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Poultry Production in Burkina Faso: Potential for Poverty Reduction and Women's Empowerment

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Abstract

Poultry rearing is widespread in rural Burkina Faso, and contributes to both the food security and cash income of smallholders farmers. The landlocked status of the country, coupled with increasing demand for poultry in urban areas implies an opportunity for significant, pro-poor growth through this sector. We use data from a survey of 1800 poultry producers to characterize smallholder poultry producers and their practices. We find that 88% of households in program areas raised poultry. While access to vaccination services and veterinary medicines at the village level is high, uptake of these services is limited, especially among smaller producers. Fewer women than men own poultry, but most women report that they control the proceeds from sales of their own birds, indicating the potential for development of the poultry sector to generate relatively equitable gains in terms of gender. Access to credit appears to increase women's poultry ownership, but remains limited, as does women's access to poultry output markets.

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1. Introduction

Poultry keeping is an important activity for many sub-Saharan African countries in terms of the proportion of the population involved, value of income generated, and dietary contribution. In Burkina Faso, poultry raised on family farms using traditional methods is estimated to constitute 70% of production (Gning, 2005; Dupaigre, Baris and Liagre., 2006). Demand for traditional poultry in the country outstrips supply and is likely to expand as population, incomes, and urbanization in the region continue to grow, implying an important opportunity for income growth in rural areas (Gning, 2005; Schneider, Gugerty and Plotnick, 2010). Unlike other West African countries, where imports make up for domestic production shortfalls, Burkina Faso's landlocked status, as well as a preference for local poultry serve to limit the penetration of imports (Gning, 2005; Schneider, Gugerty, and Plotnick, 2010; Hollinger and Staatz, 2015). As women are typically more involved in raising poultry than other types of livestock, growth in this sector represents an opportunity to increase women's assets and economic empowerment (FAO, 2004).

However, smallholder poultry farmers in Burkina Faso and other west African countries face significant barriers to increasing their productivity and profits. High rates of disease-induced poultry mortality lead to severe and often sudden economic losses. Under extensive poultry production, defined as a production system in which poultry subsist primarily by scavenging, mortality rates are estimated at 70% or higher (Sonaiya and Swan, 2004). Mortality is lower but remains significant at 20-50% in semi-intensive production systems, defined as those with limited reliance on scavenging and regular provision of feed.

Lack of access to credit often constrains the expansion of poultry-keeping enterprises. And while women's involvement in poultry rearing is widespread, their control over revenues is often limited (Nordhagen and Klemm, 2018). This implies a misalignment between effort and incentives, which may limit the impact of poultry income on women's traditional spheres of responsibility, in particular household diets and child health.

In this paper, we describe the smallholder poultry enterprises of households in rural areas of the Boucle de Mouhoun, Centre-Ouest, and Haut-Bassins regions of Burkina Faso using two rounds of pre-intervention data from a study designed to evaluate SELEVER, a poultry value chain and nutrition intervention described by Gelli et al. (2017). The first-round data were collected from March to June 2017. Recall data from this round cover poultry production activities during the previous six months. The second-round data were collected from September to October 2017 and cover production during the rainy season, as well as the lean-season period, when food is typically scarcest.

In the next section, we begin by briefly reviewing the literature on small-scale poultry production in Burkina Faso. This is followed by a description of the sample and data. In the third section, we present descriptive statistics from the first survey round, illustrating how poultry practices and outcomes vary by the scale and the gender of the producer, and explore the correlates of poultry enterprise scale, best practices, and profits through multivariate regression analysis. Finally, we analyze the seasonality of poultry production on a sub-sample of households who were re-interviewed a second time during the lean season. We offer a discussion of findings in the final section.

2. Poultry production in Burkina Faso

Production systems and the economic role of poultry in smallholder farms

The poultry sector in Burkina Faso is dominated by an estimated one million smallholder producers, with fewer than 400 specialized, intensive producers operating in the country (FAO, 2018). Previous surveys of small-scale poultry producers have found that the contribution of poultry production to household income is significant. One study reported a median of $10-$16.5 US during three different four-month periods in the Eastern (Est) Region (Nordhagen and Klemm, 2018) while another reported an annual mean

of $100 in Centre-Est Region (GALVMed, 2013). In the latter study, most of the producers interviewed (60%) purchased feed and medicines (82%) for their poultry.

Smaller-scale qualitative studies conducted elsewhere in the country point to the importance of poultry as a form of savings or insurance. One study conducted in two villages in the southern part of the country found that ownership of local chickens was ubiquitous, and that poultry were normally sold as the need for cash arose, and slaughtered during festivals or ceremonies, but seldom used for household consumption outside of such events (Adegoke and Abioye, 2016). This finding is echoed by another qualitative study conducted in 10 villages within the SELEVER study regions, in which participants tended to view poultry production as insurance rather than a commercial activity (Zougouri and Cook-Lundgren, 2016). The same study that found women viewed their contributions to poultry production as domestic work rather than as a productive activity.

Poultry mortality

Due to the short life span of poultry, the high number of birds kept relative to other livestock, and the high mortality rates in smallholder production systems, estimating poultry mortality rates based on farmer recall data can be challenging, and little evidence exists that is specific to Burkina Faso. One study estimated that 50% of chicks in Burkina Faso died before reaching eight weeks of age (Wilson, 1986). A more recent estimate from Senegal put the mortality rate at 44%, within the 20-50% range expected for small-scale, semi-intensive producers (Missouhou et al., 2005; cited by Sonaiya, 2008). Newcastle Disease is the most important poultry disease in the region and is estimated by various studies to account for between 41% and 88% of poultry mortality (e.g., Guèye, 1998). Newcastle outbreaks follow a seasonal pattern, peaking in the dry season (Sonaiya and Swan, 2004). Fowl pox, estimated to cause between 6% and 19% of poultry deaths, is also prevalent (Guèye, 1998).

While vaccination for Newcastle Disease has been shown to dramatically reduce mortality rates (Awan, Otte and James, 1994), adoption in Burkina Faso and similar contexts remains limited due to cost (Sodjinou,2011). Nordhagen and Klemm (2018) report that at least 73% of farmers vaccinated their entire flock when this service was subsidized, but this fell to around 50% once the subsidy was removed. The regulated cost of Newcastle vaccination is 50 FCFA (approximately 8 cents USD) per head (Billaz and Beauval, 2011) and the SELEVER training team recommended that farmers vaccinate their flock at least twice per year.

Household consumption of poultry products

Nationally representative data for Burkina Faso from 2010 indicate that only 5% of children aged 6-24 months had consumed eggs over the past 24 hours (Iannotti et al., 2014). While poultry ownership is correlated with higher egg consumption, this remains low even among poultry-owning households. A study conducted a year after implementation of a poultry production and nutrition education intervention in the Eastern region of Burkina Faso found that households that had been involved in the program consumed a mean of 2.5-5.5 eggs per fortnight depending on the season (Nordhagen and Klemm, 2018). In line with the goals of the project, the youngest children in these households consumed more eggs (1.9-3.2 per fortnight) than other household members.

Low egg production and a focus on hatching eggs were identified by the Nordhagen and Klemm study as factors limiting household egg consumption, as were taboos prohibiting young children from consuming eggs. Depending on the season, between 51 and 64% of households in the study reported consuming a chicken in the past 2 weeks, suggesting a higher rate of consumption than in the much smaller-scale qualitative study by Adegoke and Abioye cited above.

Marketing

Poultry from smallholders typically reaches markets through informal channels involving collectors who use bicycles and motorcycles to source and distribute poultry (Gning, 2005; Schneider, Gugerty and Plotnick, 2010). Collectors may buy poultry from the producer outright or return a portion of the revenue to the producer after they have sold the poultry. The economic benefits of small-scale poultry activity thus extend to a large network of intermediaries. Approximately 25 % of the meat consumed in Burkina Faso's urban areas is believed to originate from small-scale poultry producers in rural areas, with 20,000 chickens and guinea fowl reaching the capital daily (Gning,2005). As large urban centers are the primary market for poultry meat, intensification of the sector is expected to proceed most rapidly near these locations (Amadou et al., 2012). Ouagadougou and Bobo Dioulasso are the two main urban centers in the country, and both have growing semi-industrial poultry operations in their vicinity (Kondombo, 2007)

Gender

Smallholder poultry activity involves higher participation of women and children compared to other livestock (Schneider, Gugerty and Plotnick, 2010; GALVmed, 2013). However, selling poultry is perceived to be a man's task, particularly in the northern part of Benin (Sodjinou, 2011). In line with the norm of male poultry-keeping as an activity to generate cash income, female livestock holdings typically have a stronger relationship to child nutrition outcomes than male holdings, as found by Jin and Ianotti (2014) in Kenya. For this reason, livestock-based development interventions, including SELEVER, often target women. An evaluation of a similar intervention promoting poultry-rearing in four African countries observed a negative trend over time in women's control of income from this activity in the two countries where poultry sales increased the most, suggesting capture of its economic benefits by men (Nordhagen and Klemm, 2018).

3. Methods

A baseline household- and child-level survey for the SELEVER impact evaluation was undertaken in March 2017 in 120 rural communities targeting 1800 households across three regions of Burkina Faso including Boucle du Mouhoun, Centre-Ouest and Hauts-Bassins (Figure 1). These regions were prioritized by the SELEVER implementers on the basis of their potential to meet demand for poultry in urban markets (Some, 2015). The SELEVER trial protocol has been described in detail elsewhere (Gelli et al., 2017). Households that included a woman aged 15-35 years with at least one child aged 24-59 months at baseline were eligible for inclusion in the study. After conducting a village census, households were stratified into two groups prior to sampling based on the number of poultry they owned. 60 percent of the sample was drawn from among those reported to own between zero and 20 poultry, and 40 percent was drawn from those with a larger flock. Following Masset and Gelli (2013), larger producers were oversampled to increase the likelihood that the survey population would include producers more likely to respond to the SELEVER intervention. Baseline survey data were collected from all study households during March-June 2017 and covered poultry production activities during the previous 6 months. A subsequent round of data collection on a subset of 1080 households during September-October 2017 used the same recall period, which included the May to August lean season.

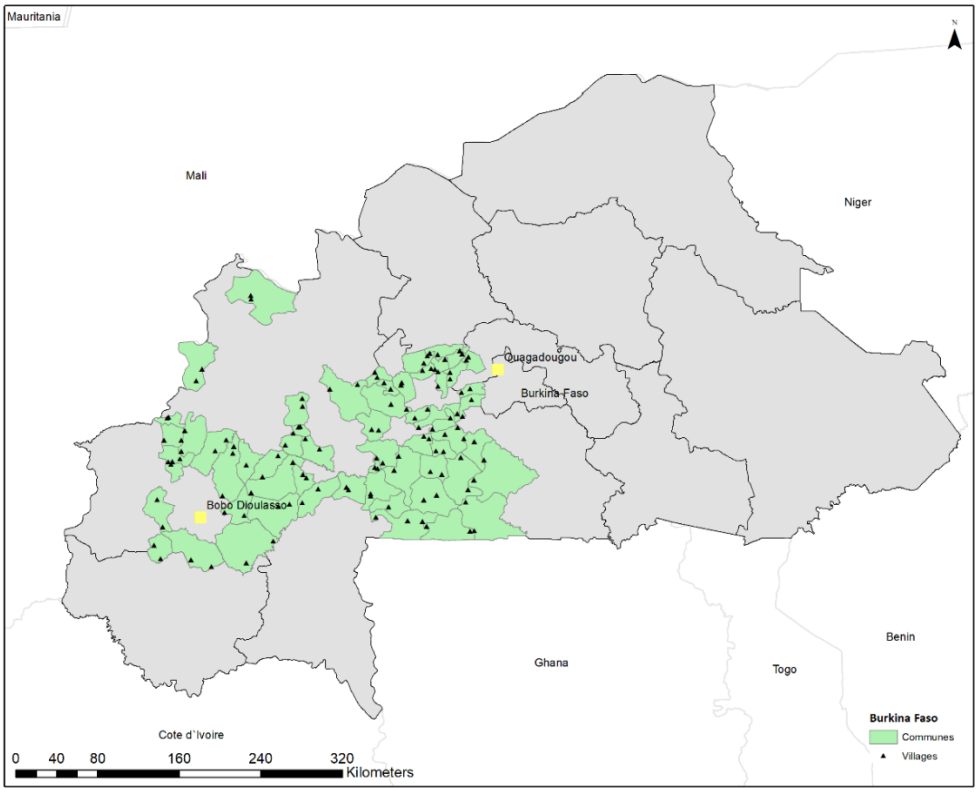


Figure 1: Map of the SELEVER study area and villages, from SELEVER census (pre-baseline) survey data.

In the next section, we first describe the distribution of poultry services and production across villages at baseline. We then compare household characteristics, poultry practices, and outcomes (production, mortality, revenue, and profit) across producers with a flock size of up to 20 birds (referred to in the text as "non/smaller producers") and those with more than 20 birds ("larger producers").[1] We also compare practices based on gender. For each of these comparisons, we regress the characteristic or outcome at baseline on the binary variable of interest (larger producer; poultry owner is female; at least some poultry in the household are owned by a woman), clustering standard errors by village and producer category to account for the sampling design. P-values indicate the probability that the difference in means between

[1] Producer size is defined according to flock size during the baseline survey and differs slightly from the classification obtained during the household census. Some households in the "non/smaller producers" category do not raise poultry; poultry practices and outcomes are only defined for those who do.

groups is zero. We next analyze the correlates of key poultry ownership, practices, and outcomes at baseline in a multiple regression framework. Inverse sampling probability weights are used throughout to account for the over-sampling of households with flocks of 20 poultry or more.

In Section 5, we make use of a second round of data collected during the lean season, but before most program activities had started.[2] We compare key variables across the baseline and lean season surveys, for the subset of 1080 households surveyed at both points. We use a similar approach as for the previous comparisons, but also include household fixed effects. We repeat the analysis of poultry mortality using data from the lean season, as outcomes may differ due to the seasonal nature of Newcastle Disease.

4. Baseline results

4.1 Access of poultry services and distribution of production

In Table 1, we show the proportion of villages in which key services related to poultry are known as available. We define known availability as respondents in at least two households indicating that the service is available in the village. Vaccine availability is ubiquitous: there is only one village in which vaccination was not reported as locally available by at least two households. Veterinary services are available in about two-thirds of villages, and poultry feed in 38%. Access to financial services is relatively low, with credit reported available in 20% of villages and savings opportunities in 14%. Technical training for poultry rearing is reportedly present in 22% of villages, while organized marketing mechanisms exist in 9%.

[2] Early-stage program activities on poultry training and microfinance started in 14 of 60 treatment villages around the time data collection was launched (September-October 2017).

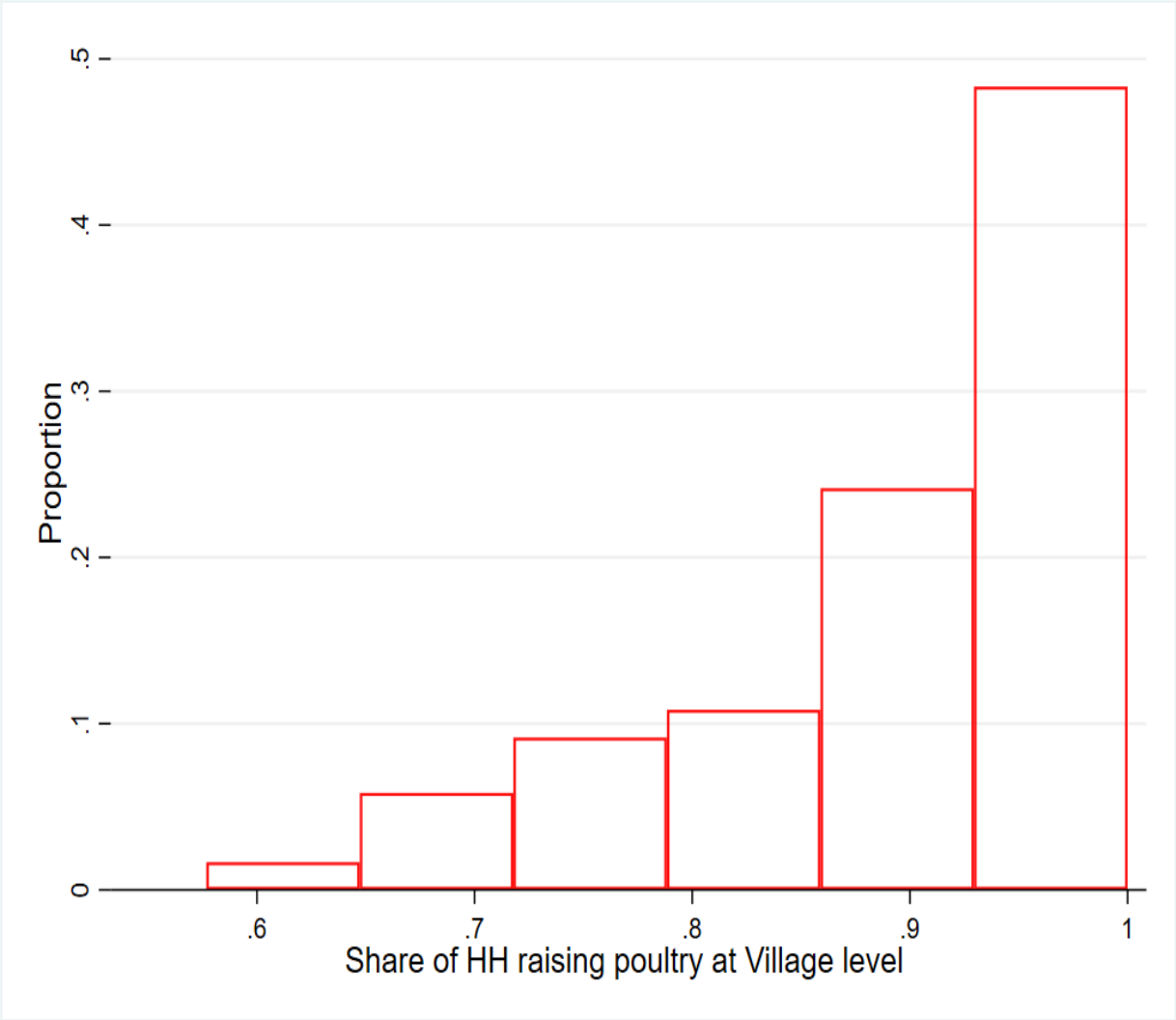
Table 1. Availability of poultry and financial services at village level in Boucle du Mouhoun, Centre-Ouest and Hauts-Bassins regions of Burkina Faso

Service	% of villages where service is known as available
Vaccination	99.2
	(0.01)
Veterinary medicines	66.7
	(0.04)
Poultry feed	38.3
	(0.04)
Technical training	22.5
	(0.04)
Credit	19.2
	(0.04)
Savings	13.3
	(0.03)
Organized marketing mechanism	9.2
	(0.03)

Note: A service is known as available in the village if at least two respondents, in separate households, indicated this to be the case. Standard errors shown in parentheses.

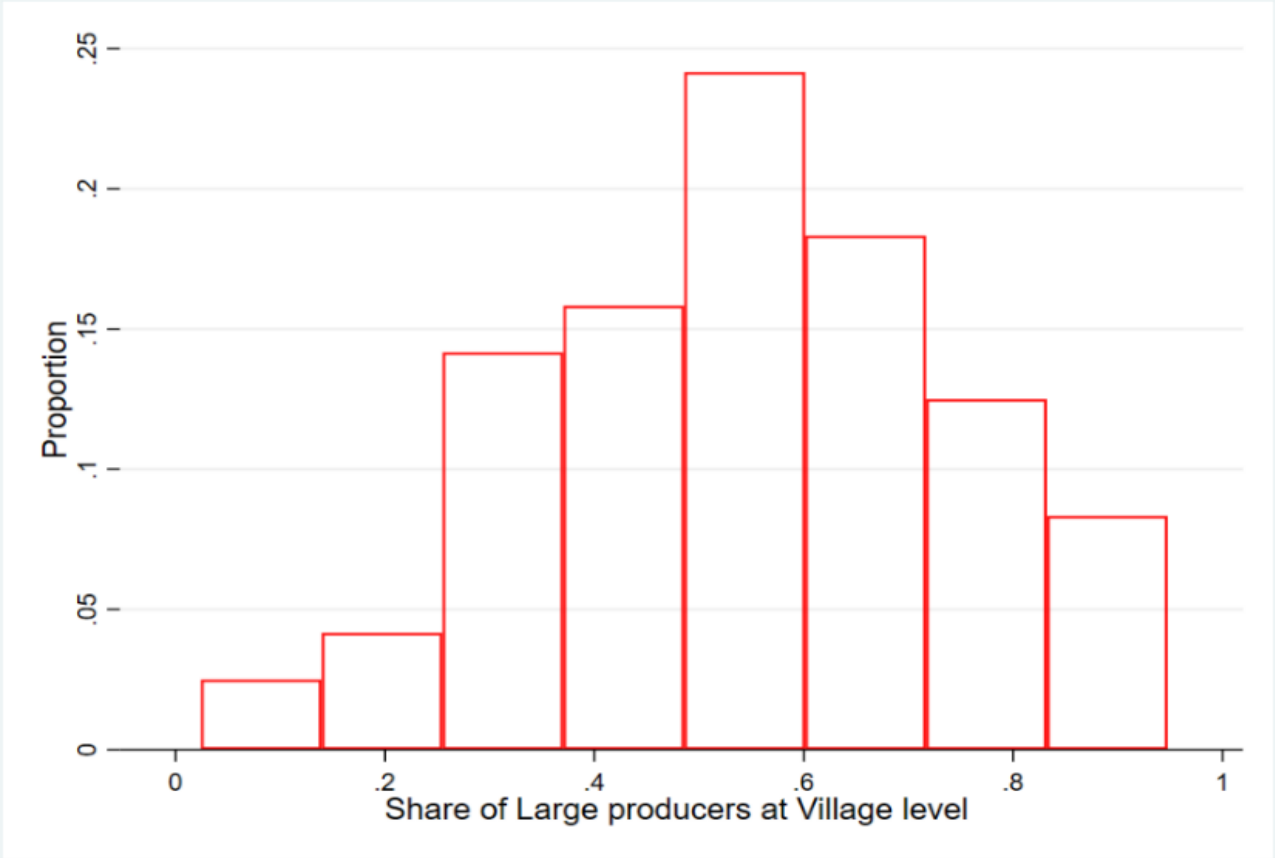
As shown in Figure 2, at least 58% of households raised poultry in all of the villages surveyed, and in most villages (65%) the proportion of households with poultry was 90% or higher. This indicates the importance of poultry rearing to rural households in the study area, and the potential for interventions targeting poultry to affect a large segment of the population. The share of sampled households in a village who belong to the "larger producer" category is presented in Figure 3. The unimodal nature of this distribution shows that the larger producers are not clustered in certain villages. Rather, we observe that most villages have a significant share of producers in this category. This suggests a general absence of village-level constraints to households' expansion of poultry rearing activities, at least up to the level of 20 poultry or more.

Figure 2: Distribution of poultry production across villages



Notes: Shares are calculated using survey weights reflecting the probability of selection in each village and are thus reflective of the population in study villages.

Figure 3: Distribution of larger-scale poultry production across villages



Notes: Shares are calculated using survey weights reflecting the probability of selection in each village and are thus reflective of the population in study villages.

4.1 Differences by scale of production

Socio-economic status

In this section, we describe the socio-economic status of households in the study villages and compare indicators across non- and smaller producers versus larger poultry producers. Statistics shown in Table 2 indicate that larger poultry producers tend to have larger families, with an average of 2.7 more members compared to those with fewer poultry, and are more likely to be polygamous (53% vs. 30% of non/smaller producers). This reflects the custom of poultry ownership at the individual rather than at the household level: the more adult members in the household, the more poultry are likely to be owned. Age of head, again higher for larger producers, is also positively related to household size, as the number of wives tends

to increase over time. Household heads in the larger producer group are less likely to have attended school, possibly related to their older age and changes in education access over time. Households headed by women are rare at 2% overall, and make up an even smaller proportion of the larger producers (1%).

Housing conditions, except for access to electrical power supply, which is more common among the larger producers, are comparable across scale categories. Larger producers cultivate significantly more land, 0.75 acres on average, than other surveyed households. Despite this difference in assets, key indicators of food insecurity (HFIAS Score) and poverty (cash expenditure per capita) do not differ across groups. Women's empowerment based on the Women's Empowerment in Agriculture Index (WEIA) (Alkire et al., 2013) is nearly identical across groups, with indicators in households belonging to both production categories assessed as adequate on approximately half of 12 indicators on average. Empowerment scores calculated for men using the same methodology rank as adequate in approximately two-thirds of domains, and are 2 percentage points higher ($p<0.1$) among the larger producers. In sum, smaller and larger producers are generally comparable, but show some differences in household structure, education, and assets that appear to align with life cycle differences. In Section 5, we explore how these observed differences in assets correlate with poultry production when controlling for other factors.

Table 2. Socio-economic characteristics of non/smaller vs. larger poultry producers

Indicator	Total sample			≤ 20 Poultry			> 20 Poultry			P-value of difference
	Mean	SE	N	Mean	SE	N	Mean	SE	N	
Household size	8.4	0.11	1,762	6.96	0.16	712	9.63	0.17	1,050	0.00***
HH is polygamous	0.42	0.01	1,762	0.3	0.02	712	0.53	0.02	1,050	0.00***
HH head is male	0.98	0	1,762	0.96	0.01	712	0.99	0	1,050	0.00***
HH head age	42.7	0.34	1,762	39.9	0.52	712	45	0.45	1,050	0.00***
HH head been to school	0.33	0.01	1,762	0.37	0.02	712	0.3	0.02	1,050	0.02**
HH head completed primary school	0.08	0.01	1,762	0.09	0.01	712	0.07	0.01	1,050	0.29
HH has concrete floor	0.54	0.01	1,762	0.52	0.02	712	0.56	0.02	1,050	0.12
HH has metal roof	0.76	0.01	1,762	0.74	0.02	712	0.78	0.02	1,050	0.11
HH has concrete banco walls	0.76	0.01	1,762	0.78	0.02	712	0.75	0.02	1,050	0.23
HH has solar, generator or grid connection	0.35	0.01	1,762	0.3	0.02	712	0.39	0.02	1,050	0.00***
HH has functional toilet	0.42	0.01	1,762	0.44	0.02	712	0.41	0.02	1,050	0.38
Cultivated land area (ha)	4.36	0.09	1,739	3.95	0.13	706	4.7	0.13	1,033	0.00***
HFIAS Score (0-27)	2.94	0.12	1,762	2.78	0.18	712	3.08	0.16	1,050	0.21
Total expenditure (pc, 1 day)	0.33	0.01	1,753	0.35	0.02	707	0.32	0.01	1,046	0.14
% adequacy over 12 WEAI indicators (women)	0.5	0	1,426	0.51	0.01	557	0.49	0.01	869	0.15
% adequacy over 12 WEAI indicators (men)	0.66	0	1,252	0.65	0.01	478	0.67	0.01	774	0.09*

Poultry ownership and practices

Poultry production practices by scale of operation are shown in Table 3. Overall, 88% of all households in study villages had raised poultry during the 6-month recall period. Flocks are dominated by chickens; guinea fowl ownership is limited to 36% of households overall and only 10% of smaller producers. Larger producers own on average 33 mature birds,[3] and the value of their poultry stock is approximately $124 US. The mean number of mature birds owned by non/smaller producers is 5, and the average flock value is $18. Women's share of (exclusive) poultry ownership is 8% overall and does not differ significantly by the scale of production.[4]

A potential concern related to the promotion of a specific activity such as poultry-rearing is that other activities, such as vegetable gardening, that contribute to nutrition could be crowded out. If households do not have the land or labor resources for production of both poultry and vegetables, they may be forced to choose between these. We explore this in the data by considering the share of households engaged in vegetable production, and the share producing both at least one vegetable crop and poultry.[5] In general, we see more overlap in these two activities than exclusivity. About one third (34%) of households that produce vegetables also keep poultry, and a slightly lower fraction of poultry producers (31%) also grow vegetables; the correlation between these two variables, estimated through a regression with standard errors clustered at the village and producer group level as elsewhere, is small and positive but not significantly different from zero, at β=0.07 (p=0.12), suggesting that poultry and vegetable production are not generally in competition. We observe a positive and statistically significant association between binary indicators of poultry and vegetable production among non/smaller poultry producers, indicating

[3] Mature birds are defined as those that are ready to sell (i.e., excluding chicks and young guinea fowl).
[4] Table 3 shows the proportion of poultry owned exclusively by women. The share of poultry owned jointly by a woman and a man is similar, at 12% for smaller and 10% for larger producers.
[5] The vegetables about which respondents were asked include tomato, onion, okra, cabbage, squash, cucumber, eggplant, carrot, green beans and various leafy greens.

Table 3. Poultry production, ownership, and practices among smaller vs. larger producers

	Total sample			≤ 20 Birds			> 20 birds			P-value of difference
	Mean	SE	N	Mean	SE	N	Mean	SE	N	
Ownership and scale of production										
Raised poultry in last 6 months	0.88	0.01	1,797	0.75	0.02	743	1		1,054	0.00***
Own any chicken	0.87	0.01	1,797	0.72	0.02	743	1		1,054	0.00***
Own any guinea fowl	0.36	0.01	1,797	0.1	0.01	743	0.6	0.02	1,054	0.00***
Number of mature birds	20.0	0.60	1,795	4.99	0.21	743	33.3	0.97	1,052	0.00***
Value of total stock (USD)	74.4	2.18	1,794	18.1	0.74	743	125	3.54	1,051	0.00***
Prop. poultry fully owned by women	0.08	0.01	1,625	0.09	0.01	571	0.07	0.01	1,054	0.19
Home gardening and crop diversity										
Home gardening in last 12 months	0.34	0.01	1,797	0.28	0.02	743	0.39	0.02	1,054	0.00***
Home gardening + Poultry	0.31	0.01	1,797	0.21	0.02	743	0.39	0.02	1,054	0.00***
Number of different crops planted	4.38	0.06	1,797	3.94	0.09	743	4.76	0.07	1,054	0.00***
Practices										
Fed cereals	0.81	0.01	1,641	0.75	0.02	587	0.86	0.01	1,054	0.00***
Correct cereal freq.	0.79	0.01	1,641	0.72	0.02	587	0.83	0.01	1,054	0.00***
Fed concentrates/vitamins	0.07	0.01	1,641	0.04	0.01	587	0.09	0.01	1,054	0.00***
Correct concentrates/vitamins freq.	0.03	0	1,641	0.02	0	587	0.04	0.01	1,054	0.00***
Gave water at will	0.94	0.01	1,641	0.93	0.01	587	0.94	0.01	1,054	0.44
Correct change of water freq.	0.93	0.01	1,641	0.94	0.01	587	0.92	0.01	1,054	0.13
Dewormed for internal parasites	0.07	0.01	1,641	0.05	0.01	587	0.08	0.01	1,054	0.01***
Vaccinated poultry	0.36	0.01	1,641	0.28	0.02	587	0.41	0.01	1,054	0.00***
Vaccinated for Newcastle	0.31	0.01	1,641	0.24	0.02	587	0.36	0.01	1,054	0.00***
Entire flock vaccinated for NC	0.29	0.01	1,641	0.22	0.02	587	0.34	0.01	1,054	0.00***
Correct freq. vaccination NC	0.01	0.00	1,641	0.01	0.00	587	0.01	0.00	1,054	0.4
Vaccinated for fowl pox	0.12	0.01	1,641	0.10	0.02	587	0.13	0.01	1,054	0.15
Entire flock vaccinated fowl pox	0.11	0.01	1,641	0.10	0.01	587	0.12	0.01	1,054	0.18
Correct freq. vaccination fowl pox	0.22	0.01	1,641	0.17	0.01	587	0.26	0.01	1,054	0.00***
Correct age of vaccination	0.22	0.01	1,641	0.17	0.02	587	0.26	0.01	1,054	0.00***
HH level practices index (0-15)	5.31	0.07	1,625	4.78	0.12	571	5.65	0.09	1,054	0.00***
Mortality										
6-month mortality	18.17	0.92	1,640	12.84	1.09	586	21.70	1.34	1,054	0.00***
6-month mortality (excl. chicks)	11.02	0.66	1,640	7.27	0.60	586	13.50	1.02	1,054	0.00***
6-mo. mortality / flock size	2.56	1.44	1,625	5.81	3.68	571	0.46	0.03	1,054	0.15
6-mo mortality / flock size (excl. chicks)	2.89	1.92	1,624	6.66	4.89	570	0.45	0.05	1,054	0.20

complementarity of these activities among those with a smaller flock. Within this group, 86% of home gardeners raise poultry and 28% of poultry producers grow vegetables β=0.28 (p<0.001).

Use of cereals for feed – as opposed to relying solely on scavenging – is high in the study sample, with over 80% of producers employing this practice, almost all at the recommended frequency. Concentrates and vitamins, in contrast, are used by only 7% of producers. 36% of producers report that they vaccinated at least some of their poultry in the past 6 months, but the proportion who vaccinated at the correct age (22%) and frequency (1% for Newcastle Disease; 22%?? for fowl pox) is markedly lower. Only 7% of respondents reported that they dewormed their poultry. Larger producers tend to invest more in their poultry operations. A greater share of these producers provide poultry with both cereal feed and vitamins or feed supplements, and they are more likely to provide these at the recommended frequency. Larger producers are also more likely to deworm and vaccinate their poultry, and to do so at the recommended age and frequency. Almost all producers (94%), reported providing water at will to poultry, and to changing this water at the recommended frequency (93%). This low-cost practice does not differ significantly between smaller and larger producers.

While many of the recommended practices are more common among larger than smaller producers, the magnitude of these differences is not generally large. The largest difference across these groups is in their rates of vaccination, at 12 percentage points. We construct an index of 15 poultry practices, in which each recommended practice contributes a value of 1. This index is 0.87 points higher for larger producers. Put another way, the average larger producers uses only one recommended practice more than the average smaller producer.

Poultry mortality due to illness is higher for larger producers, but not once flock size is accounted for. Smaller producers report having lost an average of 5.8 times as many poultry to illness over the past 6 months as they currently own, while larger producers report having lost just under half of their current flock size to illness. As chick mortality is typically higher than that of grown poultry, we also report total

deaths and deaths relative to current flock excluding chicks, which shows a similar pattern. We note that due to the variability of flock size over time this ratio may be inflated for producers with currently few poultry.

Market access, business outcomes, and household consumption

Proximity to markets is an important factor in determining the business opportunities and outcomes of agricultural producers, especially in contexts where infrastructure is poor. While distance to a population center of at least 10,000 people is similar between smaller and larger producers, we note that larger producers are on average approximately 30 km closer to both Ouagadougou and Bobo-Dioulasso than non/smaller producers (Table 4). This could suggest that access to a large-scale market is a stronger driver of commercialization than opportunities to sell in smaller market towns, or it could potentially reflect greater wealth (and thus local demand) for poultry in areas closer to these urban centers.

Approximately half of the smaller producers who had raised poultry over the past six months (37% of this group) reported any revenue from poultry sales over this period. The mean sales value for non/smaller producers during the six-month period prior to the baseline survey was just $10.5 US; subtracting the cash costs of production (not including the value of household labor), the mean of net poultry revenue per household was $6.5 US. In contrast, most larger producers (79%) reported sales in the 6 months prior to baseline, with mean sales value of $60 US and net revenue of $48. Egg sales accounted for a small share of total revenues, particularly among smaller producers, fewer than 1% of whom reported selling any eggs in the 6 months preceding the baseline survey.[6]

[6] The majority of baseline respondents reported no production of animal products (including eggs, milk, yoghurt, butter, meat, hide, or manure), and thus were not asked specifically about egg production or consumption in the associated section of the survey; the proportion responding to this section was far higher in the lean-season follow-up, suggesting the possibility that respondents misunderstood the question in the first round. This may have led to under-reporting of egg sales at baseline. We present data on household egg consumption from a separate module.

Table 4. Market access, poultry business outcomes, and household consumption among non/smaller vs. larger poultry producers

	Total sample			≤ 20 Birds			> 20 birds			Difference
	Mean	SE	N	Mean	SE	N	Mean	SE	N	p-value
Distance to markets										
km to town of pop >= 10,000	69.6	0.36	1,771	71.9	1.31	727	67.6	1.16	1,044	0.07*
Distance to Ouagadougou	188	1.02	1,776	204	2.79	728	173	3.01	1,048	0.00***
km to Bobo-Dioulasso	170	0.72	1,771	154	2.5	727	183	2.42	1,044	0.00***
Poultry revenue, costs, and profits										
Any poultry sales revenue	0.59	0.01	1,797	0.37	0.02	743	0.79	0.02	1,054	0.00***
Any egg sales revenue	0.03	0.00	1,797	0.00	0.00	743	0.05	0.01	1,054	0.00***
Poultry sales revenue	40.9	79.37	1,795	10.50	0.92	743	59.7	3.83	1,049	0.00***
Egg revenue	0.72	4.84	1,783	0.02	0.01	743	1.03	0.19	1,037	0.00***
Variable production cost	11.4	26.85	1,794	3.88	0.39	743	15.1	1.09	1,048	0.00***
Net revenue	29.9	84.1	1,797	6.51	0.89	743	48.4	5.38	1,051	0.00***
Female producers: Marketing options and choice										
Number of buyers available	0.25	0.03	1,778	0.13	0.03	727	0.35	0.04	1,051	0.00***
Buyer choice: best price	0.44	0.03	131	0.29	0.11	26	0.48	0.06	105	0.02**
Buyer choice: immediate payment	0.23	0.03	131	0.3	0.12	26	0.21	0.05	105	0.47
Buyer choice: location	0.23	0.01	131	0.3	0.11	26	0.21	0.06	105	0.14
Male producers: Marketing options and choice										
Number of buyers available	1.76	0.07	1,565	1.13	0.09	600	2.27	0.1	965	0.00***
Buyer choice: best price	0.48	0.02	710	0.44	0.04	181	0.49	0.03	529	0.28
Buyer choice: immediate payment	0.28	0.02	710	0.31	0.04	181	0.27	0.02	529	0.31
Buyer choice: location	0.14	0.01	710	0.19	0.04	181	0.13	0.02	529	0.12
Household consumption										
Poultry meat (USD, 6 months)	13.15	0.64	1,618	5.61	0.58	571	18	0.97	1,047	0.00***
Eggs consumed (past 7 days)	1.23	0.12	1,773	0.69	0.12	730	1.70	0.20	1,043	0.00***

The number of buyers known to larger producers is significantly higher than for smaller producers, and larger producers are more likely to select a buyer based on price. Regardless of the scale of production at the household level, female poultry producers are more likely to indicate location as the principal reason for selling to their usual buyer than male producers (p=0.051).

As found in previous studies of poultry producers in Burkina Faso, household consumption of poultry products, particularly eggs, is low. Smaller producers had consumed an average value of just $5.6 US worth of poultry meat from their own flock over the past 6 months. This translates to fewer than 2 hens valued at the median sales price for the sample.[7] Larger producers, which have an average of 2.7 additional household members, report consuming three times as much meat by value – equivalent to approximately 5 hens over 6 months. Egg consumption is in line with previous estimates for poultry-producing households in Burkina Faso, with larger producers consuming 1.7 eggs on average per week, and non/small producers an average of 0.7 per week.

4.2 Gender

We turn next to a description of poultry business characteristics and practices by gender of owner, shown in Table 5. The first striking feature of this comparison is that women are far less likely to own poultry. When women do own poultry, the mean number of mature birds owned (9) is less than half of that owned by male producers (19.6). Feeding and veterinary practices of men and women are comparable. While mortality as a proportion of current flock size is lower for women, the difference between this variable across gender is not statistically distinguishable by gender.

[7] Because reported sales prices and consumption value of poultry vary widely in the data and may be unreliable, we use median sales prices to assign value to poultry products. For consumption values, we use the median overall sales price (since the value of meat, in terms of nutrition, does not vary geographically). When calculating revenue and profit, we use village-level medians, since the market value does vary geographically.

In a third of cases when women sell poultry they own, men are responsible for the sale, and in 17% of cases, men control any income obtained through the sale. This indicates that promoting women's poultry ownership will usually, though not always, increase the cash income over which they have control.

Echoing the discussion of Table 4 above, we observe significant differences in the marketing practices of men and women. Women who sell poultry tend to do so closer to home, typically at the homestead itself, or through door-to-door sales, while men are more likely to sell at a market. Importantly from the perspective of impacts on nutrition, women's poultry production is more oriented toward subsistence than that of men. Half of women who owned poultry at baseline reported any sales over the past 6 months, while over two-thirds of male poultry owners reported sales. Taking the ratio of the mean value of poultry sales over the mean value of poultry meat consumed by the household, we observe that this is 2.5 for male-owned poultry, versus 0.4 for women's holdings.

Table 5. Poultry production, mortality, marketing, and business outcomes by gender of owner

Indicator	Owned by men			Owned by women			Difference
	mean	se	n	mean	se	n	p-value
Man/Woman owns any poultry	0.80	0.01	1,797	0.14	0.01	1,797	0.00***
Man/woman owns any chicken	0.81	0.01	1,797	0.15	0.01	1,797	0.00***
Man/woman owns any guinea fowl	0.35	0.01	1,797	0.01	0	1,797	0.00***
Number of mature birds	15.7	0.42	1,764	1.26	0.12	1,796	0.00***
Total poultry value (USD)	58.4	1.54	1,761	4.52	0.43	1,795	0.00***
Production practices and outcomes							
Gave cereals	0.82	0.01	1,502	0.85	0.02	293	0.29
Gave concentrates/vitamins	0.07	0.01	1,502	0.1	0.02	293	0.25
Gave water at will	0.94	0.01	1,502	0.94	0.01	293	0.95
Dewormed for internal parasites	0.07	0.01	1,502	0.07	0.01	293	0.78
Vaccinated	0.36	0.01	1,502	0.36	0.02	293	0.76
HH level practices index (0-15)	5.36	0.08	1502	5.39	0.11	293	0.85
6-month mortality	17.6	0.91	1,501	4.85	0.53	288	0.00***
6-month mortality - (excl Chicks)	10.7	0.68	1,501	2.35	0.31	288	0.00***
6-mo. mortality / flock size	2.85	1.57	1,484	0.58	0.10	290	0.15
6-mo. mortality / flock size (excl. chicks)	3.18	2.09	1,483	0.44	0.07	290	0.19
Marketing							
Male is responsible for sale	0.98	0	945	0.34	0.03	129	0.00***
Income is controlled by male	0.99	0	945	0.17	0.02	129	0.00***
Minutes' travel to place of sale	11.0	0.71	942	8.06	0.87	126	0.07*
Sell at home or farm	0.48	0.02	945	0.58	0.02	129	0.06*
Sell at village market	0.25	0.01	945	0.16	0.02	129	0.02**
Sell at other market	0.15	0.01	945	0.12	0.02	129	0.27
Sell door to door	0.08	0.01	945	0.14	0.01	129	0.10*
Business outcomes and household consumption							
Any poultry sales revenue†	0.54	0.01	1797	0.07	0.01	1797	0.00***
Sales revenue	33.09	2.07	1792	0.77	0.11	1763	0.00***
Poultry meat consumed (6 months)	13.4	0.7	1,478	1.77	0.36	284	0.00***

† Revenue from eggs is not included, as this is reported at the household level.

As shown in Table 5, while in the majority of cases women control income from the sale of poultry they own, a significant share (17%) of households indicate that the men control this income. Women in these households have little incentive to invest effort or resources in poultry production. Further, the 34% of women whose poultry sales are handled by men may face uncertainty about whether they will receive the full revenue generated from these sales. Women in both situations may thus under-invest in poultry they expect to sell.

We explore this hypothesis by comparing women's practices concerning hens and cocks. Aside from retaining a few cocks for reproduction, these are typically either slaughtered for meat or sold. Hens, on the other hand, may be kept for eggs, and thus have a higher value for subsistence purposes relative to cocks. In Table 6, it is apparent that women are more likely to own hens (285 women owned at least one hen) versus cocks (136 women owned any cocks), and that costly practices (e.g., use of cereal feed or concentrates) are inferior with respect to cocks compared with hens. In contrast, men's practices across hens and cocks are similar, and slightly favor cocks.

Table 6. Poultry practices for hens vs. cocks, by gender of owner

Indicator	Women's Practices				Men's practices				p-value	p-value	p-value	p-value
	Cocks (1)		Hens (2)		Cocks (3)		Hens (4)		(1) vs (2)	(3) vs (4)	(1) vs (3)	(2) vs (4)
	mean	n	mean	n	mean	n	mean	n				
Gave cereals	0.76	136	0.87	285	0.86	1,309	0.84	1,487	0.00***	0.02**	0.03**	0.28
Correct cereal freq.	0.75	136	0.86	285	0.84	1,309	0.82	1,487	0.00***	0.01***	0.05**	0.13
Gave concentrate/vitamin	0.05	136	0.12	285	0.08	1,309	0.08	1,487	0.02**	0.73	0.24	0.17
Correct conc./vitamin freq.	0.01	136	0.06	285	0.03	1,309	0.04	1,487	0.00***	0.15	0.00***	0.21
Dewormed for internal parasites	0.03	136	0.07	285	0.08	1,309	0.08	1,487	0.02**	0.78	0.01***	0.32
Vaccinated Poultry	0.45	136	0.44	285	0.50	1,309	0.49	1,487	0.73	0.18	0.40	0.20

Table 7. Women's Empowerment in Agriculture Index (WEIA) indicators, by women's exclusive poultry ownership in dual-headed households

WEIA Indicator (female)	Total sample			HH with no Female Ownership			HH with Female Ownership*			Difference
	mean	se	n	mean	se	n	mean	se	n	p-value
Autonomy in income	0.58	0.01	1,708	0.59	0.02	1,437	0.54	0.04	271	0.24
Self-efficacy	0.44	0.01	1,708	0.45	0.02	1,437	0.37	0.04	271	0.04**
Attitude about domestic violence	0.52	0.01	1,708	0.52	0.02	1,437	0.55	0.04	271	0.47
Respect among HH members	0.65	0.01	1,663	0.66	0.02	1,403	0.61	0.04	260	0.19
Input in productive decisions	0.80	0.01	1,708	0.81	0.01	1,437	0.78	0.03	271	0.47
Land/asset ownership	0.86	0.01	1,708	0.86	0.01	1,437	0.86	0.03	271	0.99
Control over use of income	0.51	0.01	1,708	0.52	0.02	1,437	0.46	0.04	271	0.14
Access to / decisions on financial services	0.17	0.01	1,639	0.16	0.01	1,375	0.20	0.03	264	0.24
Work balance	0.31	0.01	1,501	0.30	0.02	1,261	0.35	0.04	240	0.26
Mobility	0.52	0.01	1,708	0.52	0.02	1,437	0.52	0.04	271	1.00
Group membership	0.33	0.01	1,708	0.33	0.01	1,437	0.34	0.04	271	0.80
Influential groups membership	0.25	0.01	1,708	0.25	0.01	1,437	0.27	0.04	271	0.53

*Joint Ownership is not attributed to women; female-headed households are excluded.

Development projects that aim to expand women's control over assets typically anticipate gains in women's autonomy, control over income, participation in household decision making, and improvements in other dimensions of empowerment. We compare adequacy for the 12 Women's Empowerment in Agriculture Index (WEIA) indicators between women in dual-headed households with any female poultry ownership versus no female poultry ownership in Table 7 above.[8] With the exception of self-efficacy, which is lower in households with female poultry ownership, we see no significant differences in empowerment indicators across these groups of women. While this analysis cannot be interpreted as causal, it does suggest caution in the expectation of broader impacts on women's empowerment solely through the expansion of their engagement in poultry production.

4.3 Regression analysis

We next turn to multivariate regression analysis to explore the relationship between market and household characteristics and poultry practices and outcomes, and to relate specific practices to key outcomes including mortality and profits. We include regional indicators in all specification to control for geographical influences, and indicators for ethnicity of the household head to control for cultural influences in the models presented in Tables 8 and 9. For variables with a highly skewed distribution (flock size, costs, revenues, production value), we use the inverse hyperbolic sine (IHS) transformation in order to reduce the influence of outliers.[9] This is similar to the natural logarithmic transformation but allows for the inclusion of zero and negative values. As with the logarithmic transformation, coefficients can be roughly interpreted as percentage changes.

The first set of regressions, presented in Table 8, show the relationships between fundamental household and market characteristics, and key features of the poultry enterprise. We see that flock size is roughly twice as high for male-headed households as for those headed by women, and is positively associated

[8] Joint ownership of poultry is not attributed to women in this analysis.

[9] The IHS transformation is defined as $\ln(x+(x^2+1)^{0.5})$.

with the number of household members, wealth level as proxied by the index of housing quality, cultivated area, and (weakly) with age of head.

The proportion of the average household's poultry flock owned by women is positively related to credit access at the village level, possibly indicating the importance to women of access to finance for productive investment. Women's ownership is higher ($p<0.1$) further from major cities, and strongly negatively correlated with male household headship. Net poultry production value is defined as the total value of poultry production over the past 6 months, including sales and household consumption, minus variable costs of production, including purchases and barter of poultry, feed, veterinary fees and medications. This outcome is higher on average for male-headed and larger households and is weakly positively correlated with the head's completion of primary education. We note that the cost of household labor is not included in poultry production costs; this may bias upward the association of household size with net production value. Finally, the poultry practices index, as described in the discussion of Table 3 above, is negatively correlated with distance to a major urban center, and positively correlated with male headship, wealth level, landholdings, and (weakly) with household size.

Table 8: Relationship between market and household characteristics and poultry enterprise outcomes

	Number of mature poultry (IHS)	Proportion of mature flock owned by women	Net production value (IHS)	Practices Index
	(1)	(2)	(3)	(4)
% of HHs in village with any loans	0.18	0.10**	0.84	0.75
	(0.26)	(0.04)	(0.52)	(0.52)
Min distance to Ouaga or Bobo (100's of KM)	-0.03	0.02*	-0.01	-0.08**
	(0.04)	(0.01)	(0.05)	(0.04)
Household head is MALE	1.16***	-0.47***	1.59***	2.04***
	(0.31)	(0.10)	(0.37)	(0.48)
Head attended but did not complete primary	-0.10	0.02	-0.09	0.14
	(0.09)	(0.02)	(0.19)	(0.19)
Head completed primary education	-0.31	-0.02	0.50*	0.00
	(0.19)	(0.02)	(0.29)	(0.45)
Household head Age	0.03*	0.00	0.05	0.05
	(0.02)	(0.00)	(0.04)	(0.04)
HH Head age^2	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Household size	0.07***	0.00	0.11***	0.03*
	(0.01)	(0.00)	(0.02)	(0.02)
HH characteristics score (0-5)	0.10***	0.00	0.06	0.15**
	(0.03)	(0.01)	(0.07)	(0.07)
Cultivated land area (ha)	0.05***	-0.00	-0.00	0.09***
	(0.01)	(0.00)	(0.03)	(0.02)
Observations	1,759	1,611	1,752	1,761
Clusters (strata x villages)	240	240	240	240
R-squared	0.205	0.139	0.085	0.095

Notes: Cluster-robust standard errors in parentheses. Regional and ethnicity dummies also included. * p<0.1; ** p<0.05; ***p<0.001.

In Table 9, we consider the relationship between gender and scale of production and poultry business outcomes as well as a subset of WEIA empowerment indicators. The share of the household poultry flock owned by women has no discernable relationship with either business outcomes or empowerment indicators. The number of poultry owned is, as seen Section 4.1, strongly correlated with poultry practices, revenues, costs, and profits. Higher costs of production are also associated with cultivated land area, and weakly with formal education short of primary completion by the head. Production value is correlated

with credit access, male headship, completion of primary education by the head, age of head, and household size. Correlates of net production value in this model are similar to those shown in Table 8, though with the relationship to cultivated land area negative and significant after including flock size as an explanatory variable. This could be due to households with more land focusing their efforts on crops, rather than poultry production.

WEIA indicators for male and female intrinsic agency and work balance are uncorrelated with both the proportion of poultry owned by women and the number of poultry owned by the household.[10] Significant correlates of these indicators include distance to a major urban center (positively correlated with intrinsic agency for both men and women, and negatively correlated with women's work balance). Respondent-reported male headship is strongly correlated with both men's intrinsic agency and work balance but has no relationship with these indicators for women.[11] Women's intrinsic agency is lower when the household head has completed primary education, and men's work balance decreases with age at a decreasing rate.

[10] Under the WEAI, 'adequate' work balance is defined as fewer than 10.5 hours of work per day, where work hours are calculated as the number hours spent on a primary work activity plus 50% of the hours spent on childcare as a secondary activity

[11] Of the 47 households in the sample who are identified by the respondent as female-headed, 15 are headed by widows and 32 by married women.

Table 9: Relationship of female ownership and scale of poultry production to poultry business outcomes and empowerment indicators

	Practices index	Poultry costs (IHS)	Gross production value (IHS)	Net production value (IHS)	Intrinsic agency Female	Intrinsic agency Male	Work Balance Female	Work Balance Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Proportion of poultry owned by women	-0.06	0.26	-0.24	-0.38	-0.03	-0.01	0.03	0.04
	(0.27)	(0.23)	(0.25)	(0.34)	(0.04)	(0.04)	(0.07)	(0.07)
Number of mature poultry (IHS)	0.50***	0.49***	0.96***	0.93***	-0.01	-0.01	0.02	-0.01
	(0.07)	(0.05)	(0.06)	(0.08)	(0.01)	(0.01)	(0.02)	(0.02)
% of HHs in village with any loans	0.74	0.38	0.76**	0.84	-0.09	-0.06	-0.03	-0.04
	(0.45)	(0.29)	(0.37)	(0.56)	(0.06)	(0.05)	(0.10)	(0.09)
Min distance to Ouaga or Bobo (100's of KM)	-0.06	0.04	0.01	0.02	0.01**	0.00*	-0.02**	0.01
	(0.04)	(0.03)	(0.05)	(0.06)	(0.00)	(0.00)	(0.01)	(0.01)
Household head is male	0.61	0.01	0.85**	1.12*	-0.06	0.22***	-0.13	0.85***
	(0.45)	(0.36)	(0.37)	(0.61)	(0.05)	(0.08)	(0.14)	(0.04)
Head attended but did not complete primary	0.15	0.20*	0.11	0.03	-0.02	0.01	-0.01	-0.03
	(0.16)	(0.10)	(0.13)	(0.20)	(0.02)	(0.02)	(0.04)	(0.03)
Head completed primary education	0.53	0.20	0.70***	0.78**	-0.08**	-0.03	0.05	-0.11
	(0.40)	(0.21)	(0.25)	(0.36)	(0.03)	(0.04)	(0.09)	(0.09)
Household head Age	0.02	0.02	0.06**	0.02	-0.00	0.00	0.01	-0.02**
	(0.03)	(0.02)	(0.02)	(0.04)	(0.00)	(0.00)	(0.01)	(0.01)
HH Head age^2	-0.00	-0.00	-0.00**	-0.00	0.00	-0.00*	-0.00	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.02	-0.00	0.03**	0.06***	0.00	0.00	-0.01	-0.00
	(0.02)	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
HH characteristics score (0-5)	0.11*	0.05	-0.02	-0.04	0.00	0.00	0.02	-0.01
	(0.06)	(0.04)	(0.05)	(0.07)	(0.01)	(0.01)	(0.01)	(0.01)
Cultivated land area (ha)	0.04**	0.05***	-0.01	-0.06**	0.00	0.00	-0.00	-0.00
	(0.02)	(0.02)	(0.02)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	1,609	1,600	1,600	1,600	1,604	1,439	1,400	1,248
R-squared	0.116	0.155	0.283	0.156	0.034	0.048	0.064	0.041
Nb of clusters	240	240	240	240	240	240	238	234

Notes: Cluster-robust standard errors in parentheses. Regional and ethnicity dummies also included. * p<0.1; ** p<0.05; ***p<0.001.

In Table 10 we show the relationship between poultry practices and poultry mortality and key business outcomes, controlling for cultivated land area, a key fixed input. The number of mature poultry owned is positively associated with provision of grain, concentrates or vitamins, vaccination for Newcastle Disease, and cultivated land area.

We use the HIS transformation of poultry deaths due to illness over the past six months as a multiple of current flock size as the mortality outcome. Both use of feed concentrates or vitamins, and vaccination against fowl pox are associated with lower mortality, but vaccination for Newcastle disease has no impact. We do not have information on the timing of vaccination, but the imprecision of this estimate could potentially be due to some farmers vaccinating after symptoms of Newcastle Disease are observed, at which point the vaccine is ineffective. Cultivated land area is associated with lower poultry mortality.

Several recommended practices (provision of grains, concentrates, vaccination) increase gross production value, but as these also increase costs, there is no impact on net production value. Confinement of poultry is associated with both lower variable production costs and lower gross production value (information on the nature and cost of poultry facilities are not available).

Table 10: Relationship of poultry practices to flock size, mortality, costs, and production

	Number mature poultry (IHS)	6-month mortality as multiple of current flock size (IHS)	Variable production cost (IHS)	Gross production value (IHS)	Net production value (IHS)
	(1)		(2)	(4)	(5)
Fed grains	0.36***	-0.03	0.71***	0.77***	0.28
	(0.10)	(0.06)	(0.11)	(0.19)	(0.24)
Fed concentrates / vitamins	0.33**	-0.07***	0.62***	0.48*	-0.03
	(0.13)	(0.02)	(0.21)	(0.27)	(0.48)
Gave water at will	0.11	-0.08	0.02	0.40	0.55
	(0.20)	(0.09)	(0.21)	(0.38)	(0.51)
Dewormed for internal parasites	0.18	0.01	0.63***	0.81***	0.59
	(0.14)	(0.03)	(0.20)	(0.24)	(0.47)
Any poultry vaccinated for Newcastle	0.30***	-0.02	1.49***	0.56***	0.01
	(0.09)	(0.03)	(0.12)	(0.18)	(0.26)
Any poultry vaccinated for fowl pox	0.08	-0.07**	0.80***	0.23	-0.64
	(0.11)	(0.03)	(0.16)	(0.27)	(0.41)
Poultry is confined	-0.06	-0.03	-0.57***	-0.61**	-0.22
	(0.10)	(0.02)	(0.15)	(0.26)	(0.36)
Cultivated land area (ha)	0.05***	-0.01***	0.06***	0.04**	0.02
	(0.01)	(0.00)	(0.01)	(0.02)	(0.03)
Observations	1,628	1,614	1,621	1,621	1,621
Clusters (strata x villages)	240	240	240	240	240
R-squared	0.134	0.018	0.310	0.078	0.010

4. Seasonal variation and lean season relationship between practices and outcomes

Turning to seasonal differences in poultry production among the subset of households interviewed both at baseline and during the lean season follow-up survey, we first note that, as expected, households are more food insecure and have lower expenditures per capita at the time of the lean season survey (Table 11). We further observe that the proportion of households who had raised poultry over the past six months, particularly guinea fowl, is higher during the lean-season follow-up, leading to a larger number of birds owned and higher total stock value. This is consistent with the seasonal pattern of guinea fowl production in this region, which is typically undertaken during the rainy season from May to October.

Table 11: Food security, poultry production, ownership, and practices, by survey round

	Baseline			Follow-up			Difference
	mean	se	n	mean	se	n	p-value
Food security and total consumption							
HFIAS Score (0-27)	3.18	0.16	1,043	3.70	0.15	1,043	0.01***
Total expenditure (pc, 1 day)	0.33	0.01	1,037	0.26	0.01	1,039	0.00***
Ownership and scale of production							
Raised poultry in last 6 months	0.89	0.01	1,064	0.91	0.01	1,064	0.07*
Own any chicken	0.88	0.01	1,064	0.90	0.01	1,064	0.10*
Own any guinea fowl	0.38	0.02	1,064	0.50	0.02	1,064	0.00***
Number of mature birds	21.2	0.80	1,063	26	0.87	1,057	0.00***
Value of total stock (USD)	79.6	2.96	1,063	98.5	3.23	1,057	0.00***
Prop. poultry fully owned by women	0.07	0.01	969	0.07	0.01	979	0.85
Practices							
Fed cereals	0.82	0.01	977	0.83	0.02	977	0.84
Correct cereal freq.	0.80	0.01	977	0.79	0.02	977	0.80
Fed concentrates/vitamins	0.08	0.01	977	0.05	0.01	977	0.02**
Correct concentrates/vitamins freq.	0.03	0.00	977	0.02	0.00	977	0.01***
Gave water at will	0.94	0.01	977	0.88	0.02	977	0.00***
Correct change of water freq.	0.93	0.01	977	0.72	0.02	977	0.00***
Dewormed for internal parasites	0.07	0.01	977	0.09	0.01	977	0.16
Vaccinated Poultry	0.35	0.01	977	0.29	0.02	977	0.00***
Vaccinated for Newcastle	0.32	0.01	977	0.27	0.01	977	0.01**
Entire flock vaccinated for NC	0.30	0.01	977	0.26	0.01	977	0.02**
Correct Freq. vaccination Newcastle	0.01	0.00	977	0.00	0.00	977	0.09*
Vaccinated for fowl pox	0.10	0.01	977	0.05	0.01	977	0.00***
Entire livestock vaccinated fowl pox	0.10	0.01	977	0.05	0.01	977	0.00***
Correct Freq. vaccination fowl pox	0.24	0.01	977	0.23	0.01	977	0.47
Correct age of vaccination	0.21	0.01	977	0.22	0.01	977	0.55
HH level practices index (0-15)	5.31	0.09	969	4.67	0.11	979	0.00***
Mortality							
6-month mortality	20.2	1.35	976	26.7	1.38	983	0.00***
6-month mortality/ current flock size	3.79	2.56	969	0.78	0.07	979	0.24
6-month mortality (excl. chicks)	12.4	0.96	976	16.8	1.00	985	0.00***
6-month mort. / flock size (excl. chicks)	4.33	3.41	968	0.71	0.07	979	0.29

Poultry practices are generally worse during the lean season than at baseline. The proportion of respondents who report providing concentrates or vitamins, providing water at will and changing it at the recommended frequency, and vaccinating their poultry are all lower during the second survey round. We also see higher mortality during the lean season, though this tracks the higher number of poultry owned on average and is lower as a multiple of current flock size during this round. This pattern holds when chicks are excluded from mortality calculations.

Table 12: Poultry marketing, business outcomes, and household consumption, by survey round

Indicator	Baseline			Follow-up			Difference
	mean	sd	n	mean	sd	n	p-value
Poultry revenue, costs, and profits							
Any poultry sales revenue	0.60	0.02	1,064	0.66	0.02	1,064	0.01**
Poultry sales revenue	40.2	3.23	1,062	35	1.94	1,060	0.40
Any egg sales revenue	0.02	0.00	1,064	0.11	0.01	1,064	0.00***
Egg revenue	0.44	0.11	1,058	4.22	0.56	1,054	0.01***
Poultry production cost	7.94	0.50	1,049	12.7	0.80	1,042	0.00***
Profit	31.1	3.28	1,062	23.3	2.53	1,060	0.39
Female producers: Marketing options and choice							
Number of buyers available	0.23	0.03	1,062	0.22	0.03	1,049	0.67
Buyer choice: best price	0.45	0.04	75	0.26	0.04	84	0.52
Buyer choice: immed. payment	0.20	0.04	75	0.43	0.05	84	0.19
Buyer choice: location	0.24	0.02	75	0.20	0.06	84	0.74
Male producers: Marketing options and choice							
Number of buyers available	1.79	0.08	947	1.39	0.08	1,013	0.00***
Buyer choice: best price	0.48	0.03	443	0.45	0.03	440	0.97
Buyer choice: immed. payment	0.29	0.02	443	0.24	0.02	440	0.09*
Buyer choice: location	0.13	0.02	443	0.20	0.02	440	0.09*
Household consumption							
Poultry meat (USD, 6 months)	11.50	0.62	956	14.1	0.92	978	0.34
Eggs consumed (past 7 days)	0.96	0.12	1,049	1.40	0.15	1,064	0.03**

The proportion of households who sold any poultry was higher during the six months leading up to the lean season survey than in the months prior to baseline. This could reflect households' need for cash during this period. In contrast to the proportion of households with any poultry sales, however, total sales revenues were lower. The proportion of those who report selling eggs is also higher during the lean season. The increase in egg sales across seasons is even larger when restricting analysis to those who do not keep guinea fowl (4% at baseline compared to 19% at the lean season follow-up), suggesting that the difference is not driven by seasonal differences in production of this species, though seasonal differences in poultry productivity could be at play. Problems with the reporting of animal products at baseline could also be a factor. Similarly, there is some evidence that the difference in poultry production costs (and

thus profits) across rounds may be driven by differences in the (mis)reporting of costs at the flock versus poultry type level, which appears to have been more of a problem at baseline.

While household consumption of own-produced poultry meat does not differ significantly between rounds, egg consumption over the past 7 days (from the food consumption module) is 44% higher during the lean season than at the time of the baseline survey round. This is likely due to the seasonality of egg production.

While we observe no significant differences in the poultry marketing options available to or chosen by women between the two survey rounds, this may be attributable to the small number of women who sold poultry during this period. Comparing the point estimates, the proportion of female producers who reported that they selected a buyer based on price was over twice as high in the lean season as it was at baseline, while the proportion who selected based on price or location was lower. Price was by far the most important determinant of buyer selection for male producers in both rounds, though in the months leading up to the lean season survey, men were relatively more likely to choose based on location or immediate payment. Male producers also reported that fewer poultry buyers were available during this period.

To investigate whether differences in outcomes between the baseline and lean season rounds could reflect early treatment effects in the 16 villages where program activities were already starting at the time the lean-season survey was administered, we report means of the same variables as in Tables 11 and 12 by round and treatment group in Appendix Tables A1 and A2. The observed changes between rounds are generally consistent across treatment groups. This is consistent with the absence of significant program activities by the time of the lean season survey.

In Table 13, we consider correlates of poultry mortality and business outcomes using lean-season data. Practices associated with flock size in the lean season mirror those observed in the baseline data.

Vaccination for fowl pox remains associated with lower poultry mortality as at baseline, though at a weaker level of statistical significance. In addition, we observe a negative relationship between poultry mortality and deworming of poultry.

Table 13: Relationship of poultry practices to mortality, costs, and production value (lean season)

	Number mature poultry (IHS)	6-month mortality as multiple of current flock size (IHS)	Variable production cost (IHS)	Gross production value (IHS)	Net production value (IHS)
	(1)	(2)	(3)	(4)	(5)
Fed grains	0.42***	0.01	0.85***	0.22	-0.72*
	(0.14)	(0.03)	(0.17)	(0.28)	(0.38)
Fed concentrates / vitamins	0.16	0.05	1.13***	0.63*	-0.73
	(0.22)	(0.07)	(0.30)	(0.38)	(0.77)
Gave water at will	0.35**	0.02	0.40**	1.17***	1.14**
	(0.18)	(0.03)	(0.20)	(0.34)	(0.48)
Dewormed for internal parasites	0.16	-0.05**	-0.44**	0.49*	1.04**
	(0.14)	(0.02)	(0.21)	(0.28)	(0.50)
Any poultry vaccinated for NC	0.45***	-0.03	2.02***	0.50**	-0.54
	(0.12)	(0.02)	(0.17)	(0.23)	(0.41)
Any poultry vaccinated for FP	0.22	-0.03*	0.12	0.02	-0.59
	(0.16)	(0.01)	(0.28)	(0.41)	(0.80)
Poultry is confined	0.10	-0.00	-0.80***	-0.19	0.82*
	(0.20)	(0.03)	(0.18)	(0.33)	(0.46)
Cultivated land area (Ha)	0.03**	0.00	0.01	0.02	0.02
	(0.01)	(0.00)	(0.02)	(0.02)	(0.04)
Observations	977	972	958	958	958
R-squared	0.125	0.014	0.075	0.075	0.030
Clusters (strata x villages)	180	180	180	180	180

Notes: The model shown in column 3 (mortality rate between rounds) is estimated using a Tobit model to account for the fact that the outcome variable has a maximum value of 1. All other specifications are linear. Cluster-robust standard errors in parentheses. Regional dummies also included. * p<0.1; ** p<0.05; ***p<0.001

As at baseline, production costs are higher for those who provide grain feed, concentrates or vitamins, and who vaccinate for Newcastle Disease. In addition, provision of water at will is associated with higher costs in this round. Deworming, which was not positively associated with production costs at baseline, now has a negative relationship with cost. This could reflect a higher cost of feed when poultry are infected

with worms. The failure to detect the same relationship at baseline could be related to possible mismeasurement of grain costs at baseline as noted in the discussion of Table 12. The negative relationship between cost and confinement is consistent with that observed at baseline.

Net production value appears to be lower for producers who fed their poultry grains ($p<0.1$) and is significantly higher for those who provided water at will and dewormed their poultry. Raising poultry in confinement is also associated with a marginally significant increase in net production value, due to a strong reduction in variable cost.

5. Discussion

Poultry production is widely practiced in the three study regions both across and within villages, with 88% of the population engaging in poultry rearing activities within the six-month period prior to baseline. The primary difference between larger and smaller producers appear to be demographic and reflect differences in the life cycle, with larger producers being older, with a larger number of household members – each of whom may contribute poultry to the total owned by the household. Some asset differences are also apparent: larger producers tend to have more land and are more likely to have access to electricity. On the other hand, larger producers tend to have lower educational attainment, likely reflecting a generational difference in access to education. Consumption expenditures and food security are similar across smaller and larger producers. Overall, our analysis shows that poultry production in rural Burkina Faso is not the preserve of the elite and that improvements to poultry input and output markets have the potential to improve the economic prospects of a broad segment of the rural population.

While access to vaccination services and veterinary medicines at the village level is high, uptake of these services is limited, especially among smaller producers. On the other hand, there are inputs for which potential producer demand may outstrip supply. For example, grains are widely fed to poultry, but feed

formulated specifically for poultry is available in fewer than half of villages. Access to financial services, which appear to act as an enabler of women's entry into poultry production, is low. Neither organized marketing channels, nor opportunities for technical training on poultry production, are widely available.

Poultry practices, particularly those that require a cash outlay, are generally superior among larger producers. However, there remains much room for improvement in practices by both smaller and larger producers. Fewer than a third of poultry producers vaccinated any of their birds against Newcastle Disease, a major scourge of poultry in the region. Even fewer producers – just over 10% - vaccinated against fowl pox.

Poultry mortality as measured through this study is correlated with some, but not all, of the production practices expected to affect this outcome. We see a negative association between mortality and fowl pox vaccination in both rounds of data, and with use of concentrates or vitamins and deworming in one round each. Net production value is higher in the lean season among those who provide water at will and deworm their poultry, and marginally so for those whose poultry are confined. In the baseline data, any gains from good practices (provision of grain, deworming, vaccination) are balanced by their higher cost, leading to little or no measurable impact on net production value.

In line with qualitative gender analysis conducted in the study region, women's ownership of poultry is quite limited in this setting. However, most women who own poultry report that they control the proceeds from any sales, indicating the potential to expand women's incomes through promotion of poultry rearing. Further, poultry owned by women is more likely to be consumed by the household, compared to poultry that is owned by men. This aligns with previous studies and implies that nutritional gains through subsistence consumption are more likely if poultry interventions explicitly target women. On the other hand, positively affecting household purchases of nutritious foods through a combination of higher poultry sales and improved nutritional knowledge will require men's involvement.

Women's poultry production practices, including provision of grain, feed concentrates, water, deworming and vaccination, are equivalent to those of men, but their access to markets is weaker. Female producers know fewer poultry buyers than male producers, tend to sell closer to home, and are more likely than men to select a buyer based on location, as opposed to other factors such as price. We find suggestive evidence that women's incomplete control over poultry sales may affect their production practices. Women, but not men, tend to invest more heavily in hens, which produce a constant consumption stream of eggs, than cocks, which can only be consumed as meat or sold. The share of poultry owned by women is significantly higher in villages where more households report current credit use.

Increasing women's control over resources could boost their production of poultry. Creating the enabling conditions for women to grow their flocks and access poultry markets has the potential to benefit them economically. However, other indicators of women's empowerment are not correlated with women's ownership of poultry. This suggests that broader impacts on women's agency should not be expected to arise through projects that simply expand women's engagement in poultry production without targeting other barriers to their full participation in decision-making at the household and community level.

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Table A1: Food security, poultry production, ownership, and practices by, treatment group and survey round

	Baseline									Follow-up								
	Control			T1			T2			Control			T1			T2		
	mean	Se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n
Food security and total consumption																		
HFIAS Score (0-27)	0.9	0.02	354	0.87	0.02	353	0.9	0.02	357	0.89	0.02	354	0.92	0.02	353	0.92	0.02	357
Total expenditure (pc, 1 day)	0.89	0.02	354	0.85	0.02	353	0.89	0.02	357	0.88	0.02	354	0.91	0.02	353	0.91	0.02	357
Ownership and scale of production																		
Raised poultry last 6 months	0.9	0.02	354	0.87	0.02	353	0.9	0.02	357	0.89	0.02	354	0.92	0.02	353	0.92	0.02	357
Own any chicken	0.89	0.02	354	0.85	0.02	353	0.89	0.02	357	0.88	0.02	354	0.91	0.02	353	0.91	0.02	357
Own any guinea fowl	0.41	0.03	354	0.37	0.03	353	0.38	0.03	357	0.52	0.03	354	0.46	0.03	353	0.53	0.03	357
Number of mature birds	19	1.02	353	22.6	1.81	353	22.1	1.21	357	25.6	1.48	351	26.7	1.59	352	25.6	1.42	354
Value of total stock (USD)	73.2	4.03	353	83.5	6.51	353	82.1	4.48	357	96.7	5.53	351	99.4	5.85	351	99.4	5.42	355
Pr. poultry owned by women	0.06	0.01	329	0.11	0.02	311	0.05	0.01	328	0.08	0.01	322	0.08	0.01	323	0.07	0.01	334
Practices																		
Fed cereals	0.8	0.03	331	0.83	0.02	315	0.84	0.02	331	0.85	0.03	331	0.78	0.03	315	0.85	0.03	331
Correct cereal freq.	0.78	0.03	331	0.79	0.02	315	0.81	0.02	331	0.81	0.04	331	0.75	0.03	315	0.81	0.03	331
Fed concentrates/vitamins	0.09	0.02	331	0.09	0.02	315	0.05	0.02	331	0.02	0.01	331	0.06	0.01	315	0.06	0.01	331
Correct conc./vitamins freq.	0.03	0.01	331	0.04	0.01	315	0.02	0.01	331	0.01	0	331	0.02	0.01	315	0.02	0.01	331
Gave water at will	0.94	0.02	331	0.93	0.01	315	0.94	0.01	331	0.89	0.03	331	0.84	0.03	315	0.91	0.02	331
Correct change of water freq.	0.92	0.02	331	0.93	0.02	315	0.93	0.01	331	0.64	0.03	331	0.72	0.04	315	0.81	0.03	331
Dewormed (internal)	0.04	0.01	331	0.1	0.02	315	0.07	0.01	331	0.08	0.02	331	0.1	0.02	315	0.09	0.01	331
Vaccinated Poultry	0.37	0.02	331	0.35	0.03	315	0.34	0.02	331	0.26	0.02	331	0.34	0.03	315	0.29	0.02	331
Vaccinated for Newcastle	0.32	0.02	331	0.32	0.03	315	0.32	0.02	331	0.24	0.02	331	0.31	0.03	315	0.27	0.02	331
Entire flock vaccinated for NC	0.31	0.02	331	0.3	0.03	315	0.3	0.02	331	0.22	0.02	331	0.3	0.03	315	0.25	0.02	331
Correct freq. vacc. Newcastle	0.01	0	331	0.01	0	315	0.01	0	331	0	0	331	0.01	0	315	0	0	331
Vaccinated for fowl pox	0.15	0.02	331	0.09	0.02	315	0.06	0.01	331	0.06	0.01	331	0.05	0.01	315	0.03	0.01	331
Entire flock vaccinated for FP	0.14	0.02	331	0.09	0.02	315	0.06	0.01	331	0.06	0.01	331	0.05	0.01	315	0.03	0.01	331
Correct Freq. vaccination FP	0.21	0.02	331	0.24	0.02	315	0.27	0.02	331	0.18	0.02	331	0.27	0.03	315	0.24	0.02	331
Correct age of vaccination	0.24	0.02	331	0.23	0.02	315	0.17	0.02	331	0.19	0.02	331	0.26	0.03	315	0.22	0.02	331
HH level practices index (0-15)	5.36	0.16	329	5.38	0.16	311	5.2	0.13	329	4.59	0.18	322	4.64	0.23	323	4.77	0.17	334
Mortality																		
6-month mortality	21.2	2.11	330	18.8	2.47	315	20.3	2.45	331	28.6	2.56	326	22.5	1.74	325	29	2.77	332
6-month mortality/flock size	9.49	7.62	329	0.79	0.12	311	1.02	0.16	329	0.79	0.1	322	0.63	0.07	323	0.92	0.18	334

Table A2: Poultry marketing, business outcomes, and household consumption, by survey round

	Baseline									Follow-up								
	Control			T1			T2			Control			T1			T2		
	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n
Female producers: Marketing options and choice																		
Number of buyers available	0.25	0.05	353	0.32	0.07	353	0.13	0.04	356	0.28	0.08	348	0.24	0.05	349	0.13	0.03	352
Buyer choice: best price*	0.20	0.01	26	0.63	0.07	32	0.44	0.10	17	0.09		27	0.43	0.10	31	0.28	0.08	26
Buyer choice: immed. paym't.	0.14	0.06	26	0.19	0.07	32	0.35	0.07	17	0.63	0.13	27	0.35	0.06	31	0.29	0.05	26
Buyer choice: location	0.49	0.04	26	0.10	0.01	32	0.10	0.07	17	0.21	0.13	27	0.21	0.10	31	0.20	0.08	26
Male producers: Marketing options and choice																		
Number of buyers available	2.23	0.16	322	1.43	0.12	302	1.70	0.14	323	1.20	0.12	335	1.48	0.12	331	1.49	0.15	347
Buyer choice: best price	0.42	0.04	175	0.60	0.05	123	0.43	0.04	145	0.46	0.05	139	0.40	0.04	161	0.50	0.05	140
Buyer choice: immed. paym't.	0.35	0.04	175	0.18	0.04	123	0.31	0.04	145	0.23	0.04	139	0.29	0.04	161	0.17	0.03	140
Buyer choice: location	0.12	0.03	175	0.10	0.03	123	0.18	0.03	145	0.16	0.04	139	0.21	0.04	161	0.23	0.05	140
Poultry revenue, costs, and profits																		
Any poultry revenue	0.61	0.03	354	0.59	0.03	353	0.60	0.03	357	0.66	0.03	354	0.65	0.03	353	0.66	0.03	357
Poultry revenue	37.6	5.78	354	37.4	5.27	353	45.4	5.72	355	31.4	2.99	353	38.8	3.76	353	34.6	3.27	354
Any egg revenue	0.03	0.01	354	0.01	0.01	353	0.03	0.01	357	0.11	0.02	354	0.13	0.02	353	0.08	0.02	357
Egg revenue	0.54	0.24	351	0.20	0.09	352	0.57	0.20	355	4.80	0.96	351	5.10	1.08	347	2.79	0.87	356
Production cost	5.70	0.60	351	6.88	0.75	345	7.24	0.79	349	11.3	1.10	348	9.87	1.24	345	10.4	1.01	351
Profit	30.6	5.75	354	28.5	5.03	353	32.9	4.99	355	16.7	2.98	352	25.5	3.86	353	22.2	3.37	355
Household consumption																		
Meat (USD, 6 mo)	10.8	0.96	327	11.8	1.23	304	12.0	1.03	325	11.	1.10	321	15.9	1.67	323	15.3	1.88	334
# Eggs (7 days)	0.84	0.22	348	1.18	0.23	348	0.86	0.19	353	1.26	0.25	354	1.22	0.19	353	1.73	0.33	357

* Standard errors are not reported if any cluster contains only one observation

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