The impact of an integrated value chain intervention on household poultry production in Burkina Faso: Evidence from a randomized controlled trial*

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Abstract

This article reports on a cluster-randomized controlled trial conducted in 120 villages in rural Burkina Faso evaluating a multifaceted intervention (SELEVER) that seeks to increase poultry production by delivering training in conjunction with the strengthening of village-level institutions providing veterinary and credit services to poultry farmers. The intervention is evaluated in a sample of 1,080 households surveyed following two years of program implementation. Households exposed to the intervention significantly increase their use of poultry inputs (veterinary services, enhanced feeds, and deworming), and report more poultry sold and higher revenue; however, there is no evidence of an increase in profits. This evidence is consistent with the hypothesis that the return to inputs in the poultry market may not be sufficient to counterbalance the market costs of these inputs.

1 Introduction

Recent debates in development in both research and policy have increasingly focused on the potential of increased production of livestock and in particular poultry as a sustainable strategy to reduce poverty for poor rural households (Rawlins et al., 2014; Miller et al., 2014; Jodlowski et al., 2016; Phadera et al., 2019; Blattman, 2017). Major stakeholders

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have argued that poultry are an attractive investment, requiring minimum inputs and generating a consistent stream of revenue (Gates, 2016). Data from the Demographic and Health Surveys suggest that in eastern and southern Africa as well as the Sahel, more than half of all households engage in poultry production (Headey and Hirvonen, 2015); in Burkina Faso, the site of this evaluation, 80% of households own poultry (Gelli et al., 2019). In addition, the prices for poultry meat as well as eggs are relatively high, suggestive of supply constraints and potentially high returns to households who can successfully commercialize poultry production (Headey and Alderman, 2019).

At the same time, poultry production is often primarily the domain of women (IFAD, 2010), though men can have a meaningful role in ownership and management if and when poultry become an important source of family income. Women's role in poultry production can potentially enhance their status or control over resources within the household, and access to chicken and eggs can have significant benefits for maternal and child nutrition (Lutter et al., 2018). Given this evidence, understanding whether interventions targeting enhanced household poultry production can have positive effects on households' economic welfare and women's economic empowerment is an important research goal.

This article reports on a cluster-randomized controlled trial conducted in rural Burkina Faso evaluating a multifaceted intervention SELEVER (Soutenir l'Exploitation Familiale pour Lancer l'Élevage des Volailles et Valoriser l'Économie Rurale) that seeks to increase poultry production and improve the nutritional status of women and children. (Gelli et al., 2017). SELEVER is delivered by a non-governmental organization, Tanager, and includes three key program 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 services, and enhanced access to credit.[1] In an additional commune-level randomization, 50% of communes received an additional intensive WASH (water, sanitation and hygiene) intervention promoting appropriate management of chicken and human waste. Importantly, unlike other major livestock-related programs, SELEVER does not include any transfer of assets or any provision of subsidized or free inputs. Rather, the primary objective is to provide relevant information to enhance households' engagement in poultry production and strengthen local animal health and credit institutions.

Our objective in this analysis is to evaluate the effects of the intervention on household poultry production using an endline survey conducted in the lean season following ap-

[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.

proximately two years of intervention implementation.[2] The sample includes 90 villages in 45 communes across three regions (Boucle du Mouhoun, Centre-Ouest, and Hauts-Bassins).[3] Households with women of reproductive age and a young child (aged two to four at baseline) were eligible for inclusion in the sample and were randomly selected, yielding a subsample of 1080 households at baseline. 1011 of these households were surveyed in this follow-up survey, for an attrition rate of only 6.4%.

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 women's empowerment, poultry-related knowledge, use of poultry inputs, credit access and utilization, marketing practices, and poultry mortality (Gelli et al., 2017). There is no evidence of any effect of the intervention on the probability that households raise or sell poultry, or reported flock size or flock value. However, households in communes exposed to SELEVER report significantly higher revenue from poultry sales, an increase of 22% relative to average revenue in control households of $38 over a six month recall period. They also report significantly higher input costs, an increase of around 40% relative to the average input cost of $13 in the control arm (using the same recall period). The effect on profits is positive, but small in magnitude (approximately $3) and not statistically significant, consistent with the hypothesis that the increase in revenue has been sufficient only to compensate for households' higher incurred costs.

These patterns can also be unpacked in more detailed analysis of secondary outcomes. It is clear that households have significantly changed their poultry production practices: households are significantly more likely to use inputs that were targeted by SELEVER, including vaccination services, concentrate feeding, and deworming. Relative to households in the control arm, use of concentrate feeds roughly doubles, and the prevalence of deworming increases by about a third. This increased input use is not matched by any increased use of credit. On the revenue side, households report selling more poultry (and there is some evidence of slightly more consumption of own-produced poultry), but there is no significant shift in price or marketing choices.

The data also allows us to separately analyze the effects of the intervention for poultry owned by men and women. On average among control households, men report ownership of 20 mature birds, while women report owning only three; profits reported by men are around twenty times profits reported by women. Consistent with the intervention's objectives, there is some weak evidence that women do benefit, reporting a significant

[2]Note that for the purposes of this analysis, we use poultry production and poultry rearing as interchangeable terms, acknowledging that the sample households generally manage relatively small flocks, and thus we are not referring to any form of large-scale production.

[3]The full evaluation sample included 120 villages in 60 communes, but this analysis focuses on a subsample targeted for more detailed longitudinal tracking, and selected using a second-level randomization within the main sample (described in more detail below).

increase in stock value. However, the hypothesis that the effects for men and women are equal cannot be rejected for any of the main outcomes.[4]

Finally, we analyze whether there is any differential effect for households who chose to participate in SELEVER programming (around 60% of targeted households), though this analysis is correlational. In general, households who reported revenue from poultry production at baseline were more likely to participate in the intervention, and these households show evidence of significantly more positive effects on flock size and revenue. However, there is no evidence of an increase in profits even among this subset of producers.

This article contributes to a growing literature analyzing the effect of interventions targeting livestock production among poor households. In economics, existing interventions have primarily focused on livestock transfers, an important component of the graduation models analyzed in Bangladesh by Bandiera et al. (2017) and in a six-country study by Banerjee et al. (2015); a similar program implemented in Zambia is analyzed in Phadera et al. (2019) and Kafle et al. (2019). (While households in graduation programs can choose the asset that will be transferred, livestock is a common choice.) These programs have had positive effects on multiple measures of household economic welfare, including asset cumulation, poverty, and resilience. A number of other papers have analyzed more targeted livestock transfers outside of the context of multidimensional programming, including Thompson and Magnan (2017) analyzing a goat transfer in Haiti; Rawlins et al. (2014) analyzing a dairy cow transfer in Rwanda; Jodlowski et al. (2016) and Kafle et al. (2016) analyzing livestock transfers in Zambia; and Miller et al. (2014) and Darrouzet-Nardi et al. (2016) analyzing a transfer program in Nepal. However, some of these papers report only dietary or consumption-related outcomes.

There is very limited evidence around interventions that provide training around livestock production without an asset transfer. One recent paper analyzed a program providing cows to households in Rwanda and found it was differentially effective when training was also provided, though the offer of training was not randomized (Argent et al., 2014). Janzen et al. (2018) analyze a randomized controlled trial in Nepal in which three arms received different combinations of asset transfer-related programming: an asset transfer of goats, the transfer in conjunction with training, or training only. They find positive effects of all three treatments on financial inclusion and women's empowerment but no effects on assets, expenditure, physical health and food security; there is no evidence of any differential effects comparing across treatments. Another related paper found that the provision of information about the quality of livestock services had significant benefits in Pakistan (Hasanain et al., 2018).

[4]In addition, there is no evidence of any significant effects on broader survey-based measures of women's empowerment (time use, self-efficacy, and gender norms.

Our paper also contributes to a larger literature on agricultural extension, though this literature generally focuses more on cropping practices and related outcomes rather than livestock production. A number of literature reviews have found very mixed evidence on the effectiveness of extension programs, generally observed to have minimal or positive effects, particularly when taken to scale (Evenson, 2001; Birkhaeuser et al., 1991; Anderson and Feder, 2004; Davis, 2011), though a more recent literature has explored potential to bolster extension programs with the use of digital services (Aker, 2011). The majority of this earlier literature was non-experimental, but more recent papers have used randomized designs to analyze the effects of extension programs on adoption of new cropping practices in Mozambique (Kondylis et al., 2017), Uganda (Bobić et al., 2017) and Malawi (BenYishay and Mobarak, 2018).[5]

In addition, a number of interdisciplinary papers analyzing impacts of nutrition-sensitive agricultural development programs have argued that they can have positive effects on income as well as 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).[6] Livestock interventions in particular have been identified as a plausible strategy to provide low-income households with potential income streams (Neumann et al., 2002; Murphy and Allen, 2003). However, rigorous evidence on the role of livestock market-based interventions in improving smallholder incomes — as distinct from nutritional and consumption outcomes — is largely missing (Ruel et al., 2018; Ruel and Alderman, 2013).

Relative to the existing literature, this article is one of the first to provide randomized evidence around the effects of a training-based intervention promoting livestock production in the absence of an actual asset transfer in a developing country context. The evaluation also provides novel evidence about the potential of an intervention targeting poultry in particular to empower women and increase their engagement in household economic activity. Given the growing body of evidence documenting very positive effects of livestock transfer programs — programs that entail a significant cost — it seems extremely important to understand more about whether other potentially lower-cost strategies can be effective in increasing households' engagement in livestock production and realizing the potential associated benefits in economic welfare.

[5]Two other recent papers found large positive effects on agricultural production of cash transfers in conjunction with agricultural extension in Senegal (Ambler et al., 2019) and Malawi (Ambler et al., 2020), but minimal or negative effects of extension alone.

[6]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 Context

Poultry production is an important contributor to the agricultural economy of Burkina Faso, and it remains a major source of income and dietary inputs for large numbers of rural households (Gning, 2005). Nevertheless, the focus on crop cultures such as cotton dating back to the colonial period has rendered poultry a secondary priority at the government level, with minimal investment from government research and development policies (Kondombo et al., 2003).

The poultry sector in Burkina Faso is characterized by a large proportion of smallholders, in addition to a small number of large-scale, intensive producers. Large-scale producers are concentrated in the vicinity of the two main cities, Ouagadougou and Bobo-Dioulasso. Data from the 2010 Agricultural Census shows that 99% of the producers are smallholders (defined as owning a flock of between five and 50 poultry), owning 98% of the poultry flock, and producing 99% of the supply of meat and 86% of the supply of eggs (Food and Agriculture Organization, 2018). Other estimates suggest that 20,000 chickens and guinea fowl supplied by rural producers reach the capital daily (Gning, 2005).

Demand for local poultry is high, reflecting potentially a preference for locally raised varieties, as well as the virtual absence of chicken imports in a landlocked country with poor access to ports (Schneider et al., 2010). Accordingly, the most significant challenge facing the poultry sector is limited supply, a challenge that partly reflects the high poultry mortality experienced by smallholders. Two main diseases account for poultry mortality in this context: Newcastle disease and fowlpox, with the first more prominent and lethal. Newcastle disease follows a seasonal pattern with a peak reached during the dry season (approximately November to March) (Sonaiya and Swan, 2004). Although preventive vaccines against Newcastle are now available worldwide, in Burkina low adoption rates and limited access continue to be challenges (Alders and Pym, 2009).

In addition, poultry production by smallholders is often primarily the responsibility of women, who 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. In some cases, poultry products are brought to the market through traders who either buy poultry from multiple smallholders in villages and sell it at a higher price on markets, or serve as an intermediary between the primary buyer and

the farmer against some margin on the sales. In addition, poultry play a significant role in cultural life as gifts and sacrifices (Kondombo et al., 2003).

3 Experimental design

3.1 Sample and randomization

This evaluation was conducted in 60 communes (rural and peri-urban) within three targeted regions of Burkina Faso (Boucle du Mouhoun, Centre-Ouest, and Hauts-Bassins). The program implementer identified 79 communes that were available for scale-up in these regions 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.[7] Within this sample of eligible communes, the communes included in this evaluation were selected randomly.

Randomization occurred in two phases, and is 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; more specifically, 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.[8] 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. The relevant covariates include population size, presence of a government center, number of women's associations, main agricultural crop, main source of revenue, presence of a regular market, presence of a health center, number of functional boreholes, and number of functional wells.

The second-level randomization then subdivided the treatment communes into 15 communes (30 villages) assigned to the base SELEVER intervention and 15 communes assigned to the SELEVER + WASH intervention, and identified 15 communes in the control arm that would serve as the control subsample. More specifically, the randomization procedure similarly generated 3,000 permutations of assignment to the two treatment arms as well as selection into the control subsample, and identified the permutation char-

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

[8]Villages that did not have the target population size for the intervention were excluded from the list. On the one hand, villages projected to have fewer than 15 households with children in the two to four year old range (based on the population of women of reproductive age and age-specific fertility rates from the latest Demographic and Health Survey) were not eligible for inclusion in the evaluation. On the other hand, villages with population over 5000 were not considered to be rural, and were similarly ineligible.

acterized by the minimal predictive power of baseline covariates at the commune and village level. This subsample of 45 communes was selected for additional, intensive longitudinal data collection, and will also be used to analyze the differential effects of the SELEVER+ intervention.

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 in the evaluation, provided that members provided consent for participation and did not state an intention to move out of the study area within six months post-baseline. A household census including the full community was conducted prior to the baseline to collect basic demographic variables to enable construction of 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.

In the 45 communes (90 villages) that were included in the subsample targeted for additional longitudinal follow-up, 12 households were randomly selected within the 15 sample households for the additional longitudinal follow-up. (The remaining three households in each village were included only in the main survey rounds.) These 1080 households constitute the longitudinal subsample.

As this trial is a multidisciplinary trial incorporating nutrition and health outcomes, a full trial protocol was published (Gelli et al., 2017) that included the specification of 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.[9]

Power calculations were conducted for the primary outcomes using data from a separate impact evaluation (Olney et al., 2015). In analysis of the full sample of households, estimates suggest 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).[10] Ethical approval for the evaluation 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.

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

[10]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).

3.2 Intervention

The SELEVER intervention is multifaceted, reflecting the program's broad objectives in strengthening the poultry value chain and enhancing both the supply of and the demand for nutritious food inputs (Gelli et al., 2017). In particular, it includes intervention components in three broad sectoral areas: poultry, nutrition and health, and gender. This analysis will focus solely on the poultry intervention, and this intervention itself includes three components: training around poultry production, capacity-strengthening of village vaccination services, and enhanced access to credit.

The primary axis of the SELEVER poultry intervention is the provision of training around poultry production to rural households, delivered via village-level producers' and savings groups.[11] Eight poultry training modules were delivered by trained facilitators from the NGO partners leading SELEVER, 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. The facilitators can be viewed as broadly similar to extension agents.

The second component of the intervention is capacity strengthening of village vaccination services. Rural poultry producers rely for extension services on a system of village vaccination volunteers (VVVs), a volunteer corps trained by government extension agents to provide basic livestock services (e.g., vaccinations, deworming and nutrition advice) to households in their own and nearby villages. 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 in all communities; however, the intervention provided additional training around poultry production techniques for the volunteers (using the same training curriculum administered to producers), and also provided them with a basic start-up kit including a cold storage unit, a syringe and needle, and 100 doses each of poultry vaccines and deworming pills.[12] The VVVs were not constrained to provide these inputs to poultry producing households free of charge, however, and could sell or distribute them for a profit.

The third component of the intervention is enhanced access to credit for both male and female poultry producers. 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

[11] 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.

[12] aimed to develop a cohort of women VVVs to better reach women poultry producers.

explicit credit guarantee. Credit was available based on standard commercial criteria designed to identify a viable enterprise, and these criteria were largely discretionary.

In addition to the interventions targeting poultry production, a second major intervention domain is health and nutrition, and a cross-cutting focus on gender was integrated into both poultry and nutrition programming. An analysis of the nutritional programming and its effects on maternal and child nutrition will be reported separately. The final intervention domain focuses on gender, and seeks to provide additional training via women's associations aimed at enhancing women's role in decision-making within households and the community around entrepreneurship, agriculture, and child nutrition and caretaking. In this paper, we will present results on the effects of SELEVER on measures of women's empowerment that may reflect the effects of both the gender-sensitive poultry intervention and gender-targeted interventions.

3.3 Data collection

This analysis uses two primary waves of data collection: a baseline survey and endline survey both conducted in the lean season in 2017 and 2019, respectively, and both including only the longitudinal subsample of 1080 households (90 villages).[13]

In each wave of data collection, a household survey collected extensive information on household economic activities; sex-disaggregated data were collected on poultry production (including inputs, flock size, marketing, revenue, and profits), credit access and use of financial services, and empowerment. To collect data about poultry, questions were posed to the male member of the household who is identified to be most knowledgeable about the household's poultry activities (usually, but not always the head of household), as well as the woman who is most knowledgeable about poultry among the women of the household. For example, in a household containing both men and women, the male household head reported about poultry owned by male members of the household and poultry owned jointly by household members, and the most knowledgeable woman reported about poultry owned individually by 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

[13]Limited data will be drawn from an earlier baseline survey conducted in a different season (the post-harvest season), and including all 1800 households in 120 villages. Additional follow-up data may be collected in 2020 to measure longer-term effects of the intervention for the larger trial sample, but this is uncertain given current challenges linked to Covid-19 as well as ongoing conflict in Burkina.

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.

In addition, empowerment was measured using the project-level Women's Empowerment in Agriculture Index (pro-WEAI), soliciting responses from the same men and women who responded to the questions related to poultry production. The pro-WEAI includes six indicators of instrumental agency (input into productive decisions, ownership of land and other resources, access to and decisions on financial services, control over use of income, work balance, and visiting important locations), four indicators of intrinsic agency (autonomy in use of income, self-efficacy, attitudes about intimate partner violence against women, and respect among household members) and two indicators of collective agency (group membership and membership in influential groups). For the lean season survey, only data on time use (for the work balance indicator) and self-efficacy were collected, based on the potential for these to vary by season.

4 Empirical results

4.1 Baseline balance and trends over time

In order to characterize the sample and summarize trends over time, Table 1 presents comparisons across the (pooled) treatment arm and the control arm in the lean season baseline and lean season endline, as well as the p-value corresponding to a test of equality of lean season baseline covariates across arms.[14] Again, for concision, throughout the subsequent discussion we will denote the lean season baseline and the lean season endline as simply the baseline and endline, respectively.

We first present a summary of household demographic characteristics and baseline poultry production; 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 24 birds on average at baseline, and this number has increased only slightly at endline. (Input costs were not collected comparably at baseline and endline, and thus accordingly only endline summary statistics are presented.)

[14]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.

When we examine marketing behaviors, the probability of reporting any poultry revenue is around 67% at baseline and the probability of reporting any egg revenue around 11%, and these rates increased only marginally by endline. It is clear that it is much more common to monetize poultry production via sales of meat, vis-a-vis sales of eggs; this may reflect structural challenges in marketing eggs given their fragility. However, very substantial trends are evident in poultry revenue and poultry profits. In the control arm, poultry revenue increases by 34% over a two-year period on a base of $28, and profits increase by a factor of 2.7 in the same period, increasing from around $8.50 to nearly $23. Similar shifts are evident if we examine the median of the distributions: in the control arm, median revenue increases by 21%, and median profits increases by a factor of 3.4.

To capture this graphically, Figure 2 presents histograms for revenue and profits at baseline and endline among control arm households. (These variables are winsorized at three standard deviations above the mean to remove the influence of outliers, and a parallel strategy will be used in the main results.) It is evident that there has been a shift in mass across the distributions, with a notable reduction in the mass of households reporting zero revenue and/or negative profits, and an increase in the number of households reporting positive estimates of revenue and profits. Accordingly, it appears there has been a meaningful shift in the dynamics of poultry production even in control communities.

In addition, Table 1 reports two variables capturing aspects of empowerment drawn from the pro-WEAI (project-level Women's Empowerment in Agriculture index): self-efficacy and work balance. Self-efficacy is a scale capturing respondents' belief in their capabilities and ability to reach their goals. Work balance is a binary variable equal to one if the respondent works fewer than 10.5 hours a day, where the workload is equal to time reported spent in the respondent's primary productive activity plus half the time reported spent in childcare as a secondary activity (Malapit et al., 2019). Summary statistics suggest self-efficacy for men has decreased slightly over time in the control arm, while self-efficacy for women has increased slightly; work balance appears to have increased for both men and women.

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. The Table also reports the p-value corresponding to a joint F-test of balance across all covariates reported, and again the hypothesis of balance cannot be rejected.

4.2 Intervention exposure

Table 2 reports a series of variables capturing exposure to the SELEVER intervention for households assigned to the control and treatment arms; Column (7) reports a p-value cor-

responding to a test of equality across treatment and control arms.[15] On average, about 30% of all households in SELEVER communities report that they have benefited from the SELEVER intervention; there is some evidence of contamination in the control arm, as 14% of households report benefits, but the difference in exposure is clearly significant.

Similarly, about half of households surveyed report they attended at least one training around poultry, and attendance is relatively balanced by gender: 37% of households report at least one woman attended the training, and 43% of households report at least one man attended the training. The total number of trainings attended in aggregate by the household is around 2.6, relative to eight total modules administered. Attendance at business-oriented trainings was somewhat lower (around 28%), but again balanced for men and women. Reported household participation in poultry producers' groups, the fundamental platform for the SELEVER intervention, is lower relative to inclusion in trainings; 24% of households report that they are a member of a producer group, and again roughly equal numbers report that at least one male (female) member is a member of the group. The final row of the Table reports engagement with the village-level VVVs: here, even the control group reports that nearly 70% of households know at least one VVV, but this increases to 81% in treatment communities.

In order to capture a summary measure of intervention exposure given the program's diverse facets, 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 SELEVER.) Using this measure, around 60% of households in intervention communities reported some exposure to the poultry-related interventions rolled out, while 20% of households in control communities reported similar exposure. It is important to note that there is presumably noise in this measure, and the bias induced by the noise could run in both directions. Households may have participated to a limited extent in the intervention and failed to report it if their participation was not salient, or they did not attribute the activities experienced to SELEVER; alternatively, households may overreport their participation if they were included in another program with similar goals, and misinterpreted this experience as corresponding to this intervention.

To sum up, it is clear that SELEVER had a meaningful presence in treatment communities, reaching around half of all sampled households with poultry-related trainings, and including around a quarter in producers' groups. For all indicators examined, exposure to SELEVER is significantly higher in treatment communities vis-a-vis control commu-

[15]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.

nities. The evidence also suggests that participation is balanced by gender, consistent with the intervention's goals of enhancing women's participation in poultry production.

4.3 Main specification

The primary specification of interest is an ANCOVA specification that exploits the randomized design. More specifically, 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 $\chi_{ivc,t-1}$.[16]

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

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.

Given that the sample includes 45 communes (30 treated communes), we also report alternate p-values estimated using the wild bootstrap to adjust for any bias due to the relatively low number of clusters.[17] In addition, for primary and secondary outcomes, we report q-values corrected for multiple hypothesis testing, using the Simes method (Newson, 2010). This correction is implemented for the three primary outcomes (Panel A of Table 3), for the set of ancillary variables linked to primary outcomes reported in Panel B of the same table, and for each family of secondary outcomes (Tables 5 and 6).

4.4 Primary outcomes

Table 3 reports the effects for the main outcomes, estimating equation (1). Primary outcomes pre-specified in the protocol were poultry production (total stock value), revenue and sales, reported in Panel A. It is evident in Column (1) that there is no significant increase in total stock value. However, we observe in Column (2) an increase in the level of revenue that is significant at the five percent level and fairly substantial in magnitude: revenue increases by \$8.67 on a mean of \$37.86, an increase of 22%. (Revenue is coded as zero for households that did not report any poultry sales.) This coefficient remains significant at the five percent level using wild bootstrap p-values, and at the ten percent

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

[17]Cameron et al. (2008) suggests that overrejection can arise when the number of clusters is between five and thirty, suggesting that this case is marginal in terms of the magnitude of the bias; to estimate the wild bootstrap p-values, we utilize the Stata command boottest (Roodman, 2019).

level using q-values corrected for multiple hypothesis testing. However, there is no meaningful effect on household profits: the coefficient reported in Column (3) is positive, but small in magnitude ($3 or around 13%) and statistically insignificant.

Panel B reports ancillary variables that capture alternate dimensions of poultry production and revenue in order to explore the robustness of these results; note these variables were not pre-specified. Columns (1) and (2) confirm that there is no significant shift in poultry production as measured by the probability of reporting any poultry owned (96% of households even in the control arm report raising poultry), or the number of mature birds owned. There is no shift in the probability of reporting any revenue from poultry production in Column (3), suggesting that the previously reported effect is only along the intensive margin, rather than the extensive margin; 72% of households in the control arm report revenue from poultry production, and the increase in this probability in SELEVER communities is 2 percentage points and statistically insignificant. In addition, there is no evidence of any shift in revenue from egg production, as reported in Columns (4) and (5).

Given that one important objective of SELEVER is to increase women's engagement in and decision-making around poultry production, we also re-estimate this specification for the same variables as reported for poultry owned by men and women, as well as poultry owned jointly by multiple household members. 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).

We then re-estimate equation (1) to evaluate the effects on gender-specific dimensions of poultry production, reported in Table 4. The bottom rows of Panel B and Panel C report p-values testing the equality of coefficients across the specifications estimated for poultry owned by men and women, and poultry owned by men and jointly owned poultry, respectively. The first important observation evident in this table is that the level of poultry production reported by women is only a fraction of that reported by men. In the control arm, men report an average of 20 mature birds while women report owning only three, and men's reported flock value, revenue, and profits are nine times, ten times, and nearly twenty times women's reported values for the same variables. The estimated means for jointly owned poultry are roughly the same, or slightly higher, relative to the

means for poultry owned by women.

Given this pattern, the evidence suggests there is no meaningful difference in treatment effects comparing across poultry ownership categories, and we uniformly fail to reject the hypothesis that the effects are equal for poultry owned by men and women, and for poultry owned by men and owned jointly. Women do report increases in the number of mature birds and in stock value that are proportionally large (36% and 41%, respectively) and significant or close to significant at conventional levels, but again the estimated difference is noisy.

Thus in a context in which women's engagement in poultry production is dramatically lower vis-a-vis men, SELEVER seems to be effective in generating shifts in poultry production that are of parallel magnitude for both men and women, as well as poultry owned jointly. Given women's baseline low level of engagement, this pattern may be interpreted as promising. However, when we analyze experimental effects for a series of variables capturing women's empowerment, we see no evidence of any effects. As noted above, we analyze self-efficacy and work balance as measured in the pro-WEAI; the number of minutes reported engaged in childcare, work, and non-work activities given the importance of the respondent's work burden in a context of a project targeting increased engagement in poultry; and a gender norm attitudes scale, coded such that a higher value corresponds to more support for gender equity (Waszak et al., 2001; Nanda, 2011). The results are reported in Table A1 in the Appendix, in Panel A for variables reported by men and in Panel B for variables reported by women, and are uniformly null.[18] This while the intervention may have roughly equivalent effects on poultry production for men and women, it does not seem to explicitly enhance women's empowerment.

4.5 Secondary outcomes

Tables 5 and 6 report experimental effects for additional secondary outcomes of interest, also pre-specified in the protocol (Gelli et al., 2017). In Table 5, Panel A reports variables around poultry practices. Column (1) reports regression results for a simple knowledge index, created by aggregating the respondent's (binary) responses to a series of nine questions about appropriate poultry practices. Column (2) reports the cost of

[18]For the gender norms scale, additional treatment effects for each item are reported in Table A2 in the Appendix. For men, the only statistically significant effects are a shift toward gender equity in response to item eight ("The only thing a woman can really rely on in her old age is her sons") and a shift away from gender equity in response to item 13 ("Daughters should be told that an important reason not to have too many children is so they can work outside the home and earn money"). Other coefficients are varying in magnitude and sign. For women, the only statistically significant effect is a shift away from gender equity in response to item two ("Daughters should be sent to school only if they are not needed to help at home"). Wild bootstrap p-values are reported, but q-values corrected for multiple hypothesis testing are excluded given that this analysis is exploratory.

poultry inputs. Columns (3) through (7) report a series of binary variables capturing poultry practices: whether poultry are vaccinated, fed cereals, fed concentrate, provided deworming medications, and confined in a poultry henhouse (rather than ranging free).

The results suggest that households in the SELEVER communities report a weakly significant increase in the knowledge index: the number of questions answered correctly increases by .05 on a mean of .63; again, the mean score corresponds to the average number of (binary) questions to which the respondent provides the correct response. Column (2) suggests that there is a substantial increase in reported input costs evident in Column (4); input costs increase by nearly 50%, an increase of $6.66 relative to a mean of $13.45 in the control arm.[19] Moreover, the increased expenditure on inputs is consistent with the observed increase in vaccination, concentrate feeding, and deworming reported in Columns (3) through (7), and the shift in the probability of utilizing these practices is proportionately large: an increase of between 7 and 11 percentages points relative to a mean probability in the control arm of 52% (for any vaccination), 10% (for concentrate feeding) and 21% (for deworming).[20] These effects are observed to be consistently statistically significant using both the wild bootstrap-corrected p-values and the multiple hypothesis-corrected q-values, though the increase in vaccination is only significant at the ten percent level.

Panel B in the same table reports variables linked to use of financial services: whether the household reports any bank account, any deposits (in the last six months), the amount reported deposited (in the last six months), and whether the household reports any loans and the amount of the loan. Two variables linked to the supply of financial services at the village level are also reported: the number of credit groups, and the number of organizations promoting access to credit in the organization. In general, there is little evidence of any significant effect on use of financial services or use of credit. There is some noisy evidence of an increase in the amount deposited (an increase of 17% relative to the control arm, insignificant when multiple hypothesis-corrected q-values are employed), but no increase in utilization of or supply of credit. These results are also consistent with findings from a parallel qualitative study that reported minimal effects of the intervention on credit access (Eissler et al., 2020). Broadly, it appears that expansion of microcredit services in control communities driven by other organizational or commercial objectives has been comparable to the SELEVER-targeted expansion of microcredit services in treatment communities.

[19]Further exploration allows us to identify that this increase in input costs is driven solely by increase in inputs purchased (as opposed to poultry purchased to enlarge the flock).

[20]In addition to feeding practices, data was also captured on whether the poultry were provided water at will. However, 95% of households in the control group report that they provide water at will, and thus unsurprisingly no experimental effect was observed on this outcome.

Table 6 reports variables linked to poultry marketing and poultry mortality and consumption. In Panel A, Columns (1) and (2) report the number of birds sold and the estimated price (the product of these two variables is revenue); and Columns (3) through (5) report binary variables for whether the household reports selling poultry at home, at a market, and door to door. It is evident that the treatment households report a substantial increase in the number of poultry sold (an additional two birds relative to nine birds in the control arm, for a proportional effect of over 25%).[21] The effect on price is positive but small in magnitude and insignificant, and there is no evidence of a shift in sale locations. This suggests that households are not responding to the intervention by accessing new commercialization opportunities (i.e., in a more distant or central market).

Panel B reports variables capturing poultry mortality over the past six months and the number of poultry reported consumed. There is no evidence that households exposed to SELEVER report lower poultry losses, in absolute terms, using a binary variable for any losses, or when losses are normalized with respect to the present flock, as reported in Columns (1) through (3).[22] Treatment households do report more own-consumption in Column (4), an increase in .8 chicken consumed relative to a base of 2.6, though this effect is not significant when using the multiple hypothesis-corrected q-values. In Column (5), we confirm that there is no treatment effect on total flock size (including chicks), consistent with the previously reported null effects for the number of mature birds.

To sum up, evidence suggests that SELEVER had a significant effect on inducing households to increase their revenue from poultry production and their use of poultry inputs, holding the estimated value of the flock roughly constant (and with no significant reported decline in poultry mortality). However, there is no robust evidence of any increase in profits, consistent with the hypothesis that the increase in revenue is counterbalancing the cost of inputs. The absence of any increase in credit utilization is consistent with this pattern, suggesting that households are self-funding their increased purchases of poultry-related inputs.

4.6 Heterogeneous effects

Treatment effects by subarm In order to analyze the separate effects of SELEVER and SELEVER+, the intervention including an additional WASH intervention, we first

[21] This coefficient is narrowly insignificant at conventional levels when multiple hypothesis-adjusted q-values are employed.

[22] Mean reported poultry losses are extremely high — a mean of 35 and a median of 16 — relative to reported total flock size as of the survey date, characterized by a mean of 49 and median of 38. The distribution of reported poultry losses is characterized by significant outliers, evident in the larger gap between mean and median; this pattern is consistent with the hypothesis that large producers are particularly vulnerable to large-scale epidemics in which a large number of poultry are lost.

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 (2) in order to identify the effects of SELEVER and SELEVER+, the intervention including an additional WASH intervention.

$$Y_{ivct} = \beta_1 S_{vc} + \beta_2 S_{vc}^{+} + \beta_3 Y_{ivc,t-1} + \chi_{ivc,t-1} + \epsilon_{ivct} \tag{2}$$

Given that the causal channel of an effect of the additional WASH intervention on poultry production is not clear, we emphasize the simple comparison (pooled treatment 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 more positive for SELEVER+ (though it is not significantly different from zero). The estimated coefficient for revenue is statistically significant only for SELEVER+, but again the difference is not significant.

4.7 Treatment effects for large producers

As previously noted, the sampling strategy for the trial entailed oversampling of large producers, identified as households reporting a flock of 20 or more chickens. Accordingly, it seems appropriate to examine heterogeneous effects for households reporting flocks of various sizes. However, it is also evident in the data that the reported flock size shows high variability over a relatively short time horizon.[23] In order to abstract from this

[23]The correlation between the number of chickens reported owned in the census (in which all households in each sampled commune were identified and their poultry flock size estimated, to enable sampling

short-term variation, 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), and generate a binary variable for large producer equal to one if this mean flock size is over 20.[24]

We then re-estimate equation (1) including separate binary treatment variables for small and large producers, and including the large producer dummy as an additional covariate. The results are presented in Panel A of Table A8 in the Appendix. In general, the observed increase in revenue seems to be concentrated among large producers, though small producers report a weakly significant increase in stock value. However, the hypothesis that the effects are equal cannot be rejected for any outcome.

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. 68% 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. Here, there is no evidence of any treatment effects for households that were not selling at baseline. By contrast, households that were selling poultry show evidence of an increase in the number of birds and flock size and increased revenue, and the difference between the coefficients estimated for the two sets of households is statistically significant (at the ten percent level) for these three outcomes.

To sum up, analysis of heterogeneity based on producer size (defined using flock size) at baseline does not show any meaningful evidence of heterogeneity, perhaps reflecting the noise in baseline measurement of flock size. However, a separate analysis of heterogeneous effects allows us to conclude that the effects of SELEVER are entirely observed among households who already reported revenue from poultry sales at baseline.

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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.

[24]Using this method, we identify 55% of households as large producers, considerably higher than the sampling target of 40%. This finding appears to reflect the fact that average flock size reported in the census is considerably lower than average flock size reported in the subsequent two rounds. The median is about 29% lower than the median in the post-harvest baseline, and 50% lower than the median in the lean season baseline. This pattern would be consistent with a substantial increase in average flock size over time (though a similar time trend in flock size was not evident in Table 1), or substantial underestimation of flock size by households in the absence of a detailed poultry module.

5 Discussion

The evidence presented here suggests that an intervention that offered poultry production training for households in conjunction with capacity building in extension services and credit institutions was effective in engaging nearly 60% of households, and led to a significant increase in revenue as well as a significant increase in expenditure on inputs; however, there is no shift in profits as observed in the lean season.

In interpreting these results, it is useful to start with the question of the return to inputs. Households exposed to SELEVER programming have meaningfully increased their use of poultry inputs; what is the realized return? There is no evidence of any direct effect on flock size or flock value. However, the results previously presented suggest that households in the treatment arm are consuming and selling more poultry over the past six months, a period from roughly May to September in the calendar year. They report no reduction in losses over the past six months, but as of the survey date report on average flock sizes that are comparable to or weakly greater than households in the control arm. These patterns are prima facie incompatible, but could be consistent with two possible hypotheses.

The first hypothesis is that households are not reporting the changes in their poultry inventory accurately. Presuming that current flock and sales are most likely to be reported accurately (given that sales are relatively salient), there may be errors in reported poultry mortality or consumption. In either case, to render the estimates compatible, control (treatment) households would have to be systematically underestimating (overestimating) their poultry losses or their poultry consumption.

The second hypothesis is that treatment households expanded their flocks prior to the recall period, and then sold and consumed more over the six months immediately prior to the survey, converging to a flock size similar to those observed among control households. (Note that input use was also reported only for the past six months, but presuming there is some serial correlation in this measure, treatment households may also have used inputs more intensively in prior periods, and would have realized any positive returns to these inputs.) In this case, there would need to be some pronounced seasonality in the mortality returns to inputs, such that these returns are observed primarily outside the recall period of May to September.

Evidence around the seasonality of poultry disease is limited. Global reviews have highlighted that Newcastle disease in particular has seasonal outbreaks (Awan et al., 1994), and the dry season is identified as a higher risk period (Sonaiya and Swan, 2004). Evidence from the region suggests that poultry mortality in Nigeria (Abalaka et al., 2013) and Ghana (Awuni, 2002) is higher in the dry season (or in the case of Nigeria,

both the late rainy and the late dry seasons). In Burkina Faso, the dry season is generally identified as December through March (USAID, 2017). If mortality from diseases targeted by vaccines is highest in this period, then mortality effects may not have been evident during this survey's reporting period (approximately March through September).[25]

In general, it seems reasonable to conclude that treatment households did benefit from some positive returns to the poultry inputs employed in reducing mortality, such that they could sell and consume more chickens and still report a similar flock size. However, it remains puzzling that no direct effect on mortality can be detected, and hypotheses about seasonal effects must remain speculative.

Shifting to the observed effects on revenue, households exposed to SELEVER also report an increase in the number of chickens sold. Correlational evidence suggests that it is in fact households who are increasing their use of inputs who are simultaneously increasing their revenue: the correlation between input use and reporting any poultry revenue is positive in the control arm, but positive and significantly larger in magnitude in the treatment arm, suggesting that the intervention is encouraging a subset of responsive households to simultaneously increase input use and sales. However, these households do not command a higher price for their poultry.

Again, this pattern would be consistent with multiple interpretations. It may be that the return to inputs is observed only in flock size growth (again, seemingly primarily outside the recall period), and there is no effect on observable quality that can be rewarded in the market. It may be that the use of inputs (e.g., concentrate feeds) does increase the number of chickens who meet some minimal quality threshold rendering them suitable for sale in the market, but conditional on passing this threshold, these marginal chickens do not command a higher price. Alternatively, there may be some effect on quality that is unobservable in the market, or an effect on quality that is captured by intermediaries (i.e., traders) rather than the selling household.

From a welfare perspective, the clear absence of any effect on profits — even for households who participated in SELEVER — seems to suggest that the returns to inputs certainly do not exceed their cost in the absence of any subsidy in this context. There may be some minimal welfare benefits associated with the increase in consumption, though a separate analysis has concluded that the increase in consumption was not observed among women of reproductive age or young children, suggesting it may be primarily men who benefit from the increased consumption. This finding is also consistent with qualitative

[25]It is also important to note that returns to vaccine use may be low if vaccines are not deployed appropriately: prior to the arrival of the disease, using an appropriate dosage and a nonexpired (and appropriately refrigerated) vaccine. If vaccine services provided by the VVV do not meet these criteria, limited effects on mortality are unsurprising, and in fact adverse effects would also be possible (Dimitrov et al., 2017).

evidence that poultry are primarily consumed for celebrations or special events and not routinely, and that access to the meat is not necessarily universal even when poultry is consumed (Eissler et al., 2020). In general, however, the SELEVER intervention seems to have stimulated poultry commercialization without meaningfully enhancing household welfare, simply because the cost of the inputs utilized was substantial. These results are also consistent with a recent analysis from Ethiopia that uses dynamic modeling to estimate the effects of various interventions targeting increased poultry input use, and concludes that generally there are no positive effects on profits (Woldegiorgiss et al., 2016).

5.1 Effects for households participating in SELEVER

As previously summarized, around 57% of households in intervention communities report any participation in SELEVER. This level of attendance at an agricultural training is somewhat lower than attendance at comparable training programs analyzed in other randomized controlled trials, though not dramatically so. Ogutu et al. (2018) report take-up of agricultural extension services in Kenya between 60% and 80%; Takahashi et al. (2019) similarly reports attendance of 72% at a training for rice farmers in Cote d'Ivoire. A randomized controlled trial in Mozambique that invited contact farmers – "model" farmers who already play a role in agricultural extension – to trainings found universal attendance in the first round, but attendance of only 63% for a second training two years later (among a sample that presumably has already demonstrated high interest in training). Finally, an evaluation of a wheat package including training in Ethiopia reported attendance rates between 38% and 60% (Abate et al., 2015), but the higher rates were observed only for farmers also offered a package of subsidized inputs.

Nonetheless, given that participation in training was lower than observed in some other contexts, we present further evidence about the effects of SELEVER for households who directly participated in the intervention. More specifically, we analyze evidence about baseline characteristics that predict participation, as well as estimated treatment effects for participating households, also known as an "as treated" analysis as distinct from an intent-to-treat analysis. The latter analysis was also pre-specified in the protocol (Gelli et al., 2017). Given that households who choose to participate are clearly different from households who choose not to do so, this analysis must be considered correlational rather than causal. In particular, if households who opt to participate are those who perceive that the intervention has relatively higher returns, it is plausible to expect that these households will in fact show evidence of more positive treatment 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, the only baseline covariate that significantly predicts participation in SELEVER is baseline revenue: households that had higher revenue from poultry production at baseline are more likely to participate. (Households with higher revenue from egg sales are in fact somewhat less likely to do so.) There is also some weak evidence that households characterized by work balance for the husbands are more likely to participate, consistent with the hypothesis that other households may face time constraints that limit their engagement.

Second, we seek to estimate two specifications that allow us to evaluate the effects of SELEVER on households who participated in the intervention. The first specification simply re-estimates equation (1), restricting the sample of households in the treatment communities to those who participated in the intervention and controlling for the baseline selection variables analyzed in Table A6. The second specification is more complex, and entails estimating a difference-in-difference for households who do and do not participate in the intervention, employing kernel propensity score matching (Heckman et al., 1998; Villa, 2016).[26]

Both sets of estimates are reported in Table A7: Panel A reports the restricted sample results, and Panel B reports the difference-in-difference estimates using propensity score matching. Consistent with our hypothesis, the estimates are significantly more positive vis-a-vis the main intent-to-treat estimates reported in Table 3, and in general the results using the two specifications reported in Panels A and B do not differ meaningfully. The estimated coefficients suggest participation in SELEVER leads to a significant increase in both the number of mature birds and stock value (around 25% and 20% relative to the mean in the control arm, respectively). The increase in input costs and revenue are now larger in magnitude (more than 50% and more than 20%, respectively), and there is some evidence of an increase in the probability of reporting any poultry revenue and any revenue from egg sales (in Panel B). Interestingly, however, the estimated effects on profit remain positive but insignificant.

To sum up, this evidence suggests that there is some positive selection into participation in SELEVER for households who are already more engaged in commercialization of poultry at baseline. Unsurprisingly, these households also seem to benefit more, expanding their poultry flock and showing larger effects on input costs and revenue. However, even these households with more extensive experience in the poultry business and direct participation in SELEVER do not seem to increase their profits at this point.

[26]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).

5.2 Interpreting welfare effects

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 asset transfers may be challenging. Clearly, the cost 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, 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.)[27] 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.

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.

6 Conclusion

This article provides new evidence about the effects of a multifaceted intervention, SELEVER, providing poultry-related training and capacity-building for village-level veteri-

[27]The absence of any substantial effects on female empowerment is also consistent with the emphasis on asset transfers in the existing literature around increasing the role of women in high-value commodity prices (Quisumbing et al., 2015). Here, previous research has generally concluded that targeted asset transfers play an important role in increasing women's participation in these productive activities.

nary and credit institutions and evaluated in a randomized controlled trial in Burkina Faso. The empirical evidence suggests that the intervention was successful in engaging households in training and poultry producers' groups, and stimulated an increase in the use of poultry inputs and an increase in the commercialization of poultry (the number of poultry sold) and revenue. These effects are larger for households that already reported poultry revenue at baseline, and larger for households who directly participated in the program; however, there is no evidence of an increase in profits for any subset of households.

A growing literature analyzes interventions targeting enhanced livestock production in developing countries, and the majority of this literature has analyzed programs in which households receive an actual transfer or livestock, with or without additional training or wraparound services. In general, these interventions have shown large positive effects on household economic welfare, but there is very little evidence around programs that provide only training and other services targeting a strengthened value chain. Evidence here suggests that the positive effects of training only interventions may be small, a pattern consistent with the hypothesis that lower-cost interventions are not sufficient to increase poor rural households' profits from livestock production. Future research may benefit from exploring in more detail the barriers limiting poor households' engagement in livestock production, in particular high observed mortality and an inability to transition to larger-scale production.

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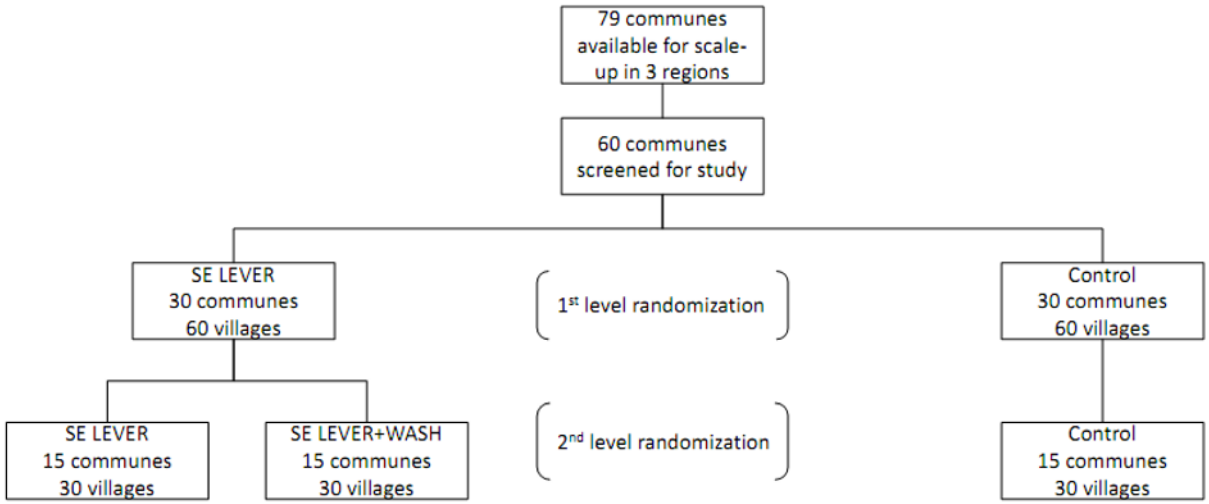
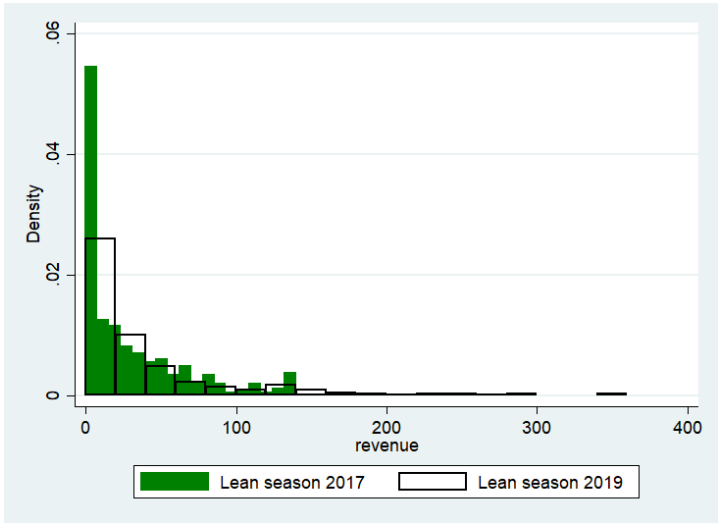
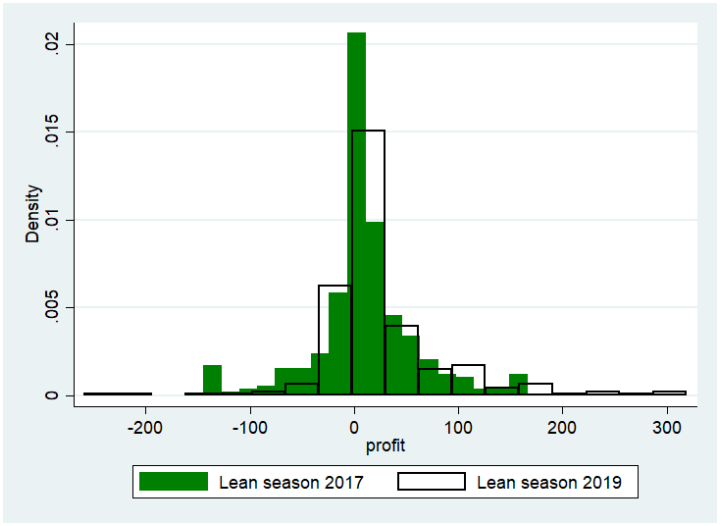


Figure 1: Evaluation design



(a) Revenue



(b) Profit

Figure 2: Histograms of revenue and profits: baseline and endline

Note: These histograms capture revenue and profits from poultry production at baseline and endline among control arm households. Outliers are winsorized at three standard deviations above the mean.

Table 1: Summary Statistics Across Arms: Lean Season 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	43.869	44.656	.213		
Any primary education (household head)	.086	.055	.01		
Household size	9.388	9.449	.356		
Polygynous	.48	.493	.268		
Any poultry	.977	.982	.221	.96	.97
Number mature birds	24.281	23.933	.799	25.754	28.517
Stock value	97.324	95.671	.722	108.874	117.18
Input costs		.333	13.446	18.671	
Any poultry revenue	.671	.685	.864	.72	.743
Any egg revenue	.129	.106	.766	.149	.129
Poultry revenue	28.29	31.929	.409	37.864	47.56
Egg revenue	1.373	1.428	.373	1.147	.873
Poultry profits	8.47	13.714	.437	22.974	27.987
Self-efficacy: men	.626	.607	.815	.598	.645
Work balance: men	.743	.741	.847	.807	.819
Self-efficacy: women	.497	.481	.802	.521	.546
Work balance: women	.231	.243	.794	.294	.216
Joint-test p-value	.190				

Note: This table reports key indicators of interest corresponding to household demographics, poultry production and gender norms 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)
	Control arm			Treatment arm			
Indicator	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.	p-value
Household reports benefits from SELEVER	.02	.14	346	.27	.44	655	.000
Any member attended poultry training	.12	.32	346	.49	.50	655	.000
Attendance at poultry training: female	.06	.24	313	.37	.48	628	.000
Attendance at poultry training: male	.09	.29	298	.43	.49	557	.000
Number of trainings attended (all members)	1.2	.76	38	2.58	2.87	308	.000
Any member attended business training	.11	.31	346	.28	.45	655	.000
Attendance at business training: female	.08	.27	313	.21	.40	628	.002
Attendance at business training: male	.05	.23	298	.21	.41	557	0
Any member participates in producers' group	.04	.20	346	.24	.43	655	.000
Participation in group: female	.02	.15	313	.17	.37	628	.000
Participation in group: male	.03	.16	298	.20	.40	557	.000
Any member knows VVV	.67	.47	346	.81	.39	655	.006
Any reported exposure to SELEVER programming	.20	.40	346	.57	.50	655	0

Note: This table reports summary statistics (mean, standard deviation and number of observations) for variables capturing program exposure as observed in the lean season endline for individuals in the control and treatment arms. 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.

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

	(1)	(2)	(3)	(4)	(5)
	Primary outcomes				
	Stock value	Revenue	Profit		
SELEVER	9.125	8.877**	3.485		
	(9.504)	(3.878)	(4.338)		
Bootstrap p-value	[.344]	[.046]**	[.440]		
Mult. hypo. q-value	[.323]	[.081]*	[.426]		
Mean control arm	108.874	37.864	22.974		
St. dev. control arm	103.904	57.091	57.644		
Obs.	1008	1008	1008		
R^2	.31	.218	.127		
	Robustness: Ancillary measures linked to primary outcomes				
	Any poultry	Number mature birds	Any revenue	Any revenue eggs	Egg revenue
SELEVER	.019	2.820	.022	-.005	-.329
	(.028)	(2.243)	(.048)	(.039)	(.332)
Bootstrap p-value	[.598]	[.224]	[.658]	[.904]	[.352]
Mult. hypo. q-value	[.809]	[.809]	[.809]	[.901]	[.809]
Mean control arm	.96	25.754	.72	.149	1.147
St. dev. control arm	.196	22.59	.45	.356	3.563
Obs.	999	1008	1008	1008	1008
R^2	.042	.267	.071	.091	.07

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, the total amount of poultry revenue, whether the household reports any revenue from egg sales, the total amount of egg revenue, and the total amount of profits. 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 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	1.511	3.744	.023	3.966	.281
	(2.241)	(10.090)	(.053)	(3.456)	(3.874)
Bootstrap p-value	[.490]	[.724]	[.670]	[.278]	[.949]
Mean control arm	20.16	86.42	.62	30.17	18.493
e(N)	1008	1008	1009	1008	1008
e(r2)	.24	.276	.069	.186	.117
Panel B: Poultry owned by women					
SE LEVER	.952*	4.271**	.030	1.183	.355
	(.567)	(2.107)	(.029)	(.777)	(.565)
Bootstrap p-value	[.105]	[.057]*	[.319]	[.135]	[.552]
p-value	.763	.975	.462	.934	.776
Mean control arm	2.683	9.773	.143	3.055	1.94
e(N)	1008	1008	1009	1008	1008
e(r2)	.086	.086	.049	.045	.006
Panel C: Poultry owned jointly					
SE LEVER	.015	.511	.008	2.768	1.884*
	(1.015)	(4.233)	(.034)	(1.731)	(.998)
Bootstrap p-value	[.991]	[.912]	[.826]	[.105]	[.062]*
p-value	.596	.8	.797	.81	.745
Mean control arm	2.357	9.454	.08	3.203	1.677
e(N)	1008	1008	1009	1008	1008
e(r2)	.013	.015	.009	.021	.013

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.

Table 5: 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	.043*	6.376***	.088**	.002	.107***	.070**	.039
	(.023)	(1.800)	(.040)	(.033)	(.025)	(.034)	(.034)
Bootstrap p-value	[.081]*	[.005]***	[.032]**	[.967]	[0]***	[.071]*	[.301]
Mult. hypo. q-value	[.086]*	[.003]***	[.065]*	[.946]	[.001]***	[.065]*	[.317]
Mean control arm	.632	13.446	.52	.969	.104	.211	.08
Obs.	938	1008	943	943	943	943	1008
R^2	.051	.091	.122	.046	.08	.378	.014
Panel B: Financial services							
	Any deposit	Amount deposited	Any loans accessed	Total loans	Num. credit groups	Num. credit-related org.	
SELEVER	.040	13.487**	.052	.139	.055	.197	
	(.051)	(6.799)	(.063)	(.126)	(.180)	(.368)	
Bootstrap p-value	[.442]	[.048]**	[.444]	[.372]	[.809]	[.484]	
Mult. hypo. q-value	[.606]	[.375]	[.606]	[.606]	[.763]	[.694]	
Mean control arm	.271	77.692	.217	.120	.600	.500	
Obs.	1007	1007	1007	1007	89	89	
R^2	.015	.023	.008	.017	.003	.006	

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 past six months; and Columns (4) through (8) analyze a series of binary variables capturing whether the household has engaged in the specified practice over the previous six months. In Panel B, Columns (1) and (2) analyze binary variables for whether the household reports ownership of a bank account or any deposit over the previous six months; Column (3) analyzes the amount reported deposited over the previous six months; Columns (4) and (5) analyze whether the household reports any access to credit, and the amount of credit accessed. Columns (6) and (7) report village-level regressions in which the dependent variables are the number of credit groups and the number of credit-related organizations. Asterisks indicate significance at the ten, five and one percent level.

Table 6: 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	1.982**	.093	.051	-.005	.017	
	(.861)	(.181)	(.075)	(.052)	(.032)	
Bootstrap p-value	[.055]*	[.727]	[.575]	[.797]	[.610]	
Mult. hypo. q-value	[.130]	[.763]	[.763]	[.927]	[.763]	
Mean control arm	9.017	4.342	.329	.314	.029	
Obs.	1008	486	1008	1008	1008	
R^2	.208	.051	.053	.14	.004	
Panel B: Poultry Mortality and Consumption						
	Number lost	Any loss	Mortality ratio	Number consumed	Any consumed	Total flock size
SELEVER	.246	.037	-.080	.775**	.041	4.045
	(5.183)	(.046)	(.162)	(.353)	(.055)	(3.418)
Bootstrap p-value	[.907]	[.393]	[.298]	[.048]**	[.455]	[.314]
Mult. hypo. q-value	[.962]	[.682]	[.750]	[.200]	[.682]	[.682]
Mean control arm	39.289	.771	1.291	2.586	.52	47.634
Obs.	1008	1008	890	1008	1008	1008
R^2	.128	.055	.012	.166	.115	.304

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 last six months, and Column (2) analyzes the price; Columns (5) through (6) analyze binary variables for reported selling in the specified location. In Panel B, the variables of interest are as follows: the number of poultry reported lost due to mortality over the last six months; 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 last six months; 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.

7 Appendix: For online publication only

Table A1: Effect of SELEVER on Gender Norms

	(1)	(2)	(3)	(4)	(5)	(6)
	Self efficacy	Work balance	Childcare time	Work time	Non-work time	Gender norms scale
Panel A: Gender norms reported by men						
SELEVER	.016	.008	6.341	-13.727	15.297	-.202
	(.055)	(.039)	(29.847)	(24.534)	(54.238)	(.390)
Obs.	779	780	780	783	780	793
R^2	.037	.021	.03	.02	.034	.015
Panel B: Gender norms reported by women						
SE LEVER	.046	-.064	-4.720	66.710	-9.410	-.560
	(.061)	(.053)	(28.881)	(70.134)	(33.167)	(.352)
Obs.	851	845	845	851	845	939
R^2	.008	.02	.003	.037	.008	.013

Note: This table reports results for the primary outcomes of interest, and the specification is identical to that described in Table 3. The dependent variables are as follows: Columns (1) and (2) analyze self-efficacy and work balance as measured in the pro-WEAI index. Columns (3) through (5) analyze the number of reported minutes engaged in childcare, in work, and in non-work activities. Column (6) analyzes a gender norm attitudes scale, in which a higher value corresponds to more support for gender equity. Asterisks indicate significance at the ten, five and one percent level.

Table A2: Effect of SELEVER on Gender Norm Attitudes Scale Items

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel A: Gender scale items reported by men														
SELEVER	-.014	-.037	-.014	-.017	.058	.015	.056	.099**	.031	.061	-.045	-.077	-.114*	-.086
	(.050)	(.035)	(.051)	(.050)	(.069)	(.062)	(.038)	(.043)	(.044)	(.051)	(.059)	(.077)	(.067)	(.062)
Wild bootstrap p-value	[.161]	[.123]	[.18]	[.849]	[.324]	[.953]	[.655]	[.210]	[.216]	[.811]	[.996]	[.787]	[.243]	[.524]
Obs.	939	939	939	939	939	939	939	939	939	939	939	939	939	939
R^2	.001	.005	.005	.003	.005	.0004	.006	.015	.003	.003	.002	.008	.016	.013
Panel B: Gender scale items reported by women														
SELEVER	-.043	-.038*	-.077	.004	.062	-.006	.026	.065	.056	-.014	.003	-.023	-.096	-.051
	(.029)	(.022)	(.052)	(.030)	(.060)	(.055)	(.055)	(.049)	(.043)	(.054)	(.077)	(.083)	(.085)	(.079)
Wild bootstrap p-value	[.785]	[.307]	[.786]	[.748]	[.407]	[.805]	[.155]	[.042]**	[.484]	[.298]	[.455]	[.322]	[.090]*	[.171]
Obs.	793	793	793	793	793	793	793	793	793	793	793	793	793	793
R^2	.01	.006	.012	.004	.01	.005	.006	.013	.012	.004	.0005	.002	.028	.015

Note: This table reports results from estimating the primary specification, identical to that described in Table 3. The dependent variables are a series of binary variables that comprise a gender norm attitudes scale capturing attitudes around male privilege and equity for girls (Waszak et al., 2001; Nanda, 2011). The binary variables capture whether or not the respondent concurs with the following statements: it is important that sons have more education than daughters; daughters should be sent to school only if they are not needed to help at home; the most important reason that sons should be more educated than daughters is so that they can better look after their parents when they are older; if there is a limited amount of money to pay for tutoring, it should be spent on sons first; a woman should take good care of her own children and not worry about other people's affairs; women should leave politics to the men; a woman has to have a husband or sons or some other male kinsman to protect her; the only thing a woman can really rely on in her old age is her sons; a good woman never questions her husband's opinions, even if she is not sure she agrees with them; when it is a question of children's health, it is best to do whatever the father wants; daughters should be able to work outside the home after they have children if they want to; daughters should have just the same chance to work outside the homes as sons; daughters should be told that an important reason not to have too many children is so they can work outside the home and earn money; I would like my daughter to be able to work outside the home so she can support herself if necessary. 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	43.78	43.557	45.648	.151
Any primary education (household head)	.086	.069	.04	.002
Household size	9.054	8.639	9.3	.164
Polygynous	.48	.461	.526	.235
Any poultry	.977	.982	.982	.347
Number mature birds	24.281	22.733	25.152	.816
Stock value	97.324	89.515	101.921	.632
Any poultry revenue	.671	.667	.704	.807
Any egg revenue	.129	.135	.076	.387
Poultry revenue	28.29	31.547	32.318	.707
Egg revenue	1.373	2.301	.543	.244
Poultry profits	8.47	15.589	11.81	.632
Self-efficacy: men	.626	.586	.629	.936
Work balance: men	.743	.762	.718	.287
Self-efficacy: women	.497	.477	.486	.965
Work balance: women	.231	.248	.237	.851
Joint-test p-value	.139			

Note: This table reports key indicators of interest corresponding to household demographics, poultry production and gender norm 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	.14	346	.23	.42	331	.31	.46	324	0	.412
Any member attended training	.12	.32	346	.45	.5	331	.52	.5	324	0	.46
Attendance at training: female	.06	.24	313	.33	.47	321	.4	.49	307	0	.296
Attendance at training: male	.09	.29	298	.38	.49	285	.47	.5	272	0	.324
Number of trainings attended (all members)	1.2	.76	38	2.62	2.42	146	2.54	3.23	162	0	.825
Any member attended business training	.11	.31	346	.25	.44	331	.31	.47	324	0	.432
Attendance at training: female	.08	.27	313	.18	.39	321	.23	.42	307	.005	.373
Attendance at training: male	.05	.23	298	.16	.37	285	.25	.43	272	.001	.162
Any member participates in producers' group	.04	.2	346	.2	.4	331	.27	.45	324	0	.104
Participation in group: female	.02	.15	313	.14	.34	321	.2	.4	307	0	.212
Participation in group: male	.03	.16	298	.14	.35	285	.26	.44	272	0	.035
Any member knows VVV	.67	.47	346	.81	.39	655	.006				
Any reported exposure to SELEVER programming	.20	.40	346	.54	.50	331	.60	.49	324	0	.763

Note: This table reports summary statistics (mean, standard deviation and number of observations) for variables capturing program exposure as observed in the lean season endline for individuals in the control and treatment arms. 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.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stock value	Revenue	Profit	Any poultry	Number mature birds	Any revenue	Any egg revenue	Egg revenue
SELEVER	13.744	8.443*	2.829	.010	3.745	-.025	-.021	-.456
	(11.946)	(4.879)	(5.218)	(.031)	(2.899)	(.054)	(.038)	(.340)
Wild bootstrap p-value	[.293]	[.083]*	[.613]	[.735]	[.231]	[.678]	[.594]	[.203]
SELEVER +	4.255	9.332**	4.171	.028	1.847	.072	.013	-.196
	(9.842)	(4.271)	(4.795)	(.029)	(2.318)	(.051)	(.050)	(.378)
Wild bootstrap p-value	[.690]	[.053]*	[.409]	[.386]	[.433]	[.184]	[.815]	[.586]
p-value: $\beta_1 = \beta_2$	.409	.857	.793	.395	.505	.034	.398	.344
Mean control arm	108.874	37.864	22.974	.96	25.754	.72	.149	1.147
St. dev. control arm	103.904	57.091	57.644	.196	22.59	.45	.356	3.563
e(N)	1008	1008	1008	999	1008	1008	1008	1008
e(r2)	.311	.218	.127	.043	.268	.078	.093	.071

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	.077*	.121	-.020	.043	.067
	(.046)	(.123)	(.150)	(.098)	(.158)
Number mature birds	-.003	-.001	.001	-.002	.001
	(.003)	(.004)	(.004)	(.003)	(.004)
Stock value	.001	.0003	-.0003	.0005	-.0006
	(.0008)	(.001)	(.001)	(.0007)	(.001)
Any revenue	.027	.002	-.047	-.054	.014
	(.048)	(.058)	(.030)	(.041)	(.058)
Any revenue eggs	-.002	-.097	-.014	.076	-.105
	(.073)	(.067)	(.073)	(.060)	(.077)
Revenue	.0005	.001	.002***	.001*	.002**
	(.0006)	(.0009)	(.0007)	(.0006)	(.0009)
Egg revenue	-.002**	.001	-.001**	-.002**	.002
	(.0008)	(.001)	(.0007)	(.0008)	(.001)
Profit	.0002	.0003	-.001**	.0001	-.0007
	(.0004)	(.0005)	(.0005)	(.0004)	(.0007)
Self-efficacy (men)	.019	.040	.027	.018	.046
	(.047)	(.051)	(.045)	(.043)	(.056)
Work balance (men)	.002	.089*	-.013	.021	.083*
	(.041)	(.046)	(.035)	(.030)	(.050)
Self-efficacy (women)	.011	.053	-.019	-.008	.076
	(.043)	(.055)	(.039)	(.045)	(.063)
Work balance (women)	.032	.025	.039	-.026	.028
	(.048)	(.052)	(.043)	(.044)	(.051)
Head age	.0003	.001	.001	.002	.003
	(.002)	(.003)	(.002)	(.002)	(.003)
Household size	.002	.006	.002	.005	.004
	(.006)	(.007)	(.006)	(.006)	(.006)
Head primary	.080	.036	-.026	.006	.112
	(.089)	(.108)	(.075)	(.062)	(.115)
Polygamous	.062	.019	.086	.042	.069
	(.041)	(.043)	(.054)	(.040)	(.048)
Obs.	657	657	657	657	657
R^2	.045	.043	.056	.051	.058

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Any poultry	Number mature birds	Stock value	Input cost	Any revenue	Any egg revenue	Revenue	Egg revenue	Profit
Panel A: "As-treated" sample									
SELEVER (participation)	.028 (.029)	5.800** (2.582)	22.461** (11.390)	11.473*** (2.246)	.082* (.049)	.023 (.043)	16.559*** (5.507)	-.115 (.369)	5.102 (5.283)
Obs.	716	716	716	716	716	716	716	716	716
R^2	.063	.324	.355	.143	.085	.118	.26	.089	.191
Panel B: Propensity score matching difference-in-difference									
SELEVER (participation)	.007 (.011)	5.795*** (1.838)	26.666*** (8.133)	10.621*** (3.201)	.062* (.036)	.083** (.037)	12.945** (6.086)	.656 (.834)	.666 (6.488)
Mean control arm	.960	25.754	108.874	13.446	.72	.149	37.864	1.147	22.974
St. dev. control arm	.196	22.59	103.904	21.921	.45	.356	57.091	3.563	57.644
Obs.	999	1008	1008	1008	1009	1008	1008	1008	1008

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.

Table A8: 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	11.254*	5.773	2.512	.051	2.383	.047	.006	.047
	(6.067)	(3.726)	(5.093)	(.065)	(1.477)	(.076)	(.026)	(.163)
Wild bootstrap p-value	[.089]*	[.144]	[.644]	[.503]	[.148]	[.541]	[.83]	[.812]
Large producer	7.293	10.805**	4.056	-.003	2.952	.004	-.013	-.577
	(11.903)	(5.262)	(5.765)	(.008)	(2.880)	(.047)		
Wild bootstrap p-value	[.552]	[.053]*	[.492]	[.755]	[.336]	[.935]	[.840]	[.304]
p-value: $\beta_1 = \beta_2$	.703	.384	.827	.403	.831	.564	.701	.220
e(N)	1008	1008	1008	999	1008	1008	1008	1008
e(r2)	.334	.222	.128	.068	.3	.09	.096	.074
Panel B: Heterogeneous effects for households reporting revenue at baseline								
No baseline revenue	-13.590	.238	-2.548	.013	-1.334	.027	-.040	-.745
	(13.325)	(4.898)	(4.917)	(.048)	(2.948)	(.088)	(.042)	(.459)
Wild bootstrap p-value	[.348]	[.964]	[.604]	[.842]	[.656]	[.773]	[.413]	[.132]
Any baseline revenue	20.582*	13.014**	7.002	.023	4.997*	.022	.017	-.103
	(11.004)	(5.697)	(6.389)	(.030)	(2.581)	(.045)	(.052)	(.397)
Wild bootstrap p-value	[.072]*	[.026]**	[.298]	[.639]	[.079]*	[.648]	[.767]	[.797]
p-value: $\beta_1 = \beta_2$	.026	.073	.210	.836	.056	.942	.270	.143
e(N)	1008	1008	1008	999	1008	1009	1008	1008
e(r2)	.312	.177	.074	.035	.274	.039	.059	.033

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 and the interaction of this variable with a binary variable for large producer, the large producer dummy, 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 a binary variable equal to one if the household reports any 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.