning member had a temporary job	22% (2)	30% (3)	26% (5)
Main earning member was a day laborer	11% (1)	0 (0)	5.3% (1)
Other household members started earning from a temporary source	11% (1)	30% (3)	21% (4)
Less work/decreased salary of the household members	44% (4)	60% (6)	53% (10)

Indicator	Non subsidy (N 42)	Subsidy (N 37)	Total (N=79)
Reported status of household income since COVID-19 pandemic			
No income	2.4% (1)	2.7% (1)	2.5% (2)
Less than previous	57% (24)	54% (20)	56% (44)
Same as previous	29% (12)	27% (10)	28% (22)
More than previous	12% (5)	16% (6)	14% (11)
Proportion of households had to take measures to fulfill the basic needs of the households	48% (20)	41% (15)	44% (35)
Reported ways followed by the households to fulfill the basic needs of the households in the previous seven days	N=20	N=15	N=35
Tried to earn additional money	15% (3)	33% (5)	23% (8)
Reduced number or size of meals for some household members	20% (4)	33% (5)	26% (9)
Relied on less preferred or less expensive food	80% (16)	67% (10)	74% (26)
Used cash or bank savings	15% (3)	33% (5)	23% (8)
Borrowed food/got help from friends/relatives/neighbor	5% (1)	0 (0)	2.9% (1)
Relied on government/nongovernmental organization assistance	5% (1)	0 (0)	2.9% (1)
Relied on donations	5% (1)	0 (0)	2.9% (1)
Took loan from someone else	20% (4)	20% (3)	20% (7)
Other (e.g., bought products from the store on credit, had to pay the installments)	10% (2)	0 (0)	5.7% (2)

3.14 QUALITATIVE RESULTS

3.14.1 Barriers and Facilitators to Building an Improved Poultry Shed

We interviewed 30 participants (21 primary poultry raisers and nine male household members) over the course of the intervention period, including 14 doers and 16 non-doers. We identified several motives, facilitators, and constraints to building an improved poultry shed in our study population through these interviews. Although there were common themes across interviews, there was also variation in how themes manifested in enrolled households.

3.14.2 Motivating Reasons for Building a Poultry Shed

Almost every participant we interviewed (28/30) said that they had built their improved shed or planned to build one out of concern for child or family health. Both doers and non-doers said that, before the intervention, they had not been aware of the health risks to humans from exposure to poultry feces. Field notes from one interview describe one non-subsidy doer's experience:

> *At first, she said that building a shed was not a priority because she had a storeroom far from her own house where she was keeping her poultry. When she opens the storeroom door, her child goes inside (with her) and sometimes touches the poultry and poultry feces. Because of the group meetings, she was more concerned…she discussed with her husband and decided to build a shed.*

Almost half of participants interviewed said that poultry health and/or safety was a main motivation for building an improved poultry shed. Other reasons given for building a shed or planning to do so were: the smell of poultry/poultry feces inside the household (5); because poultry feces inside the house provoked irritation and embarrassment (4); to be able to raise more poultry (2); because cleaning a shed was easier/more convenient (2); and because the project provided monetary support (3). Motivating reasons for building an improved poultry shed sometimes differed within households and compounds. For example, one doer noted that while her motivation to build a shed had been her child's health, her husband's motivation had been poultry health.

3.14.3 Availability and Access to Money, Materials, and Labor

Most doers we interviewed had to obtain the money and materials needed to build their shed from multiple sources. Several doers (subsidy and non-subsidy) reported taking out loans from family members or a local organization to pay for their shed. However, one non-doer said that he was unwilling to take a loan, as it could create conflict with lenders. He also said that taking out a loan was not permitted by his religion (Islam). Regarding materials, while some households had wood or tin on hand, every participant we interviewed as part of the qualitative follow-up had to purchase some, if not all, construction materials. A small number of households also purchased materials on credit from vendors in the market; others borrowed materials from family materials.

Several non-doers cited the high cost of building a shed and lack of cash on hand as barriers to building one. One participant explained that the construction cost quoted by a mason had been too high and all four households in the compound had therefore lost interest in building a shed. Some households were working to pay off existing loans, leaving little extra cash on hand. Other financial constraints mentioned were poor returns on a recent harvest, a recent high-cost purchase, and job loss.

Based on formative research findings, we expected that having a male household member who was a mason would serve as a facilitator for building a shed. However, two subsidy non-doers said the only delay to building their sheds was that their husbands (masons) lacked time to complete construction.

3.14.4 Household and Family Involvement in Building a Poultry Shed

Doers in both arms mentioned immediate and extended family members providing or loaning materials or money for sheds or encouraging participants to move forward with building a shed. One subsidy doer said he had, at first, refused to do anything without full project support, which meant he did not receive the subsidy. However, his mother then encouraged him to purchase some materials so that he could receive the subsidy and build the shed. However, involving family members could also lead to refraining from building a shed. One non-subsidy non-doer said he had consulted with his son, who had recommended to wait to build the shed until a planned household renovation.

3.14.5 Dynamics in Intervention Groups (Neighborhoods) and Villages

The households that built sheds in one non-subsidy village were mostly members of two intervention groups (neighborhoods). One participant said that her group had met often to discuss how to secure the materials and finances required to build a shed. In the non-subsidy village where no households had built sheds, participants said they did not talk with other intervention participants.

In both arms, participants said that seeing other members in their group building sheds made them want to follow suit.

3.14.6 Intervention – Design, Timeline, and Subsidy Provision

Several subsidy doers said that they would not have built a shed without the provided support or that it would have taken much longer to build one. Others said that the intervention had provided an opportunity to act on something they had wanted to do previously, or the support needed to convince male household members that building a shed was a priority. However, a few participants also said that they felt some pressure to build a shed due to the provision of the subsidy and/or frequent visits to households by CHPs and other project staff.

We also found that the intervention timeline (three months) was too short for some households to arrange the cash, materials, or labor needed for a shed. A few households said they were waiting to build a shed until a household renovation took place or until funds or materials were available.

3.14.7 Differences Between Doers and Non-Doers

When asked why some households were building sheds and others were not, most participants responded that financial constraints were the likely problem. However, a few participants noted that lack of funds was not the sole problem, saying that prioritizing building sheds, recognizing benefits, and general willingness or eagerness to build were also required.

3.15 BARRIERS AND FACILITATORS TO HANDWASHING AND FECES MANAGEMENT BEHAVIORS

3.15.1 Handwashing Recommendations

Many participants listed the project's recommended handwashing times and said they were following the recommended practice. Participants also said their handwashing practices had changed since the intervention, such as more handwashing with soap before feeding a child or eating. One participant said that, before the intervention, she did not wash her hands with soap after touching poultry and eggs, but that now she was washing her own hands and her child's hands if they came into contact with poultry. Another participant said that she previously did not wash her hands with soap after removing poultry feces because she used a "*cheni*" (farming tool) for feces disposal, and no feces came into contact in her hands. However, after attending the group meetings, she learned that germs could be on the *cheni* too, so she started washing her hands after feces removal. Participants said that they did not face any difficulties with handwashing with soap recommendations.

3.15.2 Soapy Water Bottle

Participants said that soapy water was easy to use. However, some participants preferred to use bar soap. Others had tried to use the soapy water bottle but had to stop using it because children would play with it and spill it. Some participants hung up their soapy water bottles so that children could not destroy or spill it.

Through our interviews, we learned that only the female household members who stay at home, and sometimes the children who are at home, used the soapy water. One reason male household members did not use the soap water was that men spend their day outside the home. A future iteration of our intervention should recommend that a soapy water bottle be made for household members to take when they leave their homes.

In one household, a child tried to drink the soapy water, thinking it was drinking water. Elevating the soapy water bottle out of reach of young children is an important future recommendation. One child sold/traded the soapy water bottle in another household to buy a snack from a local vendor. This indicates that some outside of intervention households recognized the value of the soapy water bottle.

3.15.3 Cleaning/Removing Poultry Feces

Participants said that they had started cleaning poultry feces as soon as they saw them, rather than waiting, because of the intervention. Participants mentioned concern for children or other family members touching or stepping on poultry feces. One participant said she was concerned that children would spread the poultry feces everywhere because it would get on their hands and feet. Another participant said that she has been cleaning poultry feces more and that it has become a habit to clean the feces more regularly.

One participant said she uses a separate *cheni* for cleaning poultry feces and washes it after using it. She said she had two *chenis* before the intervention, but that after the intervention, she designated the older *cheni* for cleaning feces only and the newer one for agricultural purposes.

3.15.4 Digging a Pit for Poultry Feces Disposal

Participants said that, prior to the intervention, they had disposed of poultry feces "here and there." Participants who built a pit said they were disposing of feces there, with one reason being so that germs could not spread and children could not come into contact with poultry feces.

One participant said she made the pit with the help of her husband; before the intervention, they disposed of poultry feces into the cow dung hole. She added: "If you build a pit, poultry feces can be disposed of there, and poultry would not scratch the waste." She also noted that when the pit filled up, she could use the feces as compost.

Not all participants built a specific pit for poultry feces disposal. One reason for not building a pit was that there was only a small amount of poultry feces from the household poultry. Available space for a pit was another issue.

3.16 INVOLVEMENT OF MALE HOUSEHOLD MEMBERS IN THE INTERVENTION

Most poultry raisers said that their husbands, fathers, fathers-in-law, brothers, and/or sons provided financial, labor, or other support during the intervention. Importantly, male and female participants reported that men's interest and support for constructing a poultry night shed increased after attending meetings and learning about the benefits of keeping poultry outside the house at night. Both male and female participants said that including men in the intervention was important. Below are two quotes from participants when asked about the importance of male involvement in the intervention:

> *(To make a shed) two people are needed, both need to listen, both need to understand, and both need to work together. (Men) will listen to women, but even if they listen, they will say "I won't do this, leave it." When you (the study team) do the research and tell a man that this is how you do it…the man will say, "Let us do it…" That is why men must go to meetings. Men need to be involved in building a shed…(referring to shed) a mason needs to be looked for, this needs to be made by me, and this needs to be outsourced. When it is about finances, men need to take care of it.* – Male household member

> *We learned many things in the meetings, but we cannot share in detail with (the male household members). So, if you (project staff) conduct the same meeting with men, they would know the same (as us) and understand and feel interested. In a family, if one is interested in doing something but the other is not, then it would not be possible to do it. Both can make it happen.* – Female poultry raiser

According to participants, male household members usually met with masons and/or purchased materials. As expected, some male participants constructed sheds themselves. Some male participants took time off work to supervise the construction of sheds. One participant said that he had taken this time to make sure that the shed included the recommended multiple compartments and ventilation. Some male participants said they would build the shed themselves but had not done so by endline.

3.17 HOUSEHOLD PROBLEM-SOLVING TO ADOPT BEHAVIORAL RECOMMENDATIONS TO SEPARATE YOUNG CHILDREN FROM POULTRY/POULTRY FECES

Financial constraints, access to labor and materials, and lack of interest were the main barriers to building an improved shed mentioned by study participants and CHPs. Some of the solutions that households applied to address these barriers mentioned above were using existing materials, borrowing material or money, or building the shed themselves rather than hiring a mason. CHPs reported additional problem-solving tactics employed by participants and/or CHPs. These included:

- Building a single-story, multi-compartment shed rather than a two-story, multi-compartment shed;
- Building a shed with lower-end materials rather than higher-end, higher-cost materials;

- Having the CHP speak with the male household member by phone if a male household member was living/working outside the village;
- Selling poultry or other animals to pay for the cost of materials and/or labor;
- Hiring a mason not trained by the project, if a project-trained mason was quoting a higher cost than the household could afford;
- Taking the model shed to the mason to help with design discussions and price negotiation;
- CHPs encouraging primary poultry raisers to discuss building the shed with male household members, asking them to prioritize this discussion and find time to do so, even if male household members were not often at home; and,
- CHPs were helping with negotiations with masons.

3.18 FEASIBILITY OF DELIVERING NEAP AT SCALE BY COMMUNITY HYGIENE PROMOTERS

As documented above, the NEAP intervention was successful at encouraging poultry-raising households to build an improved poultry shed, confine poultry outside of the household dwelling at night, reduce/prevent poultry feces in the household dwelling, and dispose of poultry feces in a specific place away from the children's reach. The NEAP intervention included 15 touchpoints with community and household (1 community engagement meeting, 6 group meetings with poultry raisers, 6 household visits with poultry raisers, and 2 male engagement meetings); participants should have received between 3 and 13 touchpoints with CHPs.

In this pilot study, due to COVID-19 limitations, intervention delivery was completed over three months. In more ordinary intervention conditions, touchpoints could be spread over a longer period to reduce time and effort needed by CHPs and frequency of touchpoints. Having a group session monthly instead of bi-weekly may be more scalable. Future iterations of the NEAP intervention might also consider trying to have fewer, longer group sessions rather than multiple, shorter sessions.

Due to the ongoing COVID-19 pandemic, the NEAP intervention was delivered by CHPs in place of icddr,b intervention staff. While there were some limitations to this approach, overall, we found that with rigorous training and continuous supervision, it is both feasible and acceptable to deliver the NEAP intervention by CHPs.

To assure the fidelity of the intervention under the pilot context, the CHP supervisors observed a total of 75 CHP touchpoints with participants as a part of process monitoring, including group meetings, household visits, and male engagement meetings (41 observation/monitoring visits in the non-subsidy arm and 34 monitoring in the subsidy arm). The performance of CHPs was comparable across study arms (see Supplementary Table 2, page 36). Overall, most CHPs' performance was good or very good. While findings suggest that ongoing training and supervision strengthen the effectiveness of CHP visits, our contact with CHPs was particularly intensive because this is a pilot study and we wanted to assure that changes in household behavior were not limited by inadequate CHP performance. We suggest such intensity would not be required under more ordinary intervention circumstances.

During qualitative interviews, a small number of participants mentioned feeling some pressure to build a shed due to the CHP's frequent visits. One participant said that recommendations given by CHPs may not be taken as seriously as those given by intervention staff.

4.0 CONCLUSION

The NEAP intervention was successful at encouraging poultry-raising households to build an improved poultry shed, confine poultry outside of the household dwelling at night, reduce/prevent poultry feces in the household dwelling, and dispose of poultry feces in a specific place away from the children's reach. Households that received the subsidy were more likely to construct an improved poultry shed than households that did not receive the subsidy. Additional research is needed to explore sustained uptake of behavioral recommendations and opportunities to improve intervention content and delivery to make the intervention more impactful. Future investigation should assess whether changes to poultry raising practices result in reduced fecal contamination of the domestic environment (as measured by the concentration of *E. coli* present in soil and on fomites), improved child health outcomes, and improved poultry health outcomes.

In this pilot study, we found that households receiving a monetary subsidy were more likely to build an improved poultry shed within the intervention period (three months) compared to households that did not receive a subsidy. However, some households in the non-subsidy arm were able to build a shed without monetary support (Table 3.4). In the absence of a subsidy, households may need several months to accumulate the money and materials to build a shed. Subsidies may be especially useful for intervention programs with short implementation periods and may serve as incentives to prioritize building a shed over other resource-intensive tasks. Future iterations of the NEAP intervention might consider alternatives to subsidies that support households with financial and other resource constraints, such as group or individual loans. It is possible that some households still need subsidies even with longer project duration. In that case, targeted subsidies may be considered.

As part of the pilot study, we explored whether having an improved shed enabled poultry raisers to house their poultry outside the household dwelling. Our data suggests that having an improved poultry shed does serve as an enabling technology for confining poultry separate from people at night (Table 3.5). We also explored if having an improved poultry shed would reduce the presence of poultry feces in the household dwelling and courtyard. Although households with improved poultry sheds had fewer poultry feces piles inside the household dwelling, the difference was small and could be due to chance alone. The small sample size of this study limited this analysis; future studies with a larger sample size should explore this research question further.

Due to the COVID-19 pandemic, the NEAP intervention was delivered by CHPs hired from the intervention communities. We rigorously trained, supervised, and evaluated CHPs throughout the study period. Based on our assessment, it is both feasible and acceptable to train local residents from intervention communities as CHPs to deliver this intervention. Our learnings from this pilot study have application to other similar programs. Based on our experience, we would recommend training CHPs incrementally rather than training on the entire curriculum at once for a multi-touch-point intervention. We would also recommend some contact by external program staff to help assert the credibility of CHPs. Finally, process monitoring and supervision are important to ensure the intervention is being delivered as designed.

In this intervention, our target audience was ultimately all adult household members of poultry-raising households. While most intervention components were designed to support primary poultry raisers (who were all female in this study), we also targeted adult male household members. As predicted, the support of adult male household members in allocating household resources toward building a poultry shed was crucial. Male household member involvement in the intervention was viewed as important and appreciated by both male and female participants. The NEAP intervention design provides a model for future WASH and child health interventions to include male household members as both a target audience and target for behavioral recommendations. Future interventions should carefully consider

men's work schedules and motivations for participating in the intervention and reallocating household resources. Although we observed a small increase in men's involvement in poultry feces management, our findings did not suggest that men took on additional workload related to poultry raising. Future interventions might explore additional opportunities for male household members to support the workload related to poultry raising. Future interventions could consider conducting household visits with both male and female household/family members to facilitate communication about building a shed. Future interventions might also consider adding modules for female poultry raisers to facilitate communication with male household or family members. During male engagement meetings, more emphasis can be given on couple communication or talking about the benefits of women making decisions regarding poultry management or listening to women before making decisions. Lastly, future interventions might also consider training women in masonry related to building and repairing poultry housing, which could benefit both male- and female-headed households, ensuring that women continue to see tangible benefits of taking this on, rather than further burdening them.

Post-intervention, more female household members were reported to make decisions regarding the selling of eggs and have control of earnings from selling eggs. We did not observe any impact on household-produced egg consumption by female household members, the ability for women to make decisions to sell poultry, control over earnings from selling poultry, or consumption of slaughtered poultry by females. Nor did we find any significant changes in prevalence of household-produced egg consumption by females, females' decision to sell poultry, females' control over earnings from selling poultry, females' decision-making power to slaughter household's poultry, or consumption of slaughtered poultry by females. We can assert that our intervention did not result in any loss of poultry-related decision-making or control of earnings among female household members. Future interventions could consider including intervention content to improve women's self-efficacy on communication with men and negotiation of resources, while at the same time working with men and women to shift norms around the value of women's input in decision-making and control of resources related to and resulting from poultry husbandry.

This study has several limitations. First, the study was conducted during a pandemic, which caused the Bangladeshi government to stop most transportation and economic activity in the country for several weeks. As a result, some enrolled households experienced a loss of income. In a non-pandemic situation, more households may have been able to build sheds during the study period. Second, this study was designed to assess trends in behavior change and to test the need for a subsidy to build a poultry shed in this setting. We did not have a control group and we were not powered to generate conclusive evidence to detect small effects with high confidence. However, even with limited sample size, we saw indicative evidence of behavioral uptake. Finally, we were not able to assess whether or not the improved poultry raising practices promoted will improve child health and poultry health and productivity outcomes.

Future studies are required to establish if the NEAP approach can lead to sustained changes in improved poultry housing and feces management practices that reduce children's exposure to poultry feces and reduce the risk of infection with *Campylobacter*. Future studies are also required to explore whether improved poultry housing and feces management improves poultry health and productivity.

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SUPPLEMENTARY TABLES

- Supplementary Table 1: Phase II Process Monitoring and Documentation Summary
- Supplementary Table 2: CHPs' Performance According to the Perspective of the Supervisor
- Supplementary Table 3: Types of Poultry Housed Inside the Household Dwelling During Endline
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Supplementary Table 1: Phase II process monitoring and documentation summary

Tools	Objective(s)	Responsible Person for Data Collection	Frequency	Type of Data Collected
Group meeting daily record form	Record the attendance, duration, and challenges of each group meeting/male engagement meeting conducted by the CHPs	CHPs	One per each group meeting with each group (primary poultry raiser/male household members)	Quantitative
Household visit daily record form	Record the attendance, duration, and challenges of each household visit conducted by the CHPs	Female CHPs	One per each household during each household visit with the primary poultry raisers	Quantitative
Pictorial progress book	Assess the progress of the households in planning and executing the recommended behavior	CHPs	One book for each household and group meeting specific targets and challenges were filled up during each household visit	Quantitative
Supervisor monitoring form	Record the session conduction quality and performance of the CHP	icddr,b research officers	One per CHP during group meetings; two per CHP during household visits	Quantitative
Observation notes (group meetings, male engagement meetings, and household visits)	Record the perspective of the icddr,b research officers regarding the meeting content, method of delivery, the interaction between the CHPs and the participants, the performance of the CHPs, and challenges	icddr,b research officers	One per each CHP during each group meeting, male engagement meeting, and household visit	Qualitative
Meeting specific in-depth interview guideline for the CHPs	Record the perspective of the CHPs regarding the meeting content, method of delivery, and challenges	In-depth interviews with CHPs by icddr,b research officers	One interview per CHP after completion of each group meeting (total of four after completion of each group meeting)	Qualitative
Meeting specific in-depth interview guideline for the households	Record the perspective of the households regarding the meeting content, method of delivery, facilitator, and challenges	In-depth interviews with the primary poultry raisers by icddr,b research officers	One interview with one study participant from each study village (total of four after completing each group meeting)	Qualitative
Training notes	Record observation notes of the training facilitators regarding the training of the CHPs	Training facilitators (icddr,b research officer)	One note per training session	Qualitative
Training evaluation form	Record the perspective of the CHPs regarding the training modality, content, and facilitator	CHPs	Each CHP filled out one form after each training session	Both quantitative and qualitative

Supplementary Table 2: CHPs' Performance According to the Perspective of the Supervisor

Performance Indicators	Non Subsidy Arm (N 41) %	Subsidy Arm (N=34) %
CHP gave introduction before starting the activity		
Not at all	7.3%	5.9%
Partial	42%	44%
Complete	51%	50%
CHP discussed all the key topics of the meeting	93%	97%
CHP summarized key points at the end of the meeting	71%	88%
CHP praised and encouraged making progress on action items since the previous meeting (N=60)[27]	67%	63%
Relationship of the CHP with the participants observed		
Mixed rapport	7.3%	2.9%
Good rapport	93%	97%
CHP's performance in demonstrating the meeting activities		
Very good	73%	59%
Fairly good	22%	41%
Not very good	4.9%	0%

Supplementary Table 3: Types of Poultry Housed Inside the Household Dwelling during Endline

Indicator	Non Subsidy N=41 (Endline)	Subsidy N=36 (Endline)	Total N=77 (Endline)
Type of poultry housed inside during endline	N=30	N=22	N=52
Healthy adult chicken	87% (26)	46% (10)	69% (36)
Healthy chicks	67% (20)	37% (8)	54% (28)
Egg-laying or brooding hen	30% (9)	46% (10)	37% (19)
Sick chicken or chicks	20% (6)	4.6% (1)	14% (7)
Healthy adult ducks	10% (3)	27% (6)	17% (9)
Healthy ducklings	0 (0)	32% (7)	14% (7)
Egg-laying or brooding ducks	17% (5)	4.6% (1)	12% (6)
Sick duck or ducklings	0 (0)	0 (0)	0 (0)
Type of poultry housed inside during endline by the households who had an improved poultry shed	N=4	N=17	N=21
Healthy adult chicken	50% (2)	41% (7)	43% (9)
Healthy chicks	75% (3)	29% (5)	38% (8)
Egg-laying or brooding hen	50% (2)	53% (9)	52% (11)
Healthy adult ducks	0 (0)	18% (3)	14% (3)
Healthy ducklings	0 (0)	35% (6)	29% (6)
Proportion of households housed any but not all poultry outside during endline	17% (7)	36% (13)	26% (20)
Type of poultry kept inside by the households who confined any but not all poultry outside	N=7	N=13	N=20
Healthy adult chicken	57% (4)	23% (3)	35% (7)
Healthy chicks	57% (4)	23% (3)	35% (7)
Egg-laying or brooding hen	43% (3)	46% (6)	45% (9)
Sick chicken or chicks	14% (1)	0 (0)	5% (1)
Healthy adult ducks	0 (0)	7.7% (1)	5% (1)
Healthy ducklings	0 (0)	39% (5)	25% (5)

[27] Not applicable for the first group meeting, household visit, and male engagement meeting. Thus here the "N" is lower than the total observed session

Supplementary Table 4: Material, Money, and Labor Status for Building Shed in Study Households

Indicator	Non Subsidy N=41 (Endline)	Subsidy N=36 (Endline)	Total N=77 (Endline)
Proportion of households had to buy all the materials to build improved poultry shed	N=14	N=32	N=46
	50% (7)	28% (9)	35% (16)
Proportion of households had to buy at least some materials to build improved poultry shed	N=14	N=32	N=46
	86% (12)	97% (31)	94% (43)
List of materials had to buy by the households	N=12	N=31	N=43
Wood	92% (11)	84% (26)	86% (37)
Tin	92% (11)	81% (25)	84% (36)
Brick	0 (0)	3.2% (1)	2.3% (1)
Others (metal screw, nails, hinge, plastic sheet, plastic net, metal net, and wooden flat board)	100% (12)	100% (31)	100% (43)
Proportion of households didn't need to buy any material (all the materials were available in the house)	N=14	N=32	N=46
	7.1% (1)	0 (0)	2.2% (1)
Proportion of households used at least some material without buying	50% (7)	72% (23)	65% (30)
List of available materials used by the households	N=6	N=22	N=28
Wood	100% (6)	82% (18)	86% (24)
Tin	83% (5)	55% (12)	61% (17)
Brick	17% (1)	41% (9)	36% (10)
Others (nails and plastic fruit crates)	0 (0)	9.1% (2)	7.1% (2)
Mason type who built the improved poultry shed	N=13	N=31	N=44
Household member	7.7 % (1)	29% (9)	23% (10)
Member of the compound	0 (0)	13% (4)	9.1% (4)
Relative outside the compound	15% (2)	3.2% (1)	6.8% (3)
Mason from the same village	69% (9)	55% (17)	59% (26)
Mason from the other village	7.7% (1)	0 (0)	2.3% (1)
Level of difficulty faced to find a mason for building improved poultry shed	N=10	N=17	N=27
Not a problem at all	60% (6)	100% (17)	85% (23)
Moderate problem	10% (1)	0 (0)	3.7% (1)
Large problem	10% (1)	0 (0)	3.7% (1)
Extreme problem	20% (2)	0 (0)	7.4% (2)
Type of difficulty faced by the households in finding masons	N=4	N=0	N=4
Mason was busy	50% (2)	-	50% (2)
Mason was charging more	75% (3)	-	75% (3)
Others	0 (0)	-	0 (0)
Reported ways followed to arrange money for building improved shed	N=13	N=31	N=44
Saved money since project initiation	7.7% (1)	3.2% (1)	4.6% (2)
Used previous savings	46% (6)	71% (22)	64% (28)
Took loan	39% (5)	6.5% (2)	16% (7)
Borrowed money from family members	15% (2)	0 (0)	4.6% (2)
Borrowed money from friends	23% (3)	13% (4)	16% (7)
Sold assets	7.7% (1)	13% (4)	11% (5)
Purchased materials on credit	7.7% (1)	3.2% (1)	4.6% (2)
Got support from project	7.7% (1)	100% (31)	73% (32)
Others (money given by family members, loan from relatives, sold poultry and eggs, son built the shed, and some materials given by brother-in-law)	23% (3)	19% (6)	21% (9)
	N=12	N=26	N=38

Indicator	Non Subsidy N=41 (Endline)	Subsidy N=36 (Endline)	Total N=77 (Endline)
Average total cost of building the improved shed (who had to spend at least some money)	4058 ± 1393	4733 ± 1438	4520 ± 1440
Average cost for masons the households had to pay	N=10	N=19	N=29
	1150 ± 242	1426 ± 470	1331 ± 423
Average cost for buying the materials	N=11	N=24	N=35
	3009 ± 1223	3725 ± 1227	3500 ± 1254
Average proportion of endline monthly income spent on building an improved poultry shed (without considering subsidy for the subsidy arm)	N=12	N=26	N=38
	61% (±29%)	70% (±46%)	67% (±41%)
Average proportion of endline monthly income spent on building an improved poultry shed (excluding subsidy for the subsidy arm)	N=12	N=26	N=38
	61% (±29%)	40% (±29%)	46% (±30%)

Supplementary Table 5: Changes in Females' Involvement in Poultry-Related Decision Making and Consumption of Poultry and Poultry Products from Baseline to Endline

Indicators	Baseline %	Endline %	Prevalence Difference (Baseline to Endline) % (95% CI)
Household's females consumed poultry eggs produced by their poultry during previous two weeks	N = 33	N=28	
	52%	71%	20% (-4.6%, 44%)
Household's females decided to sell poultry eggs during previous two weeks	N=34	N=6	
	24%	83%	60% (23%, 97%)
Household's female controlled earnings by selling eggs during previous two weeks	N=34	N=6	
	21%	67%	46% (9.1%, 83%)
Household's females decided to sell poultry during previous two months	N=22	N=16	
	91%	88%	-3.4% (-24%, 17%)
Household's females controlled earnings by selling poultry during previous two months	N=22	N=16	
	82%	88%	5.7% (-18%, 30%)
Household's females decided to slaughter poultry of the household	N=24	N=42	
	96%	79%	-17% (-35%, 0.50)
Household's females consumed slaughtered poultry of the household	N=24	N=42	
	88%	93%	5.4% (-9.2%, 20%)

APPENDICES

All appendices are provided in the following google drive folder.

https://drive.google.com/drive/folders/1N7xT20Ttzc50X2C4FU1yQjb9a-02u1th?usp=sharing

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