How light is too light touch: The effect of a short training-based intervention on household poultry production in Burkina Faso*

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Abstract

This paper reports on the effects of a training-based intervention seeking to increase household engagement in poultry production in Burkina Faso, analyzing data from a large-scale cluster randomized trial in which 1,798 households in 60 communes were observed over a period of three years. The intervention SELEVER — entailing a short series of trainings for households as well as capacity building for local animal health and credit services — had little effect on household poultry production and no effect on profits. There is some evidence of an increase in the utilization of poultry vaccines and an associated reduction in poultry mortality. However, the findings broadly suggest that a relatively low cost and light-touch intervention did not generate positive welfare effects, in contrast to the large effects on livestock production and household economic outcomes previously observed for more intensive asset transfer programs.

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1 Introduction

Livestock production is widely viewed as a promising avenue for poor households in rural sub-Saharan Africa to diversify beyond staple crop production and enhance their economic welfare, and this is particularly true for poultry production given its relatively modest investment requirements (Sonaiya and Swan, 2004). However, the majority of the existing literature analyzing strategies to enhance livestock production focuses on transfer programs in which households receive a subsidized animal asset (Rawlins et al., 2014; Miller et al., 2014; Jodlowski et al., 2016; Phadera et al., 2019; Blattman, 2017; Mullally et al., 2021). There is relatively little evidence around strategies that provide information, training or other lower-cost services, despite the fact that these interventions, if effective, could potentially be more scalable and more cost-effective.

This paper reports on a randomized controlled trial implemented in Burkina Faso evaluating SELEVER (Soutenir l'Exploitation Familiale pour Lancer l'Élevage des Volailles et Valoriser l'Économie Rurale), a multifaceted intervention seeking to increase poultry production and improve the nutritional status of women and children among poor rural households (Gelli et al., 2017). SELEVER is delivered by a non-governmental organization Tanager and includes three key elements focused on increasing households' engagement in poultry production: training for producer households, training and enhanced provision of equipment to village-level providers of vaccination and extension services, and enhanced access to credit.[1] The intervention also particularly targets women for inclusion in training with the objective of increasing female engagement in poultry production. Importantly, unlike other major livestock-related programs, SELEVER does not include any transfer of assets or any provision of subsidized or free inputs.

The analysis measures the effects of this intervention on household poultry production following two and a half years of program implementation, analyzing a sample of 1,798 households observed in 119 villages in 60 communes across three regions. Within the original sample, 1669 were surveyed again at endline between March and August 2020, for a minimal attrition rate of 7%. (Due to disruptions in fieldwork linked to the ongoing COVID-19 pandemic, data collection was implemented in two phases, launching first in March and then resuming subsequently in June.) The primary analysis is an intention-to-treat specification: pre-specified primary outcomes include poultry production, sales and profits, and pre-specified secondary outcomes include poultry-related knowledge, use of poultry inputs, credit access and utilization, marketing practices, and poultry mortality

[1] Additional dimensions of the SELEVER intervention not analyzed in this paper included behavioral change communication around nutrition and health designed to promote improved diets and nutritional status for women and children; and community-level sensitization around women's economic empowerment.

(Gelli et al., 2017).

Our primary findings suggest that there is little evidence of any significant effect of the intervention on household engagement in poultry production. There are no statistically significant increases for the primary outcomes, stock value, revenue and profit, and the point estimates are small in magnitude or negative. There is some evidence of an increase in the number of mature poultry owned, suggesting a 14% relative to the control arm; however, this effect is only marginally significant.

The results for secondary outcomes of interest including production practices, marketing and credit access are generally similar. Respondents in communities exposed to SELEVER do report more knowledge about poultry production, and are more likely to feed poultry concentrate feed and to vaccinate them (though the latter effect is not statistically significant). Consistent with the noisy evidence of enhanced flock size and the shift in poultry practices, there is a reduction in the number of poultry reported lost to disease, suggesting some mortality benefits of poultry feeding and/or vaccination. By contrast, there is no evidence of experimental effects for other variables analyzed.

Given the intervention's emphasis on promoting women's engagement in poultry production, we also examine experimental effects on disaggregated measures of poultry owned by men and women, and owned jointly. Here, we observe a significant increase in the number of mature birds, reported stock value, revenue and profits reported for poultry production managed by women. While small in absolute magnitude, the effects are proportionally large: thus profit from women's poultry production increases by $1.39 relative to a mean in the control group of $1.94, an increase of 72%. These effects are, however, counterbalanced by negative (though noisily estimated) effects on production and profits for poultry owned by men and owned jointly, generating the null effect observed at the household level.

To explore potential seasonality of the observed effects, we also report additional panel estimates for the same primary outcomes of interest in which we use data from two supplementary survey rounds conducted during the lean season, pre-intervention (post-baseline) and post-intervention (pre-endline). Detailed results from the lean season follow-up survey were reported separately (Leight et al., 2020), and the panel estimates allow us to compare treatment effects across the two seasonal endline rounds. In the lean season endline (conducted between August and October 2019), there is evidence of a much larger effect of SELEVER on poultry practices including vaccination, feeding and deworming, as well as an increase in revenue (though there is no significant shift in profits). By the post-harvest endline, the effects on poultry practices are reduced and not statistically significant, but the returns to the utilization of these earlier inputs may be evident in the slightly larger flock size. The effects on poultry revenue, however, have

disappeared. We interpret this as evidence that the returns to vaccination are observed primarily in the dry season, included in the recall period for the post-harvest endline. On the other hand, financial pressures may prompt poultry sales only in the lean season when households' need for liquidity for food purchases and school fees is highest, accounting for the seasonality of revenue effects, though as previously noted the null effect on profits is consistent.

These generally modest findings are in contrast to the large and positive effects on household welfare, consumption and/or dietary outcomes observed for a number of previously evaluated interventions providing livestock transfers (Darrouzet-Nardi et al., 2016; Kafle et al., 2016; Jodlowski et al., 2016; Miller et al., 2014; Rawlins et al., 2014; Thompson and Magnan, 2017; Glass et al., 2017; Mullally et al., 2021). Similarly large effects have been observed for multifaceted graduation programs providing asset transfers, in which livestock is a common asset choice (Krishna et al., 2012; Bandiera et al., 2017; Banerjee et al., 2015; Phadera et al., 2019; Kafle et al., 2019; Misha et al., 2019).

By contrast, this analysis suggests that programs providing only training and capacity strengthening in the absence of transfers have limited effectiveness. Existing evidence around livestock-related training is more limited. In Rwanda, a program providing cows as an asset transfer was differentially more effective when training was also provided, though the offer of training was not randomized (Argent et al., 2014), and in Nepal, a training-only program targeting goat production increased financial inclusion and women's empowerment, though there were no effects on assets, expenditure or food security (Janzen et al., 2018).

In addition, a growing interdisciplinary literature has analyzed the effects of nutrition-sensitive agricultural development programs such as this intervention on a range of outcomes including food availability, access to food, diet quality, women's empowerment, and gender norms (Ruel et al., 2018; Heckert et al., 2019; Olney et al., 2015, 2016).[2] However, rigorous evidence on the role of livestock market-based interventions in improving smallholder incomes — as distinct from nutritional and consumption outcomes — is very limited (Ruel et al., 2018; Ruel and Alderman, 2013). This paper is one of the first to our knowledge to provide evidence of effects on household production and income, and suggests that at least in this context, a light-touch, market-based livestock intervention without asset transfers was not sufficient to generate meaningful effects on economic welfare.

[2]A nutrition-sensitive agricultural intervention is defined as an intervention that seeks to "address underlying determinants of fetal and child nutrition and development— food security; adequate caregiving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment—and incorporate specific nutrition goals and actions." See Ruel and Alderman (2013) for more details.

2 Experimental design

2.1 Context

Poultry production is a major contributor to the agricultural economy of Burkina Faso, and it remains an important economic activity for large numbers of rural households (Gning, 2005). Data from the 2010 Agricultural Census shows that 99% of poultry producers are smallholders (defined as owning a flock of between five and 50 poultry), owning 98% of the total flock, and producing 99% of the supply of meat and 86% of the supply of eggs (Food and Agriculture Organization, 2018). Similarly, another more recent household survey suggests that 80% of rural households own poultry (Gelli et al., 2019).

In addition to its salience for the rural economy, poultry production has important implications for the economic role of women, who often manage the daily care of poultry. Qualitative work linked to this study found that husbands often sell poultry on women's behalf, as there are norms against women entering into the areas of the market where meat is sold, and traveling poultry traders often will not purchase from women without their husband's consent (Eissler et al., 2020). When men do sell women's chickens, women maintain the rights to the profits from the sale. However, it is common for the husband to still exert considerable control over the income earned. Given the substantial role women play in poultry production, exploring the effects of any intervention on their economic engagement is also crucially important.

2.2 Intervention and evaluation

The SELEVER intervention is multifaceted, encompassing intervention components in three broad sectoral areas: poultry, nutrition and health, and gender (Gelli et al., 2017); the description here draws substantially on the description provided in Leight et al. (2020). This analysis will focus solely on the poultry component, centered around the provision of training around poultry production to rural households constituted in village-level producers' and savings groups.[3] Eight poultry training modules were delivered by trained facilitators (similar to extension agents) to the producers' groups, focusing on the following topics: opportunities for income in poultry production; appropriate housing practices for poultry; poultry reproduction; chick management; best feeding practices; compiling poultry feed; poultry health; and business and entrepreneurial management for poultry production. (Results analyzing the effects of nutrition / health and gender

[3]These groups are known as Mutuelles de Solidarité, MUSOs, or Solidarity Groups, GS. They were formed or in some cases reinforced by the organizations delivering SELEVER.

interventions on nutrition and empowerment outcomes will be reported separately.)

In addition, SELEVER sought to strengthen village animal health and credit services. Rural poultry producers rely on a system of Village Volunteer Extension Services Workers (VVVs following the name in French), a volunteer corps trained by government staff to provide basic livestock services (e.g., vaccinations, deworming and nutrition advice).[4] The government also bulk purchases vaccines and sells them at discounted rates to VVVs, who can then earn income on the provision of these services (Gning, 2005). VVVs are active across the sample; however, SELEVER provided additional training to the VVVs as well as a start-up kit including a cold storage unit, a syringe and needle, and 100 doses each of poultry vaccines and deworming pills. The program also developed a cohort of women VVVs to better reach women poultry producers. In the credit sphere, two microcredit organizations collaborated with Tanager to expand into the treatment communes, providing at least one microcredit branch in each commune if such a branch was not already present. They also assumed the role of providing credit to poultry producers participating in SELEVER, but there was no explicit guarantee. Credit was available based on standard commercial criteria designed to identify a viable enterprise, and these criteria were largely discretionary.

The sample for the evaluation included 60 communes (rural and peri-urban) within three targeted regions of Burkina Faso (Boucle du Mouhoun, Centre-Ouest, and Hauts-Bassins). These communes were selected randomly from a group of 79 communes in these regions identified as eligible for scale-up based on the following criteria: they had not previously been exposed to SELEVER pilot programming, they were identified as rural or peri-urban in the national census, and they were accessible by road year round.[5]

The randomization for this evaluation was a two-phased process summarized graphically in figure 1. The first phase of randomization assigned 30 communes to the SELEVER intervention and 30 communes to the main trial arm using a re-randomization procedure described in more detail in the trial protocol (Gelli et al., 2017).[6] An additional second-level randomization then assigned 50% of the communities in the SELEVER arm to receive an additional WASH (water, sanitation and hygiene) intervention focused on

[4]Until about ten years ago, the VVVs provided only vaccination services, and their name accordingly reflected this role (Vaccinateurs Volontaires Villageois). More recently, the V for "vaccinateurs" in French has been replaced by "vulgarisateurs" to denote their wider role in extension and information provision.

[5]For the Hauts-Bassins region, an additional criterion was proximity to the other two intervention regions.

[6]To minimize any imbalance in covariates, a re-randomization procedure was implemented. A randomization routine that selected 30 treatment communes from the sampling frame, and two villages within each commune, was run with 3,000 replications. Villages that did not have the target population size for the intervention were excluded from the list. The research team then selected the randomization permutation in which the r-squared of a regression of village and commune covariates on assignment to treatment was minimized.

promoting community-led total sanitation concepts; there was a particular emphasis on the appropriate management of chicken waste.

In sampled communities, households with a woman 15–35 years of age and a child aged 2-4 years living together were eligible for inclusion, following a full household census conducted to collect basic demographic variables used to construct the sample. In each village, 15 households were then randomly selected for inclusion, with oversampling of households identified as large poultry producers (flock size of more than 20 mature birds). This yields a target baseline sample of 1800 households (60 communes, 120 villages) in the full trial. Ultimately, data was collected in only 119 villages.[7]

As this trial is a multidisciplinary trial incorporating nutrition and health outcomes, a full trial protocol was published (Gelli et al., 2017) that specified primary and secondary outcomes, and we utilize this protocol as our reference rather than a separate pre-analysis plan. Pre-specified primary outcomes include poultry production, sales and profits, and pre-specified secondary outcomes include women's empowerment, poultry-related knowledge, use of poultry inputs, credit access and utilization, marketing practices, and poultry mortality.[8] Power calculations were conducted for the primary outcomes using data from an earlier evaluation (Olney et al., 2015), and indicate the analysis has 80% power to detect an effect size of .18 standard deviations for household poultry production and .15 standard deviations for household poultry sales (Gelli et al., 2017).[9] Ethical review and approval was provided by the Institutional Research Board at the International Food Policy Research Institute and the Comité Éthique pour la Recherche en Santé MS/MRSI in Burkina Faso.

2.3 Data collection

The main endline survey for this analysis was conducted in the post-harvest period in 2020; due to interruptions linked to the COVID-19 pandemic, data collection was conducted in March and then resumed in June following the conclusion of pandemic-related lockdowns in Burkina Faso. The corresponding baseline survey was collected in the post-harvest period (March – June) in 2017. An additional analysis will also draw on two surveys conducted in the lean seasons (August – October) in 2017 and 2019, respectively, focusing on a subsample of 1080 households selected for more detailed longitudinal

[7]One village was omitted due to a failure to correctly identify the community in the field.

[8]Table 3 in the published trial protocol provides full details.

[9]This is assuming an intracluster correlation of .001 at the level of the commune and between .05 and .1 at the level of the village. Data employed for power calculations was drawn from two observational studies evaluating food intake in the study regions, and a recent impact evaluation of the Helen Keller International homestead food production intervention (Arsenault et al., 2014; Martin-Prevel et al., 2016; Olney et al., 2016).

follow-up.

In each wave of data collection, household surveys were conducted, collecting sex-disaggregated data on poultry production (including inputs, flock size, marketing, revenue, and profits). The first survey respondent for the poultry module was the male member of the household identified to be most knowledgeable about the household's poultry activities (usually the head of household), and the second survey respondent was the female member identified as most knowledgeable about poultry production among the women of the household. Each respondent reported separately the number of poultry owned by type of bird (roosters, hens, pullets, and chicks) and breed (chickens and guinea fowl), and answered a series of detailed questions about poultry inputs, sales, and mortality. The reference period for the variables of interest is generally the previous six months. The respondent reported whether there was any engagement in poultry production over this period, and for poultry practices reported whether she or he engaged in that practice over this period. For variables such as input cost, revenue, and profits, the respondent reported the total amount spent or earned over this period. The only exception is flock size and the estimated value of the flock, reported as of the day of the survey.

3 Empirical results

3.1 Baseline balance

Table 1 presents baseline summary statistics and p-values corresponding to tests of balance across experimental arms.[10] The table includes demographic characteristics and baseline poultry production, and all monetary values are presented in real 2017 U.S. dollars. The average household includes nine members and is led by a male head of around 45 years of age. Only 7% of household heads have received some primary education, and about half of households are polygynous. Virtually all households are engaged in poultry production, reporting a flock around 27 birds on average at baseline. Baseline revenue is around $46, and baseline profits are around $30.

The p-values for the tests of balance are reported in Column (3) of Table 1, and generally suggest that the hypothesis that covariates are balanced across arms cannot be rejected for poultry-related variables. For demographic variables, there are some differences that are significant: households in the treatment arm are characterized by heads who are slightly older and less likely to be educated, and households in treatment communities are more likely to be polygynous. (The differences in age and the probability

[10] More specifically, baseline covariates are regressed on a treatment dummy, with standard errors clustered at the commune level. The regression is weighted to take into account household-level oversampling of large producers.

of polygyny are small in magnitude though precisely estimated, while the difference in the probability of any education is relatively large.) The table also reports the p-value corresponding to a joint F-test of balance across all covariates reported. The hypothesis of balance can be rejected for the full set of covariates ($p = 0.029$), but not for the set of covariates linked to poultry production ($p = 0.536$).

To enable assessment of some simple trends, we also report summary statistics for the control and treatment arms at endline. There is little evidence of substantial shifts in mean stock value or revenue in the control arm over the evaluation period, though there is a substantial reported increase in profits in the control arm (from $28 to $36). In general, this evidence suggests that poultry production in this sample has been relatively stable.

3.2 Intervention exposure

In order to assess households' engagement with the SELEVER intervention in the communities in which it was implemented, Table 2 reports a series of variables linked to exposure; Column (7) reports a p-value corresponding to a test of equality across treatment and control arms.[11] In addition, for comparison we report in Columns (8) through (11) parallel variables as observed within the longitudinal subsample surveyed in the lean season endline conducted in 2019. Intervention activities largely concluded at the end of 2019, and thus some decline in reported exposure in the 2020 survey is expected, particularly given the delay in survey timing linked to the COVID-19 pandemic. (The time period for reported exposure is over the previous 12 months.) However, some persistent or lagged benefits from intervention activities in 2019 may still be observed in poultry outcomes, and thus previous exposure is also useful to document.

On average, about 13% of all households in SELEVER communities report that they have benefited from the SELEVER intervention in the final endline survey in 2020, while 27% reported that they had benefited in the 2019 survey. Nearly 30% reported that at least one member of the household had attended at least one SELEVER training, relative to about half of households reporting attendance in 2019. In both rounds, attendance is relatively balanced by gender, based on the numbers of households who report at least one woman attended and households who report at least one man attended. The average number of training sessions reported attended is 1.8 in 2020 and 2.6 in 2019, relative to eight total modules offered, though in some cases multiple modules may have been included in a single session. For business-oriented trainings, attendance is lower (17% in

[11] We report the p-value from a regression in which the indicator of interest is regressed on a binary variable for assignment to SELEVER; the regression is weighted to take into account sampling probabilities and standard errors are clustered at the commune level.

2020 and 29% in 2019), but again balanced for men and women. Finally, participation in poultry producers' groups is reported to be 15% in 2020, and 24% in 2019.

One dimension of exposure that is increasing over time is knowledge of the VVVs, who are deployed in both control and treatment communities but receive some capacity building in treatment communities. In 2020, 90% of households in the control arm reported they know at least one VVV, rising to 95% in the treatment arm, while in 2019 the corresponding percentages ranged from 70 to 80%. Reported receipt of VVV services is slightly higher in treatment communities in both years (59% relative to 54% in 2020), but the difference is not statistically significant.

To summarize engagement with the intervention, we also report a variable capturing any exposure, equal to one if the household reports any benefits from SELEVER, attended a poultry training, attended a business training, or is a member of a producers' group. (Knowledge of the VVV is excluded from this measure given that the VVV system is not an innovation introduced by the intervention.) Using this measure, around 40% of households in intervention communities reported some exposure to the poultry-related interventions in 2020, and 60% in 2019. There is also some evidence of contamination in the control arm, though the differences between the treatment and control arms are uniformly statistically significant: 12% of households in the control arm reported exposure to SELEVER in 2020, and 20% did so in 2019. This may reflect measurement error in which households mis-report their exposure to another, similar program.

3.3 Main specification

In order to analyze the experimental effects of interest, the primary specification is an ANCOVA regression in which outcome variables Y_{ivct} for household i in village v, commune c and time period t are regressed on a dummy variable S_{vc} capturing whether the commune is assigned to the treatment arm, as well as the baseline level of the outcome variable $Y_{ivc,t-1}$ and household covariates $\chi_{ivc,t-1}$.[12]

$$Y_{ivct} = \beta_1 S_{vc} + \beta_2 Y_{ivc,t-1} + \chi_{ivc,t-1} + \epsilon_{ivct} \tag{1}$$

Period t refers to the endline, and period $t-1$ refers to the baseline. Standard errors are clustered at the level of the commune, and the regression is weighted using the probability of selection to account for the over-sampling of large producers.

In addition, for primary and secondary outcomes, we report q-values corrected for multiple hypothesis testing, using the Simes method (Newson, 2010). This correction

[12]The household covariates include household size, the age of the head of household, and the baseline flock size (number of mature birds).

is implemented for the three primary outcomes (Panel A of Table 3), for the set of ancillary variables linked to primary outcomes (Panel B of Table 3), and for each family of secondary outcomes (Tables 4 and 5).

We also report estimates from a panel specification using all four survey rounds (two baseline and two follow-up surveys). Note that the smaller longitudinal sample (1054 households at baseline) is represented in all four survey rounds, while only the primary (post-harvest) baseline and endline rounds include the full sample (1,798 households at baseline). For the panel analysis, we follow the specification employed for multiple follow-up rounds in Fafchamps et al. (2014). Outcome variables are regressed on two dummy variables corresponding to the effects of SELEVER in the lean season (S^l_{vc}) and in the harvest season (S^h_{vc}) as well as survey round fixed effects γ_t, employing the same clustered standard errors and weights. The coefficients on both β_1 and β_2 are reported, in addition to a test of equality $\beta_1 = \beta_2$ in order to identify whether treatment effects vary significantly by season.

$$Y_{ivct} = \beta_1 S^l_{vc} + \beta_2 S^h_{vc} + \gamma_t + \epsilon_{ivct} \tag{2}$$

3.4 Primary and secondary outcomes

Table 3 reports the effects for the main outcomes. In Panel A, it is evident that there is no significant effect on reported stock value, revenue or profits for poultry production, and the latter point estimates are in fact negative and close to zero. In Panel B, there is no evidence of any significant effects on the probability of reporting poultry production, the probability of reporting revenue from poultry production, the probability of reporting revenue from egg production, or the amount of revenue from eggs. There is an increase in the reported number of mature birds owned that is significant at the ten percent level in the conventional specification, though not statistically significant when corrected for multiple hypothesis testing. The magnitude suggests an increase of three birds relative to a mean in the control arm of 22.

The results for secondary outcomes reported in Tables 4 and 5 are largely consistent. The only significant effects are observed for poultry practices: households in treatment communities are more knowledgeable about poultry production (an increase of .05 in a knowledge index relative to a control mean of .69; the index corresponds to the percentage of eight questions for which the respondent provided correct answers). They are more likely to vaccinate their poultry (though this effect is not significant at conventional levels), and are more likely to use concentrate feeds. The effects on knowledge and feeding practices are significant even when adjusted for multiple hypothesis testing. There is no evidence of any effects on utilization of credit (Panel B of Table 4) or marketing practices

(Panel A of Table 5).

In Panel B of Table 4, we report results for poultry mortality and consumption. Here, there is some evidence of a decline in the number of poultry lost to disease, consistent with the previously reported increase in total poultry owned. The coefficient suggests a reduction in total losses of four and half poultry relative to a mean in the control arm of 33; it is significant at the five percent level using conventional standard errors, and close to significant at the ten percent level using multiple hypothesis-adjusted standard errors ($p = 0.123$).[13]

Finally, in order to corroborate the null effects observed for revenue and profits from poultry production, we also report treatment effects for total household expenditure per-capita as well as expenditure on food and non-food items. These results are reported in Panel A of Table A1 in the Appendix. Consistent with the previously presented evidence there are no significant effects on household expenditure. We also estimate treatment effects for some simple summary measures of crop cultivation (total area cultivated in hectares, total production of crops in kilograms, and number of crops cultivated) to assess whether there are any ancillary effects of the intervention on households' other economic activities. These results are presented in Panel B of the same table, and again show no significant effects.

3.5 Effects on poultry production by women

In addition to targeting increased household engagement in poultry production, the SELEVER intervention sought to enhance women's engagement in poultry production and increase their decision-making power. To evaluate the effects of the intervention along this dimension, we report in Table 8 the estimated treatment effects for primary outcomes of interest for poultry reported owned by men, women and jointly by multiple members of the household. Again, characteristics of the flock and associated poultry business decisions were reported separately by a male respondent (usually the household head) for poultry owned by the head as well as poultry owned jointly by multiple members of the household, and by a female respondent for poultry owned by the women of the household. The sample is consistent for each set of variables (male-owned, female-owned, and joint-owned) as all households report for all three categories, though they may report values of zero for any category. The only exceptions are household engagement in poultry production (reported only for the household) and variables linked to egg revenue (reported only for the household).

[13]We also evaluated alternate measures of poultry mortality such as the mortality ratio, defined as the number of birds lost normalized by total flock size. While we see a pattern of negative effects on these other variables capturing mortality, the coefficients are not statistically significant.

In Panel A and Panel C we observe generally null (and often negative) effects for flock size, revenue and profits as reported for poultry owned by men and owned jointly by multiple members of the household. However, in Panel B we observe that for poultry owned by women, households in communities exposed to SELEVER report a significant increase in the number of mature birds, stock value, revenue and profits. Moreover, given the low mean level of poultry production reported for women, the effects are proportionately large: there is a 48% increase in the number of birds owned, a 45% increase in stock value, a 52% increase in revenue, and a 74% increase in profits. In absolute magnitude, this corresponds to increased profits of $1.40 for poultry owned by women over the six-month reference period.

If we compare the coefficients estimated in Panels B and C, the point estimates for poultry owned jointly reported in Panel C are negative, though not statistically significant, and generally of comparable magnitude to the point estimates for poultry owned by women. This is consistent with the overall null effect on household-level measures of poultry production previously reported. We also report in the bottom rows of Panels B and C p-values testing the equality of coefficients across the specifications estimated for poultry owned by men, women and couples. Given the noise in the estimated treatment effects, the hypothesis that the effects are equal for poultry of different ownership types cannot be rejected at conventional levels. However, the pattern of treatment effects in magnitude and sign seems consistent with the hypothesis that there has been an intrahousehold shift from poultry owned jointly to poultry owned by women.

3.6 Heterogeneous effects

Treatment effects for large producers As previously noted, the sample purposively oversampled large producers, identified as households reporting a flock of 20 or more chickens, in order to facilitate the analysis of heterogeneous effects for households reporting flocks of various sizes. In characterizing large producers, it is evident in the data that the reported flock size shows high variability over a relatively short time horizon, and thus to address this challenge, we construct a mean estimated flock size equal to the mean of three available pre-intervention observations (flock size in census, post-harvest baseline, and lean season baseline). We then generate a binary variable for large producer equal to one if this mean flock size is over 20.[14]

[14]The correlation between the number of chickens reported owned in the census (in which all households in each sampled village were identified and their poultry flock size estimated, to enable sampling for the core experimental sample) and the number reported owned in the comprehensive post-harvest baseline conducted approximately two to three months later is only about .4. Similarly, the correlation between the flock size reported in the post-harvest baseline and in the lean season baseline conducted six months later is only .3. Using the method described, we identify 55% of households as large producers,

We can re-estimate equation (1) including separate binary treatment variables for small and large producers, controlling separately for the large producer dummy. The results are presented in Panel A of Table A2 in the Appendix, and there is no meaningful evidence of heterogeneity for any outcome of interest.

In order to deepen this analysis, we also analyze heterogeneous effects with respect to baseline commercialization of poultry; this analysis was not prespecified, and should be considered exploratory. 65% of households reported revenue from poultry production at baseline, and we again estimate treatment effects separately for households that do and do not report revenue. These results are presented in Panel B of the same table. Again, there is little evidence of any differential effects: households who did not report commercialization of poultry at baseline show a noisy increase in the probability of owning any poultry, while the increase in the number of mature birds previously reported appears to be concentrated among households reporting revenue at baseline. Again, the difference between the coefficients estimated for the two subgroups is not statistically significant.

Treatment effects for the WASH subarm In order to analyze the separate effects of SELEVER and SELEVER+, the intervention including an additional WASH intervention, we first report baseline balance and summary statistics on treatment exposure for these subarms. Table A3 in the Appendix reports baseline balance in covariates for households in the control arm and the two treatment subarms; again, the joint p-value suggests we cannot reject the hypothesis that baseline characteristics are balanced on average. Table A4 in the Appendix reports the same summary measures of program exposure for households assigned to the two treatment subarms, and reports two p-values: a joint test $\beta_1 = \beta_2 = 0$ that the average level of program exposure in the two treatment subarms is different from the average level in the control arm, and a simple test $\beta_1 = \beta_2$ evaluating whether program exposure in the two subarms is significantly different. In general, the hypothesis that program exposure is balanced across the two subarms cannot be rejected.

Table A5 in the Appendix reports the treatment effects for the primary outcomes estimated using the following equation (3) in order to identify the effects of SELEVER and SELEVER+, the intervention including an additional WASH intervention.

$$Y_{ivct} = \beta_1 S_{vc} + \beta_2 S^{+}_{vc} + \beta_3 Y_{ivc,t-1} + \chi_{ivc,t-1} + \epsilon_{ivct} \tag{3}$$

Given that the causal channel of an effect of the additional WASH intervention on poultry production is not clear, we have emphasized the simple comparison (pooled treatment

considerably higher than the sampling target of 40%.

versus control) as primary, but also report the disaggregated treatment effects as well as a p-value for the test $\beta_1 = \beta_2$ to evaluate if the effects are consistent across the treatment subarms. (For concision, for the subsequent set of results we do not report q-values corrected for multiple hypothesis testing.)

The results suggest that in general, and consistent with our hypothesis, the effects of both intervention subarms are parallel for poultry-related outcomes. The hypothesis that $\beta_1 = \beta_2$ can be rejected only for the probability that a household reports any revenue from poultry production, where the effect is positive and statistically significant only for SELEVER+.

3.7 Panel estimates

In order to analyze whether there is any variation in the estimated treatment effects comparing over the two follow-up rounds, Tables 6 and 7 estimate the panel specification, equation (2), and report the results for the primary outcomes of interest as well as poultry practices. Note the sample in this analysis is restricted to those households who were surveyed in all four rounds. (For concision, the panel results for the other secondary variables are not reported.) Multiple hypothesis q-values are omitted for these tables given that they were previously reported. (This discussion also draws on a separate and longer analysis of the treatment effects as observed in the lean season, Leight et al. (2020).)

In Table 6, in general the null effects of the intervention are consistent across both follow-up survey rounds. There is a significant and large increase in revenue reported for households exposed to SELEVER in the lean season survey ($11, relative to a mean in the lean season of $38), while the corresponding coefficient in the post-harvest survey is lower in magnitude and not statistically significant. However, the hypothesis that the effects are equal in magnitude cannot be rejected. Conversely, the increase in the number of mature birds owned for households exposed to SELEVER is statistically significant only in the post-harvest endline, though of similar magnitude in both rounds.

In Table 7, there is more meaningful variation across waves in the estimated treatment effects for poultry practices. In the lean season survey, there is a significant increase in total input costs for poultry, and an increased probability of vaccination, concentrate feeding, and deworming among households exposed to SELEVER. These coefficients are reduced in magnitude in the post-harvest endline round and statistically significant only for concentrate feeding as previously noted. However, again the imprecision in the estimated effects does not allow us to reject the hypothesis that the treatment effects are consistent across rounds.

3.8 As-treated analysis

To conclude our empirical analysis, we also report an "as-treated analysis" analyzing the effects of SELEVER for those who in fact participated in the intervention, an analysis that was also pre-specified in the protocol (Gelli et al., 2017). Given that participation is non-random, this evidence should not be considered to be causal, and in general, if households who rationally expect higher benefits from SELEVER opt into participation, the as-treated effects would be expected to be more positive relative to the intent-to-treat effects.

First, in order to analyze selection into participating in treatment, we estimate a simple specification in which we regress various household-level measures of participation drawn from Table 2 on the same baseline covariates as reported in Table 1. The results are reported in Table A6 in the Appendix. In general, households reporting any revenue from poultry production at baseline and reporting higher profits at baseline are more likely to participate in the intervention. (By contrast, those reporting revenue from egg sales are less likely to participate, possibly reflecting the fact that only the very largest producers report revenue from egg sales at baseline, and they may not perceive a benefit to additional services or information linked to poultry production.[15])

Second, we estimate a difference-in-difference for households who do and do not participate in the intervention, employing kernel propensity score matching to compare households who endogenously opt in to SELEVER to similar households in the treatment arm. (Heckman et al., 1998; Villa, 2016).[16] These results are reported in Table A7; Panel A uses the pooled measure of exposure to the poultry-linked programming previously reported in Table 2, and Panel B uses a broader variable that is equal to one if households report exposure to poultry as well as nutrition programming provided by SELEVER. Using this second definition, mean exposure in the treatment communities is 25%. (The nutrition intervention and its effects will be described in further detail in a separate manuscript.)

The results in Panels A and B are consistent. Households who participated in SELEVER show evidence of an increase in the number of mature birds that is larger in magnitude and more precisely estimated relative to the estimated coefficient in the intent-to-treat specification (four when using the poultry-specific measure of exposure, and seven using the pooled measure, relative to a control mean of 23). There is also some weak evidence of an increase in the probability of reporting any poultry revenue, an increase

[15] At baseline, only 4% of households report revenue from egg sales, and these households report an average flock size of 122, a flock size corresponding to nearly the 99th percentile of the baseline distribution.

[16] Similar propensity score matching techniques have been widely employed in evaluating interventions in developing countries; see for example Ninno and Dorosh (2003), Gilligan et al. (2009), de Brauw and Hoddinott (2011) and Asfaw et al. (2012).

of between six and 10 percentage points relative to a mean of 75% in the control arm. Again, however, there are no significant effects on stock value, revenue or profits.

4 Discussion

To sum up these findings, in general the evidence suggests that a relatively light-touch intervention providing poultry-related training to rural Burkinabe households did not have a significant effect in stimulating increased production of or profits from poultry. There is some weak evidence of enhanced use of poultry inputs, and some evidence that poultry flocks may have expanded; these effects are particularly observed for households who were commercializing poultry at baseline, and for households who participate more actively in the intervention. There is also some evidence that poultry reported owned by women increased, counterbalanced by a decline in poultry reported to be jointly owned.

These effects stand in contrast to those previously observed in a follow-up survey conducted among a longitudinal subsample during the 2019 lean season, and replicated in panel estimates reported in this paper. In the lean season in 2019, there were substantial effects on the use of poultry inputs and thus on total input cost, as well as an increase in poultry revenue; the increases in cost and revenue were of roughly equal magnitude, however, yielding no increase in profits (Leight et al., 2020). There was also little evidence of any positive return to the enhanced use of inputs, particularly the increased utilization of vaccines. The lean season analysis hypothesized that the returns to these inputs might be primarily realized in the dry season (January to March), a peak period of vulnerability to Newcastle disease, and thus be observed only in the 2020 survey when the recall period encompasses the dry season.

By the point of the full-scale endline survey in 2020, the effects on poultry inputs and cost have attenuated and are generally no longer statistically significant. This is consistent with the observed reduction in reported SELEVER participation, reflecting both the conclusion of the majority of program activities by January 2020 and the increased disruption of normal activities linked to the COVID-19 pandemic as well rising conflict-related insecurity in the region. In the absence of continued program activities, it seems that the behavioral shifts observed for poultry producers during the program period may not be persistent.

However, there is evidence of a reduction in poultry losses and an increase in poultry flock size among households exposed to SELEVER surveyed in the 2020 round that would be consistent with some benefit from previously administered vaccinations, and this effect does appear to be larger among households who in fact participated in the program. This may corroborate the hypothesis that the return to vaccinations is positive,

but seasonal. The endline survey also collected data on past-month poultry mortality (as distinct from poultry mortality over the last six months, reported above) and this variable shows no significant effect. Since the past-month recall period would not overlap with the dry season for the majority of households, particularly those surveyed following the COVID-19 disruption, this again suggests that the reduction in mortality may be highly concentrated in the dry season period.

At the same time, any positive effect on revenue previously observed for households exposed to SELEVER in the lean season has disappeared. One interpretation of this pattern is that the previous increase in poultry sold during the lean season reflected primarily a need for liquidity during a more resource-constrained period, even if the revenue thus earned did not in fact exceed what was previously expended on poultry inputs. The lean season period of late summer and early fall also corresponds to the period around the launch of the school year, and thus it is common for households to sell assets (including livestock) to fund school fees.[17]

Finally, the 2020 results show for the first time evidence of positive treatment effects for poultry owned by women; however, this seems to be counterbalanced by adverse treatment effects for poultry reported jointly owned. While this pattern may have various interpretations, one parsimonious explanation is that households exposed to SELEVER are induced to "reclassify" poultry as female-owned rather than jointly owned, possibly reflecting a shift in the intrahousehold view of ownership or control rights over these poultry. The welfare implications of this difference, in the absence of any increase in reported flock size or profits at the household level, are unclear. While the literature suggests that enhanced female control over assets can be beneficial — increasing women's bargaining power within the household, and potentially benefiting children (Doss, 2006; Johnson et al., 2016)— separate analyses have suggested that there is no evidence of a significant effect on SELEVER on women's empowerment as measured by the Women's Empowerment in Agriculture (WEAI) index, and effects on children's nutritional status are not observed.

Returning to the literature on asset transfer programs, these results suggest that sustaining the large positive effects on household economic activity generally observed in these programs without substantial investments in the assets themselves may be challenging. Clearly, the costs of an asset transfer-based program vis-a-vis a training-based program such as SELEVER and the associated implied direct benefit for households are dramatically different: to cite one example, the BRAC program analyzed in Bandiera et al. (2017) entailed an asset transfer valued at $560. In this intervention, by contrast,

[17]The increase in supply of livestock to markets in this period is also associated with generally low prices for those livestock, a pattern that is widely noted among those potentially interested in purchases.

households accessed only poultry inputs valued at $6 — and paid market price, approximately, for these inputs — in addition to accessing the training modules themselves, a service that is challenging to value. (They did not ultimately benefit from any increased access to credit.) This much lower cost program clearly had some significant effects on household's poultry production methods, but did not increase profits as observed on this roughly two-year timeline.

5 Conclusion

This paper seeks to provide evidence about the effectiveness of a relatively light-touch, informational intervention in expanding household poultry production in rural Burkina Faso. The SELEVER cluster randomized controlled trial tracked a large cohort of households over three years, including surveys in both major seasons. While there is some evidence that the intervention generated a shift in poultry practices and possibly some intrahousehold reassessment of poultry ownership — as evident in women increasing the probability that they report poultry ownership, while joint ownership of poultry declines — there is no robust evidence of substantial shifts in the number of poultry owned at the household level, revenue or profits. In this context, poultry training in conjunction with some enhanced availability of animal health and credit services does not seem to be sufficient to stimulate major transformation in the poultry sector or in the economic benefits households derive from it.

This finding also links to a broader literature around economies of scale in poultry production. In richer countries, poultry production is overwhelmingly concentrated in high-input, large-scale producers that utilize modern breeds of poultry in conjunction with improved feeds, strict disease control mechanisms, and poultry housing (Narrod et al., 2008). In developing countries, however, the majority of production is "extensive" backyard production characterized by low inputs and low productivity (Mcleod et al., 2009; Gilbert et al., 2015). While there is no universal criterion for an intensive producer, the flock size necessary to begin to achieve meaningful economies of scale may be 100 birds or more (Beesabathuni et al., 2018); this corresponds roughly to the 98th percentile of the distribution of flock size observed in the pooled sample (treatment and control) in the endline sample analyzed here. Accordingly, another plausible interpretation of the findings is that rural Burkinabe households are simply producing at too small a scale to easily realize significant profits from poultry production, and that larger or more intensive interventions would be required to catalyze a shift toward significant economies of scale.

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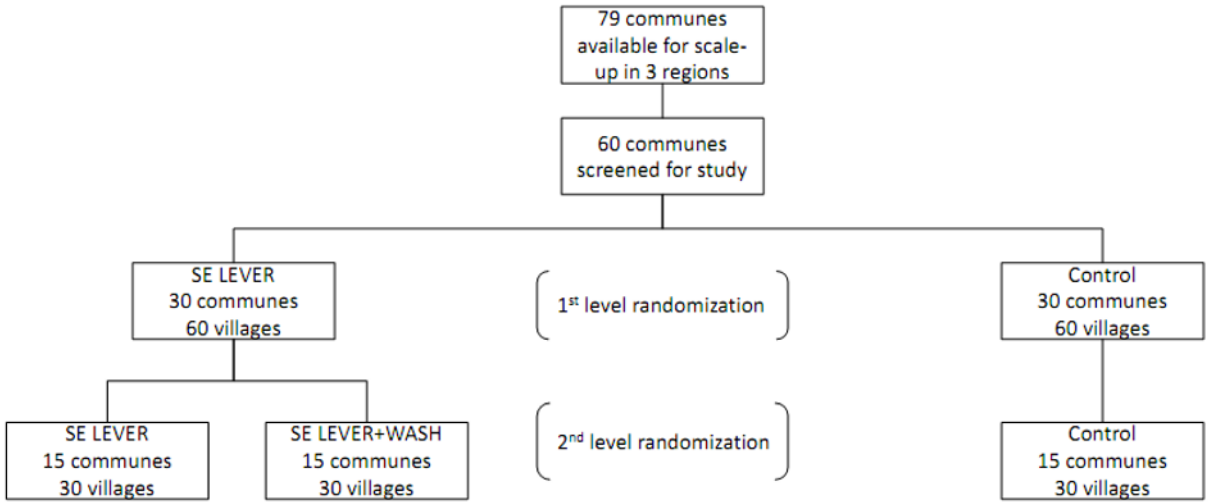

Figure 1: Evaluation design

Table 1: Summary Statistics Across Arms: Baseline and Endline

	(1)	(2)	(3)	(4)	(5)
	Baseline Control arm	Baseline Treatment arm	Balance test p-value	Endline Control arm	Endline Treatment arm
Age household head	43.534	44.286	0.032		
Any primary education (household head)	.083	.059	0.009		
Household size	8.791	8.87	0.084		
Polygynous	.467	.484	0.081		
Stock value	91.573	94.991	0.110	95.286	97.963
Poultry revenue	42.164	50.873	0.182	48.168	47.508
Poultry profits	27.649	33.41	0.641	36.363	34.228
Any poultry	.957	.949	0.539	.958	.966
Number mature birds	29.461	24.302	0.776	22.54	24.286
Any poultry revenue	.654	.651	0.423	.749	.752
Any egg revenue	.049	.027	0.239	.116	.105
Egg revenue	.275	.136	0.553	.867	.756
Joint-test p-value	0.029				
Joint-test p-value (poultry variables)	0.536				

Note: This table reports key indicators of interest corresponding to household demographics and poultry production as observed at baseline in communes assigned to the control and treatment arms, and as observed at endline. Column (3) reports the p-value corresponding to a regression in which the indicator of interest at baseline is regressed on a binary variable for assignment to SELEVER; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. At the bottom of the Table we report a joint p-value corresponding to a F test across all outcomes analyzed.

Table 2: Summary Statistics for SELEVER Exposure in Treatment Communities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Primary (post-harvest) endline, 2020							Lean season endline, 2019			
	Control arm			Treatment arm				Control arm		Treatment arm	
Indicator	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	p-value	Mean	Obs.	Mean	Obs.
Household reports benefits from SELEVER	.01	.1	827	.13	.34	815	0.000	.02	346	.27	664
Any member attended poultry training	.07	.25	827	.27	.44	815	0.000	.12	346	.49	664
Attendance at poultry training: female	.03	.18	802	.18	.38	787	0.000	.06	313	.37	637
Attendance at poultry training: male	.06	.23	716	.21	.41	704	0.000	.09	298	.43	564
Number of trainings attended (all members)	1.23	1.43	53	1.83	1.76	215	0.006	1.2	38	2.63	313
Any member attended business training	.07	.25	827	.17	.37	815	0.000	.11	346	.29	664
Attendance at business training: female	.04	.19	802	.1	.3	787	0.000	.08	313	.21	637
Attendance at business training: male	.04	.21	716	.12	.32	704	0.000	.05	298	.21	564
Any member participates in producers' group	.02	.14	827	.15	.36	815	0.000	.04	346	.24	664
Participation in group: female	.01	.09	802	.09	.29	787	0.000	.02	313	.17	637
Participation in group: male	.02	.14	716	.13	.33	704	0.000	.03	298	.2	564
Any member knows VVV	.9	.3	827	.95	.23	815	0.004	.67	346	.81	664
Ever received VVV services	.54	.5	802	.59	.49	787	0.137	.47	313	.53	637
Any reported exposure to SELEVER programming	.12	.33	827	.4	.49	815	0.000	.2	346	.57	664

Note: This table reports summary statistics (mean, standard deviation and number of observations) for variables capturing program exposure as observed in the post-harvest endline for individuals in the control and treatment arms in Columns (1) through (6). Column (7) reports the p-value corresponding to a regression in which the indicator of interest is regressed on a binary variable for assignment to SELEVER; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. Columns (8) through (11) report the mean and number of observations for variables capturing program exposure in the lean season endline conducted in 2019.

Table 3: Effect of SELEVER on Household Poultry Production: Primary Outcomes

	(1)	(2)	(3)	(4)	(5)
	Primary outcomes				
	Stock value	Revenue	Profit		
SELEVER	4.850	-.621	-.692		
	(6.612)	(4.281)	(3.986)		
Mult. hypo. q-value	0.839	0.885	0.885		
Mean control arm	95.286	48.168	36.363		
St. dev. control arm	90.998	66.388	66.722		
Obs.	1669	1669	1669		
	Robustness: Ancillary measures linked to primary outcomes				
	Any poultry	Number mature birds	Any revenue	Any revenue eggs	Egg revenue
SELEVER	.013	2.954*	.029	-.004	-.020
	(.011)	(1.788)	(.029)	(.021)	(.174)
Mult. hypo. q-value	0.546	0.546	0.546	0.908	0.908
Mean control arm	.958	22.54	.749	.116	.867
St. dev. control arm	.200	20.859	.434	.321	3.327
Obs.	1669	1669	1669	1669	1669

Note: This table reports results for the primary outcomes of interest. The dependent variables are regressed on a binary variable for assignment to SELEVER, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. The reference period for variables is generally the past six months. The variables of interest are as follows: a binary variable for any poultry reported raised by the household over the reference period, the number of poultry owned on the day of the survey, the estimated value of the flock on the day of the survey, the total reported input cost over the reference period, whether the household reports any revenue from poultry sales over the reference period, the total amount of poultry revenue over the reference period, whether the household reports any revenue from egg sales over the reference period, the total amount of egg revenue over the reference period, and the total amount of profits over the reference period. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table 4: Effect of SELEVER on Secondary Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Poultry practices							
	Poultry knowledge index	Input cost	Any vaccination	Fed poultry cereals	Fed poultry concentrate	Any deworming	Poultry confined
SELEVER	.051***	.943	.062	.005	.084***	.016	-.010
	(.014)	(1.696)	(.039)	(.022)	(.028)	(.033)	(.013)
Mult. hypo. q-value	0.004	0.737	0.276	0.807	0.012	0.737	0.737
Mean control arm	.687	12.244	.501	.931	.104	.256	.052
Obs.	1638	1669	1574	1574	1574	1574	1669
Panel B: Financial services							
	Any deposit	Amount deposited	Any loans accessed	Total loans			
SELEVER	.010	-104.492	.033	37.212			
	(.043)	(135.721)	(.051)	(56.838)			
Mult. hypo. q-value	0.826	0.695	0.695	0.695			
Mean control arm	.348	123.364	.265	92.85			
Obs.	1668	586	1668	1668			

Note: This table reports results for the secondary outcomes of interest, and the specification is identical to that described in Table 3. The reference period for all variables is the past six months. The variables of interest are as follows. In Panel A, Column (1) analyzes an index of poultry-related knowledge; Columns (2) and (3) analyze total reported expenditure on poultry purchases and other inputs over the reference period; and Columns (4) through (8) analyze a series of binary variables capturing whether the household has engaged in the specified practice over the reference period. In Panel B, Columns (1) and (2) analyze binary variables for whether the household reports any deposit over the reference period, and the amount deposited; Columns (3) and (4) analyze whether the household reports any access to credit, and the amount of credit accessed. Asterisks indicate significance at the ten, five and one percent level.

Table 5: Effect of SELEVER on Poultry Marketing, Mortality and Consumption

	(1)	(2)	(3)	(4)	(5)	(6)
	Number sold	Price	Sell home	Sell market	Sell door	
Panel A: Poultry Marketing						
SELEVER	.078	-.213	.007	.015	.004	
	(1.026)	(.196)	(.056)	(.051)	(.010)	
Mult. hypo. q-value	0.940	0.940	0.940	0.940	0.940	
Mean control arm	11.027	4.711	.458	.267	.017	
Obs.	1669	786	1669	1669	1669	
Panel B: Poultry Mortality and Consumption						
	Number lost	Any loss	Mortality ratio	Number consumed	Any consumed	Total flock size
SELEVER	-4.403**	-.010	-.159	-.285	.030	1.769
	(1.849)	(.030)	(.114)	(.347)	(.032)	(3.544)
Mult. hypo. q-value	0.123	0.748	0.508	0.622	0.622	0.743
Mean control arm	23.475	.791	1.091	3.868	.589	44.751
Obs.	1669	1669	1460	1669	1669	1669

Note: This table reports results for the secondary outcomes of interest, and the specification is identical to that described in Table 3. The reference period for all variables is the past six months. The variables of interest are as follows. In Panel A, Column (1) analyzes the number of poultry sold over the reference period, and Column (2) analyzes the price; Columns (3) through (5) analyze binary variables for reported selling in the specified location over the reference period. In Panel B, the variables of interest are as follows: the number of poultry reported lost due to mortality over the reference period; a binary variable for any poultry reported lost; the mortality ratio (the number of poultry reported lost divided by the number owned as of the survey date); the number of poultry reported consumed over the reference period; a binary variable for any poultry consumed; and the total flock size (including chicks) as of the survey date. Monetary variables are reported in real U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table 6: Effect of SELEVER on Household Poultry Production: Panel estimates

	(1)	(2)	(3)	(4)	(5)
	Primary outcomes				
	Stock value	Revenue	Profit		
Treatment lean season	11.130	10.881*	5.155		
	(15.578)	(5.712)	(5.379)		
Treatment post-harvest	15.800	4.600	1.685		
	(12.280)	(6.475)	(6.066)		
Test: $\beta_1 = \beta_2$	0.574	0.255	0.554		
Mean (lean season) control arm	109.942	38.078	22.897		
Mean (post-harvest) control arm	91.68	45.924	34.998		
Obs.	3908	3908	3908		
R^2	.008	.009	.009		
	Robustness: Ancillary measures linked to primary outcomes				
	Any poultry	Number mature birds	Any revenue	Any revenue eggs	Egg revenue
Treatment lean season	.019	3.047	.023	-.0008	-.252
	(.046)	(3.300)	(.054)	(.046)	(.446)
Treatment post-harvest	-.006	4.789*	.043	.019	.865
	(.025)	(2.728)	(.041)	(.029)	(.754)
Test: $\beta_1 = \beta_2$	0.538	0.356	0.665	0.754	0.233
Mean (lean season) control arm	.943	25.997	.726	.151	1.268
Mean (post-harvest) control arm	.940	21.88	.762	.096	.720
Obs.	3908	3908	3908	3908	3908

Note: This table reports results for the primary outcomes of interest. The dependent variables are regressed on a binary variable for assignment to SELEVER interacted with a binary variable for the lean season, a binary variable for SELEVER interacted with a binary variable for the post-harvest season, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. The reference period for variables is generally the past six months. The variables of interest are as follows: a binary variable for any poultry reported raised by the household over the reference period, the number of poultry owned on the day of the survey, the estimated value of the flock on the day of the survey, the total reported input cost over the reference period, whether the household reports any revenue from poultry sales over the reference period, the total amount of poultry revenue over the reference period, whether the household reports any revenue from egg sales over the reference period, the total amount of egg revenue over the reference period, and the total amount of profits over the reference period. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table 7: Effect of SELEVER on Household Poultry Practices: Panel estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Input cost	Any vaccination	Fed poultry cereals	Fed poultry concentrate	Any deworming	Poultry confined
Treatment lean season	5.410*	.099***	.007	.116***	.135***	.012
	(2.866)	(.037)	(.030)	(.027)	(.046)	(.009)
Treatment post-harvest	1.704	.048	.009	.074**	.048	.003
	(2.372)	(.050)	(.029)	(.036)	(.050)	(.014)
Test: $\beta_1 = \beta_2$	0.107	0.337	0.950	0.329	0.119	0.502
Mult. hypo. q-value						
Mean (lean season) control arm	15.037	.518	.968	.102	.214	0
Mean (post-harvest) control arm	11.943	.503	.949	.105	.242	.045
Obs.	2931	2823	2823	2823	2823	2931

Note: This table reports results for the primary outcomes of interest. The dependent variables are regressed on a binary variable for assignment to SELEVER, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. The reference period for variables is generally the past six months. The variables of interest are as follows: total reported expenditure on poultry purchases and other inputs over the reference period; and a series of binary variables capturing whether the household has engaged in the specified practice over the reference period. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table 8: Effect of SELEVER on Household Poultry Production by Ownership Category

	(1)	(2)	(3)	(4)	(5)
	Number mature birds	Stock value	Any revenue	Revenue	Profit
Panel A: Poultry owned by men					
SE LEVER	2.347	2.719	.031	1.112	-.988
	(1.829)	(7.000)	(.034)	(3.936)	(3.590)
Mean control arm	18.626	78.919	.645	40.14	30.515
Obs.	1669	1669	1669	1669	1669
Panel B: Poultry owned by women					
SE LEVER	.996***	3.538***	.040	1.520**	1.385**
	(.345)	(1.240)	(.026)	(.688)	(.618)
p-value: $\beta^w = \beta^m$	0.336	0.977	0.810	0.795	0.920
Mean control arm	2.062	7.787	.147	2.911	1.94
Obs.	1669	1669	1669	1669	1669
Panel C: Poultry owned jointly					
SE LEVER	-.459	-1.714	-.022	-1.913	-1.363*
	(.339)	(1.306)	(.016)	(1.441)	(.707)
p-value: $\beta^j = \beta^m$	0.107	0.492	0.341	0.654	0.266
p-value: $\beta^j = \beta^w$	0.108	0.219	0.317	0.595	0.248
Mean control arm	1.194	5.012	.070	3.484	2.586
Obs.	1669	1669	1669	1669	1669

Note: This table reports results for the primary outcomes of interest as described in Table 3, as measured separately for poultry reported owned by men, owned by women, and owned jointly by the household. The specification is identical to that described in Table 3. Monetary variables are reported in real 2017 U.S. dollars. The p-value reported in Panels B and C correspond to a test of equality comparing across the coefficients in each column as estimated in Panel A vis-a-vis those estimated in Panels B or C. Asterisks indicate significance at the ten, five and one percent level.

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6 Appendix: For online publication only

Table A1: Household expenditure and crop production

	(1)	(2)	(3)
	Panel A: Household expenditure		
	Total expenditure per capita	Food per capita	Non-food per capita
SELEVER	-.562	-5.948	7.793
	(19.762)	(6.499)	(18.049)
Mean control arm	260.842	64.454	193.714
Obs.	1662	1665	1662
	Panel B: Crop-related outcomes		
	Area cultivated	Total produced	Number crops
SELEVER	.560	-100.902	.342
	(.484)	(264.056)	(.354)
Obs.	1648	1640	1640

Note: This table reports results for household expenditure (in Panel A) and variables linked to crop production (in Panel B). The dependent variables are regressed on a binary variable for assignment to SELEVER, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. Expenditure is reported in real 2017 CFA. Crop variables reported are area cultivated in hectares, total crop output produced in kilograms, and the number of crops. Asterisks indicate significance at the ten, five and one percent level.

Table A2: Heterogeneous Effects

	(1) Stock value	(2) Revenue	(3) Profit	(4) Any poultry	(5) Number mature birds	(6) Any revenue	(7) Any egg revenue	(8) Egg revenue
Panel A: Heterogeneous effects for baseline large producers								
Small producer	-3.695	-1.833	-1.948	.029	-.435	.009	-.027*	-.311**
	(5.841)	(3.544)	(3.126)	(.022)	(1.451)	(.041)	(.016)	(.152)
Large producer	3.281	-2.233	-3.115	-.002	2.592	-.005	.002	.037
	(7.757)	(5.195)	(5.506)	(.008)	(1.718)	(.027)	(.029)	(.256)
p-value: $\beta_1 = \beta_2$	0.482	0.891	0.589	0.162	0.144	0.833	0.653	0.541
Obs.	1669	1669	1669	1669	1669	1669	1669	1669
Panel B: Heterogeneous effects for households reporting revenue at baseline								
No baseline revenue	-2.032	.049	-3.760	.038*	.130	.002	-.034	-.536**
	(8.818)	(4.050)	(3.434)	(.020)	(2.215)	(.044)	(.023)	(.216)
Any baseline revenue	3.331	-2.267	-1.256	-.005	2.814*	.005	.009	.177
	(7.121)	(5.419)	(5.504)	(.008)	(1.669)	(.027)	(.025)	(.233)
p-value: $\beta_1 = \beta_2$	0.485	0.946	0.295	0.083	0.126	0.615	0.537	0.074
Obs.	1669	1669	1669	1669	1669	1669	1669	1669
Mean control arm	95.286	48.168	36.363	.958	22.54	.749	.116	.867
St. dev. control arm	90.998	66.388	66.722	.200	20.859	.434	.321	3.327

Note: This table reports results for the primary outcomes of interest as described in Table 3. In Panel A, the dependent variables are regressed on a binary variable for assignment to SELEVER interacted with binary variables for small and large producers, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. In Panel B, a parallel regression is estimated, but the binary variable for SELEVER assignment is interacted with binary variables for households who did and did not report revenue from poultry production at baseline. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table A3: Baseline Balance Across Arms: SELEVER and SELEVER+

	(1)	(2)	(3)	(4)
	Baseline Control arm	Baseline SELEVER	Baseline SELEVER+	Balance test p-value
Age household head	43.789	43.25	45.374	0.032
Any primary education (household head)	8.923	8.509	9.248	0.028
Household size	8.923	8.509	9.248	0.028
Polygynous	.465	.45	.520	0.081
Stock value	89.825	92.962	97.114	0.195
Poultry revenue	39.921	42.145	60.01	0.061
Poultry profits	25.399	25.282	41.92	0.310
Any poultry	.969	.927	.973	0.090
Number mature birds	28.894	23.432	25.212	0.906
Any poultry revenue	.659	.621	.682	0.542
Any egg revenue	.041	.021	.032	0.463
Egg revenue	.219	.113	.161	0.712
Joint-test p-value	0.026			
Joint-test p-value (poultry variables only)	0.186			

Note: This table reports key indicators of interest corresponding to household demographics and poultry production as observed at baseline in communes assigned to the control arm and the two treatment arms (SELEVER and SELEVER+). Column (3) reports the p-value corresponding to a regression in which the indicator of interest is regressed on two binary variables for assignment to SELEVER and SELEVER+, and the joint test $\beta_1 = \beta_2 = 0$ is conducted; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. At the bottom of the Table we report a joint p-value corresponding to a F test across all outcomes analyzed.

Table A4: Summary Statistics for SELEVER Exposure in Treatment Communities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Control arm			SELEVER arm			SELEVER+ arm				
Indicator	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	p-value $\beta_1 = \beta_2 = 0$	p-value $\beta_1 = \beta_2$
Household reports benefits from SELEVER	.02	.13	404	.13	.33	419	.14	.35	396	0.000	0.572
Any member attended poultry training	.08	.27	404	.26	.44	419	.28	.45	396	0.000	0.362
Attendance at poultry training: female	.04	.2	397	.17	.37	406	.19	.39	381	0.000	0.252
Attendance at poultry training: male	.06	.25	344	.2	.4	363	.22	.41	341	0.000	0.706
Number of trainings attended (all members)	1.37	1.85	30	1.83	1.64	105	1.84	1.88	110	0.021	0.892
Any member attended business training	.06	.25	404	.16	.37	419	.17	.38	396	0.000	0.855
Attendance at business training: female	.04	.18	397	.1	.3	406	.1	.3	381	0.001	0.545
Attendance at business training: male	.05	.21	344	.11	.32	363	.13	.33	341	0.000	0.953
Any member participates in producers' group	.02	.14	404	.15	.36	419	.15	.36	396	0.000	0.506
Participation in group: female	.01	.09	397	.09	.28	406	.09	.29	381	0.000	0.726
Participation in group: male	.02	.13	344	.13	.34	363	.12	.33	341	0.000	0.408
Any member knows VVV	.93	.25	404	.94	.25	419	.96	.2	396	0.002	0.059
Ever received VVV services	.56	.5	397	.55	.5	406	.63	.48	381	0.317	0.431
Any reported exposure to SELEVER programming	.14	.35	404	.38	.49	419	.43	.5	396	0.000	0.350

Note: This table reports summary statistics (mean, standard deviation and number of observations) for variables capturing program exposure as observed in the post-harvest endline for individuals in the control and both treatment arms. Columns (10) and (11) report the p-values corresponding to a regression in which the indicator of interest is regressed on binary variables for assignment to SELEVER and SELEVER+, and we estimate the p-values for the tests $\beta_1 = \beta_2 = 0$ and $\beta_1 = \beta_2$; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level.

Table A5: Effects of SELEVER and SELEVER+ on Household Poultry Production

	(1) Stock value	(2) Revenue	(3) Profit	(4) Any poultry	(5) Number mature birds	(6) Any revenue	(7) Any egg revenue	(8) Egg revenue
SELEVER	5.517	3.115	1.639	.021	2.888	-.020	.027	.196
	(9.810)	(6.660)	(6.481)	(.014)	(2.624)	(.038)	(.030)	(.262)
SELEVER +	9.379	1.534	1.313	.011	4.409**	.054	.016	.134
	(8.350)	(5.159)	(4.966)	(.015)	(2.161)	(.040)	(.028)	(.248)
p-value: $\beta_1 = \beta_2$	0.653	0.811	0.960	0.456	0.566	0.055	0.724	0.831
Mean control arm	91.555	44.602	33.364	.954	21.566	.753	.089	.588
Obs.	1669	1669	1669	1669	1669	1669	1669	1669
R^2	.2	.126	.046	.085	.117	.053	.037	.019

Note: This table reports results for the primary outcomes of interest as described in Table 3. The dependent variables are regressed on two binary variables for assignment to SELEVER and SELEVER+, the baseline level of the dependent variable, and demographic controls; the regression is weighted to take into account baseline sampling probabilities, and standard errors are clustered at the commune level. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.

Table A6: Selection into Treatment Participation

	(1)	(2)	(3)	(4)	(5)
	Reports benefits	Poultry training	Business training	Producers group	Any exposure
Any poultry	.00005	.0002*	.0001	.0002*	.0001
	(.00007)	(.0001)	(.0001)	(.00008)	(.0001)
Number mature birds	-.00005	-.00007	-.00009	.0001	.0001
	(.00008)	(.0002)	(.0001)	(.0002)	(.0003)
Stock value	.00009	.0001	.0001	-.00008	-.00002
	(.0001)	(.0002)	(.0001)	(.0002)	(.0002)
Any revenue	-.008	.072**	.057**	-.011	.073
	(.027)	(.031)	(.024)	(.031)	(.045)
Any revenue eggs	-.00002	-.0002**	-.0002***	-.00004	-.0003***
	(.00003)	(.00009)	(.00007)	(.00005)	(.00008)
Revenue	.004	-.006	-.016	-.002	.017
	(.016)	(.025)	(.021)	(.018)	(.032)
Egg revenue	-.104**	-.049	-.125	-.150***	-.233**
	(.041)	(.081)	(.108)	(.036)	(.099)
Profit	.012	.012	.051**	.023**	.058***
	(.010)	(.012)	(.023)	(.009)	(.020)
Head age	.0007	.0005	.0001	.002*	.0009
	(.0007)	(.001)	(.0009)	(.0008)	(.001)
Household size	.0007	.0005	.0001	.002*	.0009
	(.0007)	(.001)	(.0009)	(.0008)	(.001)
Head primary	.001	.004	.004	.0001	.003
	(.002)	(.004)	(.003)	(.003)	(.004)
Polygamous	.038	.026	.045	.023	.021
	(.031)	(.040)	(.033)	(.030)	(.050)
Polygamous	-.028	.010	.041	.009	.045
	(.020)	(.033)	(.027)	(.021)	(.037)
Obs.	1639	1639	1639	1639	1639
R^2	.007	.019	.039	.017	.026

Note: This table reports a series of regressions in which binary variables capturing participation in different dimensions of SELEVER programming are regressed on baseline covariates. The covariates are parallel to those reported in Table 1, and the dependent variables are parallel to those participation variables reported in Table 2. Asterisks indicate significance at the ten, five and one percent level.

Table A7: Effects of SELEVER: As Treated Analysis Using Propensity Scores

	(1) Stock value	(2) Revenue	(3) Profit	(4) Any poultry	(5) Number mature birds	(6) Any revenue	(7) Any egg	(8) Egg revenue
Panel A: Propensity scores using engagement in poultry								
SELEVER	12.036	7.186	-.217	.001	4.015**	.064*	-.03	.05
	(9.304)	(9.014)	(13.921)	(.011)	(1.825)	(.039)	(.029)	(.3)
Obs.	1673	1673	1673	1673	1673	1673	1673	1673
R^2	.268	.177	.111	.108	.272	.071	.075	.053
Panel B: Propensity scores using engagement in SELEVER								
SELEVER (participation)	12.91	12.956	17.323	.02	6.964***	.096*	.036	.337
	(9.428)	(15.52)	(21.996)	(.019)	(2.816)	(.055)	(.037)	(.478)
Obs.	1673	1673	1673	1673	1673	1673	1673	1673
Mean control arm	95.286	48.168	36.363	.958	22.54	.749	.116	.867
St. dev. control arm	90.998	66.388	66.722	.200	20.859	.434	.321	3.327

Note: This table reports results for the primary outcomes of interest as described in Table 3. In Panel A, the subset of households in the treatment arm who report participation in SELEVER are compared to households in the control arm, including additional controls for the full set of baseline covariates analyzed in Table A6. In Panel B, a propensity score matching difference-in-difference specification is utilized to compare households who did and did not participate in SELEVER. Monetary variables are reported in real 2017 U.S. dollars. Asterisks indicate significance at the ten, five and one percent level.