



INTERNATIONAL  
FOOD POLICY  
RESEARCH  
INSTITUTE

IFPRI

ILRI  
INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE



CGIAR  
BETTER DIETS  
AND NUTRITION

CGIAR  
SUSTAINABLE ANIMAL  
AND AQUATIC FOODS

**IFPRI Discussion Paper 02390**

December 2025

## **Closing the Regulatory Gap**

**Experimental Evidence on Oversight and Worker Incentives**

Elizabeth Anne Jessie Cooke

Kate Ambler

Vivian Hoffmann

Lilian Kwamboka Otoigo

Alice Njoki Kiarie

Julia Wagner

Markets, Trade, and Institutions Unit

## INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), a CGIAR Research Center established in 1975, provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition. IFPRI's strategic research aims to foster a climate-resilient and sustainable food supply; promote healthy diets and nutrition for all; build inclusive and efficient markets, trade systems, and food industries; transform agricultural and rural economies; and strengthen institutions and governance. Gender is integrated in all the Institute's work. Partnerships, communications, capacity strengthening, and data and knowledge management are essential components to translate IFPRI's research from action to impact. The Institute's regional and country programs play a critical role in responding to demand for food policy research and in delivering holistic support for country-led development. IFPRI collaborates with partners around the world.

### AUTHORS

Elizabeth Anne Jessie Cook ([e.cook@cgiar.org](mailto:e.cook@cgiar.org)) is a Senior Scientist of Epidemiology in the Animal and Human Health (AHH) Program of the International Livestock Research Institute (ILRI), Nairobi, Kenya.

Kate Ambler ([k.ambler@cgiar.org](mailto:k.ambler@cgiar.org)) is a Senior Research Fellow in the Markets, Trade, and Institutions (MTI) Unit of the International Food Policy Research Institute (IFPRI), Washington, DC.

Vivian Hoffmann ([v.hoffmann@cgiar.org](mailto:v.hoffmann@cgiar.org)) is a Senior Research Fellow in IFPRI's MTI Unit, Washington, DC.

Lilian Kwamboka Otoigo ([l.otoigo@cgiar.org](mailto:l.otoigo@cgiar.org)) is a Research Officer in ILRI's AHH Program, Busia, Kenya.

Alice Njoki Kiarie ([a.kiarie@cgiar.oeg](mailto:a.kiarie@cgiar.oeg)) is a PhD Student in the Department of Veterinary and Animal Sciences, University of Copenhagen, Denmark and a Graduate Fellow at ILRI, Nairobi, Kenya.

Julia Wagner is a PhD Candidate in Economics at the Institut d'Économie Scientifique Et de Gestion (IÉSEG) School of Management, Paris, France.

### Notices

<sup>1</sup>IFPRI Discussion Papers contain preliminary material and research results and are circulated in order to stimulate discussion and critical comment. They have not been subject to a formal external review via IFPRI's Publications Review Committee. Any opinions stated herein are those of the author(s) and are not necessarily representative of or endorsed by IFPRI.

<sup>2</sup>The boundaries and names shown and the designations used on the map(s) herein do not imply official endorsement or acceptance by the International Food Policy Research Institute (IFPRI) or its partners and contributors.

<sup>3</sup>Copyright remains with the authors. The authors are free to proceed, without further IFPRI permission, to publish this paper, or any revised version of it, in outlets such as journals, books, and other publications.

## **Abstract**

Weak enforcement of regulatory standards is widespread in low- and middle-income countries. Low firm capacity and standards inappropriate to local contexts imply that traditional punitive enforcement approaches may be counterproductive. We test the impact of a regulatory oversight intervention leveraging the soft power of meat inspectors in the context of 140 rural slaughterhouses in western Kenya. The intervention focused meat inspector attention on hygiene practices and was combined with training of workers and provision of basic equipment and supplies. Practices improved significantly relative to control facilities, but microbial contamination of meat did not. Outcomes were similar in a subset of treatment facilities where workers were additionally given a hygiene performance incentive. Higher volume of business in treatment facilities, which customers perceived as cleaner, suggests that retailers value less contaminated meat, but may counteract the effects of improved practices through cross-contamination and crowding.

**Keywords:** Worker training, regulation, food safety, monitoring

## **Acknowledgments**

Shared lead authorship, order is randomized. We thank REMIT for excellent data collection support, Mike Murphy for research assistance, and the county governments in the project area for their collaboration. We thank participants at seminars at American University, the 2024 One Health Congress in Cape Town, the FAO Community of Practice on the Progressive Management Pathway for Terrestrial Animal Biosecurity online seminar series, and Carleton University School of Public Policy and Administration for useful suggestions. This publication has been prepared as an output of Sustainable Animal and Aquatic Foods (SAAF) and the Better Diets and Nutrition (BDN) Science Programs of CGIAR, and the CGIAR One Health Initiative, and has not been independently peer reviewed. Any opinion(s) expressed here belong to the author(s) and are not necessarily representative of or endorsed by CGIAR. We would like to thank all funders who supported this research through their contributions to the [CGIAR Trust Fund](#).

# 1. Introduction

The exercise of regulatory power is an important tool used by states to reshape markets characterized by significant externalities or power imbalances. Absent effective enforcement, however, *de jure* regulations are meaningless. Worse, they may serve as opportunities for rent-seeking by corrupt officials (Amin & Soh, 2021). Weak enforcement of regulatory standards is widespread in low- and middle-income countries, affecting diverse domains including environmental pollution (Greenstone & Hanna, 2014) labor rights (Berkel et al., 2022), and building safety (Krimgold & Moullier, 2015). Noncompliance with food safety standards exemplifies this problem and contributes to the large burden of foodborne disease, comparable on a global scale to that of malaria and highly concentrated in LMICs (Grace, 2023).

Regulatory control of food safety is generally recognized as important because of its unobservability (Antle, 2001). In LMICs with limited regulatory and scientific capacity, food safety regulators often adopt standards developed by high-income countries or international standard-setting bodies; this has the important benefit of aligning with the rules of export markets (Wieck & Grant, 2021). However, attaining these standards is often infeasible in the context of limited infrastructure and enforcement capabilities, especially in segments of the food system serving the domestic market (Grace, 2023). Moreover, punitive measures for noncompliance may backfire by pushing food production underground or reducing the overall food supply (Jaffee & Henson, 2024; Unnevehr & Hirschhorn, 2000). This leads to a situation in which moving practices in the direction of compliance is likely to be welfare-improving, but the appropriate design of regulatory enforcement mechanisms is unclear.

In this paper, we study an approach that explicitly aims to improve food hygiene practices through regulatory oversight without the use of punitive enforcement measures. Specifically, the approach harnesses the *soft power* of regulatory enforcement personnel through targeted education, provision of inexpensive equipment, and low-stakes monitoring with no explicit negative consequences, to improve compliance with a subset of regulatory standards. We additionally study whether the provision of compliance incentives for workers further changes behavior, and whether both approaches ultimately impact food safety outcomes. We implement a randomized controlled trial evaluating these interventions among livestock slaughter facilities in rural Kenya, considered a critical control point for the management of food safety hazards in meat (Food Safety Inspectorate Service, 2021). Animal-source foods are believed to be responsible for the majority of foodborne

illness across most countries (Grace, 2023), and slaughter of animals is highly regulated across jurisdictions due to the potential for pathogen contamination of meat at this processing stage (Nagel-Alne et al., 2022).

Achieving acceptable hygiene levels in meat at the point of slaughter can be costly (Antle, 2000). In high-income countries, where regulations are strictly enforced, the cost of slaughter can range from 50 to 200 USD, representing 4% to 15% of the value of a dressed carcass. In low- and middle-income countries (LMICs), both the quality and costs of slaughter services tend to be far lower, both in absolute terms and as a share of the product value. In our data from rural Kenya, modal slaughter costs per animal range from less than one USD for sheep and goats to two dollars for cattle, amounting to less than 1% of the value of a dressed carcass.<sup>1</sup> This reflects both the rudimentary nature of the slaughter facilities and low wages. Conditions in these slaughterhouses have previously been characterized as posing occupational hazards to workers and contamination risk to the food supply (Cook et al., 2017). Given the low level of baseline hygiene infrastructure and practices in this context, and the high cost of foodborne disease, basic improvements have the potential to cost-effectively reduce the burden of infectious disease.

The intervention we study was designed to improve hygiene practices and food safety outcomes at the point of slaughter through a randomized controlled trial in 140 slaughter facilities in western Kenya. It built on existing regulatory capacity, engaging government veterinary officers to train workers and leveraging the presence of meat inspectors to complete a low-stakes monitoring exercise. Meat inspectors conducted observations and filled out a weekly hygiene checklist on worker adherence to recommended practices, but there were no negative consequences associated with the monitoring exercise. Personal protective equipment and basic hygiene equipment and supplies were also provided. The intervention was designed in such a way that it could be – and indeed later was – continued and scaled by local authorities within Kenya’s decentralized governance structure. In a randomly selected subset of facilities, workers were given bonus payments equivalent to 25% of average weekly wage earnings for collective adherence to good hygiene practices.<sup>2</sup> Slaughter workers are generally paid a share of the fee per animal

---

<sup>1</sup> US and Kenyan values of dressed carcasses are calculated from bone-in beef prices and yield per carcass (FAOStat, 2016), adjusted to prices during the study period using national CPI. Kenyan slaughter prices are taken from endline survey data; US slaughter prices collected from online sources: [https://www.reddit.com/r/farming/comments/1hlxbwt/what\\_do\\_you\\_pay\\_for\\_a\\_cow\\_to\\_be\\_slaughtered\\_and/](https://www.reddit.com/r/farming/comments/1hlxbwt/what_do_you_pay_for_a_cow_to_be_slaughtered_and/), <https://www.farmersvilleabattoir.com/pricing-1>

<sup>2</sup> This comparison is based on the earnings of workers paid regular wages, as opposed to a piece rate per animal.

slaughtered by the facility; in our sample 84% of workers report that they were paid per animal.<sup>3</sup> This implies a group-level incentive to work fast, potentially at the expense of exercising care to maintain good hygiene. The hygiene bonus was intended to counter this effect and to create a competing incentive to follow hygiene protocols that would otherwise have little direct benefit to workers. Impacts were evaluated both during the monitoring period while payments were being sent to workers, and a month after both monitoring and payments ended.

Both versions of the intervention improved worker knowledge, observed hygiene practices, and the cleanliness of water and equipment. Impacts on hygiene practices were generally similar regardless of whether workers were given incentives. Slaughterhouse customers noticed changes in facility cleanliness and practices, and intervention facilities saw a marked increase in the number of animals processed, suggesting that good perceived hygiene standards convey an advantage even in markets upstream of consumers. However, meat contamination levels were not lower in intervention facilities – indeed for the treatment group without incentives, carcass contamination was worse on some measures than in control facilities during the intervention. This negative effect may be due to increased volume and congestion in treatment facilities. Impacts on worker knowledge and behaviors persisted a month after monitoring activities and payments stopped, suggesting that intermittent monitoring may be sufficient to obtain persistent changes in behavior. Overall, the results suggest that a fairly low-cost intervention can have the intended impacts on worker behavior in this context. Notably, incentive payments for workers have no additional impact beyond those of information provision and low-stakes monitoring. However, the content of any such program design should be modified to ensure meat contamination levels are better addressed.

This study relates to a small literature describing the effectiveness of regulatory enforcement in low and middle-income countries using experimental or quasi-experimental methods. This literature has addressed environmental controls (Hanna & Oliva, 2010; Oliva, 2015) and health service delivery (Bedoya et al., 2023), but food safety has not been studied in this way. Oliva (2015) documents that nearly 10 percent of the drivers of older cars in Mexico cheat on emissions test by paying small bribes to technicians. Bedoya et al. (2023) show that inspections of health facilities coupled with the threat of regulatory action (closure or timeline for improvement) resulted in increased compliance with patient safety metrics without reducing facility use.

---

<sup>3</sup> This statistic is from the control group at project endline, and was not collected at baseline.

Our primary contribution is to examine the effect of a scheme that employs the soft power of regulation without explicit threats of penalties. This soft power may arise by triggering internalized pro-social or rule-following norms. Cues referencing public observability (public sign-up, images of faces or eyes) have been demonstrated in other contexts, including household energy conservation and hand hygiene in medical settings (Yoeli et al., 2013; Beyfus et al., 2016). This approach is well suited to the context of food safety as well as health and educational applications in which tradeoffs may exist between the enforcement of quality standards and availability of goods or services.

The hygiene performance bonus implemented in one of the treatment arms also connects to the large literature on performance-based payment. Performance-based pay has been shown effective at improving worker performance in a range of private and public sector contexts, including in rural LMIC settings (Duflo et al., 2012) and food processing (Jones et al., 2010). However, piece rate pay is also associated with higher rates of workplace injury and lower compliance with safety protocols (Johansson et al., 2010), implying a potential tradeoff between speed and adherence to hygienic slaughter practices. The hygiene bonus introduced as part of intervention was structured as a reward for group performance, which is generally observed to outperform individual performance contracts (Wood et al., 2023). The temporary nature of the incentive payments allows us to test for the persistence of effects after it was discontinued. Previous work on this question, in the context of payments for ecosystem services, has mostly shown that the impacts of incentives generally wane once payments end (Winkler-Schor & Brauer, 2025). This finding relates to a large body of evidence showing that intrinsic motivations are often – though not always – crowded out by monetary incentives (Ezzine-de-Blas et al., 2019). On the other hand, temporary incentives may support habit formation, leading to longer-term impacts (Allcott & Rogers, 2014).

We also contribute to the evidence linking food safety interventions and market outcomes. Empirical research in diverse settings including the US, UK and China shows that negative food safety information, including recalls and scares, sharply reduce consumer demand for affected goods (Bovay, 2023). Two recent experimental studies investigate the effects of capacity building and food safety signaling on consumer demand in LMICs. In India, Brown and Tomassi (2025) find that the provision of highly visible equipment to facilitate food hygiene drives improved practices and increased profits, but that trainings have no additional impact. In Vietnam, Ambler et al. (2025) show that a program providing trainings and independent, visible ratings of a market vendor's

hygiene practices had modest impacts on hygiene practices and sales. Reputational risk faced by retailers and other downstream actors implies that demand for food safety can be transmitted up the value chain. For example, in South Africa, some formal sector retailers require compliance with private standards such as GlobalG.A.P., while others conduct food safety audits of suppliers that include microbiological and chemical analysis (Boatema et al., 2019). However, the effects of improved food hygiene practices on upstream demand among upstream market actors have not previously been studied.

Finally, our results speak to a body of work on the impacts of slaughterhouse upgrading in low-resource contexts. Hygiene infrastructure and practices in the slaughter facilities of LMICs are widely recognized as problematic (Ovuru et al., 2024). To our knowledge, impact evaluations of slaughterhouse upgrading have thus far been limited to small-scale pre- vs. post- comparisons (Grace et al., 2012; Ngo et al., 2023). These studies have documented improvements in practices and microbial contamination. Given the potential for time-varying environmental conditions to affect microbial outcomes, our use of a randomized methodology to assess the impact of a slaughterhouse hygiene intervention makes a significant improvement on this evidence base. The lack of positive impact on meat contamination, despite behavioral improvements, suggests a need for technical innovation and potentially greater capital investment in LMIC slaughter facilities. Meanwhile, our documentation of a demand response to perceived improvements in hygiene could be used to motivate such investment.

The paper proceeds as follows. Section 2 documents the study design, section 3 describes the data and estimation strategy, section 4 presents the results, and section 5 concludes.

## 2. Study design

### 2.1 Study setting and sample

In Kenya, hygiene and sanitation facilities and practices in slaughterhouses often fall well below established regulatory standards (Cook et al., 2017). The typical slaughter facility in this region is a simple, one-room building with a concrete floor and open doors and windows, to which water is hauled by bucket. Some facilities, particularly those that are larger and operated by the counties, have somewhat improved facilities. In general, lack of access to networked water and electricity infrastructure makes meeting hygiene standards, which include a minimum volume of water used per animal and the availability of heated water for cleaning, challenging. Investment in lower-cost

technologies such as handwashing stations and personal protective equipment for workers are more feasible at the individual facility level, but also largely absent (Cook et al., 2017).

Regulatory standards in slaughterhouses are enforced by county governments. These governments employ meat inspectors who are responsible for visiting slaughterhouses on a daily basis to inspect the health of animals pre-slaughter and the quality of meat post-slaughter. Functionally, meat inspectors are all assigned to multiple slaughterhouses. Their schedules allow them to check meat for the presence of certain parasites, injuries, and insufficient bleeding, signs of infection, and other visible abnormalities, but they are not usually able to conduct pre-slaughter inspections of animals. They are also not generally tasked with enforcing slaughter hygiene standards, which include facility standards (a supply of hot water, modern lavatory accommodations with hot and cold water) and process standards (separation of stomachs and intestines from other meat, wearing of protective clothing and footwear, frequent handwashing with soap by meat handlers) (Meat Control Act, 2012). The tools available for regulatory enforcement theoretically include fines and the closure of non-compliant slaughterhouses. However, discussions with regulators reveal that these tools are rarely used (Otoigo et al., 2025). Low levels of compliance, combined with the recognition that facility closures could threaten the local food supply and potentially drive slaughter activities to informal facilities outside of any regulatory oversight, imply that shutdown threats are functionally applicable only in the most egregious cases.

The study sample for this project is drawn from slaughter facilities in six counties in Western Kenya.<sup>4</sup> To build the sample, lists of all slaughter facilities were obtained from regulatory authorities in the study counties. Facilities processing fewer than two animals per day, open fewer than two days per week, or processing more than 20 animals per day were excluded, as were the four facilities in which a pilot study was conducted.<sup>5</sup> After excluding one slaughterhouse located within a boarding school that was closed during the intervention, the study sample consisted of 140 slaughterhouses, covered by 75 meat inspectors.

## 2.2 Intervention and experimental design

With this context in mind, we now describe the implementation of the hygiene intervention. Because meat inspectors are the point of contact between the regulatory authority responsible for

---

<sup>4</sup> The study counties were: Bungoma, Busia, Kakamega, Kisumu, Siaya, and Vihiga.

<sup>5</sup> One meat inspector was responsible for seven slaughterhouses. To avoid excessively burdening this meat inspector with additional tasks, two of these slaughterhouses were randomly dropped.

slaughterhouse hygiene and already make daily visits to slaughter facilities, they were identified as the most appropriate actor to implement the monitoring treatments to be described below. In order to limit spillovers, treatment was assigned at the level of the meat inspector. Meat inspectors were stratified by county and then randomized with equal probability to one of three groups: Control; Training, Equipment and Monitoring (TEM), and TEM + incentives. All slaughterhouses to which a meat inspector was assigned followed that inspector's treatment assignment.<sup>6</sup>

#### *T1: Training, Equipment and Monitoring (TEM)*

At facilities assigned to the Training, Equipment and Monitoring treatment group, workers (including managers) were trained on good hygiene practices during a single on-site session that typically lasted one to two hours. Trainings were delivered by Sub-County Veterinarians, who had been trained by researchers at the International Livestock Research Institute (ILRI). The trainings were developed by veterinarians at ILRI based on FAO resources (Mann et al., 1984; Sheridan, 1991; Skaarup, 1985). The training session covered sources of contamination and processes to follow to maintain cleanliness during slaughter. Instructions included hanging carcass off the floor during skinning and evisceration, ensuring the carcass does not touch the hide, techniques for safe removal of viscera, and transportation. Proper knife and hand washing techniques and sequencing were also emphasized. At the end of the training session, all workers were provided with gumboots and waterproof aprons. A handwashing station, cleaning equipment and supplies,<sup>7</sup> and posters (see Appendix A for two examples) illustrating the hygiene practices on which workers were trained were provided to the slaughterhouse owner. Project staff assisted managers to hang the posters in high-visibility locations where they would serve to remind workers of key practices.

Meat inspectors assigned to this group were asked to monitor hygiene practices, provide feedback to workers, and complete a hygiene checklist once a week at each of their assigned slaughter facilities. The form was based on observation of the slaughter process for one specific animal from beginning to end (when possible), and captured information related to the points on which meat handlers had been trained, including whether the carcass was raised off the floor, whether intestinal contents or guts spilled on the floor, separation of digestive organs from meat, and post-slaughter cleaning practices. The checklist also included questions about when

---

<sup>6</sup> Two meat inspectors who were assigned to facilities within 500 meters of each other were grouped together for the purpose of treatment assignment.

<sup>7</sup> The following cleaning materials were provided: three buckets, one broom, three brushes, 10 L of detergent, six bar soaps, one nail brush, six 500 mL bottles of AquaGuard water treatment solution.

handwashing occurred and whether soap was used, the technique and supplies used to clean knives, and whether the water used for washing was chlorinated.<sup>8</sup> Meat inspectors noted how many workers present were wearing clean gumboots and aprons or dustcoats. Inspectors were trained on how to enter this information into a tablet, and were provided with tablets on which to do so. They were paid 300 Kenyan Shillings (approximately 2 USD) for each form they submitted. This monitoring protocol was implemented weekly for 12 weeks. Notably this intervention was designed to be low-cost so that it could be scaled by county governments. Costs, including trainer wages and transport, equipment, posters, provision of a smartphone and payments for completed forms to inspectors over 12 weeks, were calculated to be 76,185 Kenyan Shillings (approximately 590 USD) per slaughterhouse, a number that would likely drop when scaled.

This variant of the intervention aimed to change worker hygiene behavior through three channels. First, information constraints were overcome through the training of workers and managers. Second, resource constraints were addressed through the provision of necessary equipment and supplies. Some of these items, like soap for handwashing, are inexpensive and may not have been purchased due to lack of knowledge or motivation. Others, like handwashing stations and worker PPE may be unaffordable for managers and workers. Third, the weekly checklist focused meat inspectors' attention on slaughter hygiene, potentially leading workers to increase adherence to these behaviors by creating small social or psychic costs of non-compliance.

#### *T2: TEM + Incentives*

In addition to the training and equipment provided and monitoring conducted at Training, Equipment, and Monitoring facilities, workers in the TEM + Incentives facilities were provided with a bonus payment of 50 Kenyan Shillings for each day the slaughterhouse was typically open. For example, for slaughterhouses open six days a week, workers who qualified would receive 300 Kenyan Shillings (approximately 2 USD). This is equivalent to a quarter of workers' median earnings during weeks when they collectively scored well on the hygiene checklist. The payments were made via mobile money transfers. The posters displayed in these facilities indicated the hygiene practices necessary to earn this bonus, while the posters in the facilities with no monitoring simply indicated that these were "good" practices. The facility received points for each positive response on the weekly checklist and were awarded the bonus if they exceeded a certain threshold. These point

---

<sup>8</sup> Meat inspectors were given materials that allowed them to test the cleaning water for chlorine.

values and the specific threshold for receiving the bonus payment were unknown to the slaughterhouse workers and to the meat inspector. Incentive payments were made in each of the 12 weeks of the intervention.

The TEM+ Incentives treatment tests the addition of a positive incentive in addition to the information and equipment provided in the TEM only group. In a setting where the enforcement of regulations via punitive measures is not likely, these payments can serve as an additional mechanism to motivate behavior change. In particular, in a setting where worker behavior is a key component of hygiene improvements, but where these workers do not benefit directly from the extra effort and face a competing incentive under their piece-rate payment structure to work as quickly as possible, such incentives can motivate workers to follow the hygiene protocols.

#### *Control*

Control facilities were only visited for data collection during the study period. Training, equipment, and posters were provided at these facilities after endline data collection.

## 3. Data and estimation strategy

### 3.1 Data

The data used in this study was obtained during three rounds of visits by enumerators trained to conduct surveys and collect biological samples. Baseline data collection was conducted in all slaughterhouses selected for inclusion in the study approximately 2 to 3 weeks prior to the training sessions and equipment delivery. The trainings constituted the beginning of the intervention period. The baseline took place in September and October of 2023, followed by the trainings and equipment delivery in October and November 2023. The work was staggered by county, meaning that the entire baseline was conducted in a county (1 to 2 weeks of field work) followed by the trainings in that county 2 to 3 weeks later. While training sessions were ongoing in the initial counties, the baseline was being conducted in the next set of counties. This same order was followed for all survey rounds, maintaining approximately the same timing breaks between baseline, training, and follow-up data collection rounds across counties.

Midline data collection occurred 4 to 5 weeks after the completion of training and equipment delivery in each county (November and December of 2023) during the 12-weeks while

monitoring visits occurred and incentive payments were sent to workers. In all slaughterhouses, endline data collection occurred 4 to 5 weeks after the meat inspector was no longer asked to fill out and send in the monitoring forms and after the last incentive payments were made, in February and March 2024.

Each round of data collection comprised a set of surveys, behavioral observations, and microbiological samples. A survey was conducted with the facility manager covering basic information about the slaughterhouse, hygiene knowledge, and at endline, his assessment of the program and information on prices. Managers also provided the names and roles of all workers employed at the slaughterhouse. This information was used to select workers for interview. Four workers were systematically selected based on their job descriptions, with the goal of interviewing workers who were involved in a variety of slaughter and post-slaughter roles, and always including the worker who sectioned the carcass into sides. Workers were interviewed about their age, education level and experience, hygiene knowledge, and about their typical practices. At endline they were also asked about wages. Individual workers were not followed from round to round, nor were they excluded from re-interview in a subsequent round. Three customer or livestock owner interviews were also conducted at each facility, focused largely on perceptions of the slaughterhouse. Like workers, customers were selected based on their availability at the facility on the day of the interview and thus do not constitute a panel.

In addition to the surveys, enumerators conducted a detailed observation exercise. They identified one animal to follow from beginning to end of the slaughter process and noted the hygiene-related behavior of the slaughterhouse workers as the carcass moved through the slaughter process. This included information on hand and knife washing at various steps, information on whether the carcass and its elements touched the floor at different points in the process, and information related to the cleaning of the slaughter facility. The observation form included the same fields as the meat inspector monitoring form, as well as additional details.

The final source of data was a set of swabs and samples analyzed for microbial contamination. Enumerators swabbed four locations on the carcass they followed for observation immediately before it was sectioned. These samples were then pooled for analysis. Enumerators also swabbed the hands of the worker who sectioned the carcass, and the knife used for this purpose. Finally, the enumerator took a sample of the water used to wash knives.<sup>9</sup> Swabs and

---

<sup>9</sup> If multiple steps washing steps were employed, the sample was taken from water used in the final rinsing step.

samples were put on ice in coolers and sent to the ILRI lab in Busia for refrigeration and analysis by the end of the day. Counts were made of total coliform and of *E. coli*, which indicate fecal contamination and serve as proxies for potential pathogen contamination. Swab samples were enumerated for coliforms and *E. coli* using media pads (MC-Media Pad®, Sigma-Aldrich, Burlington, MA) according to the manufacturer’s instructions (MilliporeSigma, 2020). Presence of pathogenic *E. coli* and *Salmonella* was assessed using culture methods.<sup>10</sup>

### 3.2 Outcomes and empirical specification

The goal of this research is to understand how to influence the behavior of workers in a regulated context, when traditional punitive regulatory tools are either infeasible or inappropriate. We additionally seek to understand whether this behavior change achieves the regulatory objective – specifically, reduced levels of microbial contamination of meat leaving slaughterhouses. Further, we explore whether customers respond to our intervention, by examining a limited set of business outcomes. Analysis in line with these objectives is conducted as detailed in a pre-analysis plan registered on the AEA RCT Registry<sup>11</sup> and presented here in Appendix B. We note any deviations from the pre-analysis plan in our discussion of the analysis.

To reduce the number of hypotheses tested, most outcomes presented in this paper are indices constructed using the Anderson (Anderson, 2008) inverse covariance-weighted (ICW) approach (Schwab et al., 2020), standardized against the control group value. The primary outcomes are an index of hygiene practices observed by enumerators and an index of microbial contamination of the carcass. The hygiene practice index includes information on where the carcass was skinned or scalded (floor, raised platform, or hanging), handwashing at each stage of slaughter, intestinal contents and organs falling on the floor, washing of the floor, storage of processed meat, proportion of workers wearing appropriate PPE, knife washing at various stages of

---

<sup>10</sup> *E. coli* was cultured on MacConkey agar (Oxoid™ Hampshire, England) and Cefixime Tellurite-Sorbitol MacConkey agar (CT-SMAC, Oxoid™ Hampshire, England) according to Bacteriological Analytical Methods (BAM) guidelines. *Salmonella* was cultured on Xylose lysine tergitol agar-4 (XLT-4, Oxoid™ Hampshire, England) and *Salmonella* chromogenic agar base (Oxoid™ Hampshire, England) according to ISO 6579-1:2017 guidelines. Presumptive colonies were stocked in Tryptone Soya broth (Oxoid™ Hampshire, England) for later identification using MALDI-TOF. Identification of *E. coli* pathotypes (Shiga toxin-producing *E. coli* 1 and 2 (STEC), ETEC, EPEC, EAEC, non-O157 STEC O103 and O121) was conducted by polymerase chain reaction (PCR) as previously described (Okumu et al., 2023).

<sup>11</sup> <https://www.socialscisearch.org/trials/12126>

the slaughter process, and carcass contact with the floor. The elements of the practices index are listed in Appendix Table C1a. Carcass contamination was chosen as the primary contamination outcome because it is the most important for public health; the index describing this outcome includes the logarithm of colony-forming units (CFU) of coliforms per cm squared and the logarithm of CFU *e coli* per cm squared. We also study an indicator for whether either pathogenic *E. coli* or *Salmonella* was found on the carcass swab. The contamination variables are described in Appendix Table C1b.

A set of secondary outcomes examines worker behavior in more detail. We present ICW indices for specific activities (e.g., handwashing and use of PPE) and processing stages (flaying, evisceration, etc.) to more fully understand which practices were most affected by the interventions. These are described in more detail in Appendix Table C1a. We also analyze ICW indices of hygiene knowledge of both meat handlers (workers) and slaughterhouse managers, to understand whether our interventions changed knowledge in addition to behavior. The elements of these indices are described in Appendix Table C1c. Additionally, we include indices of the same microbial contamination measures for hand and knife swabs and water samples (described in Appendix Table C1b), to measure whether the intervention reduced contamination at intermediate points in the slaughter process. Finally, while we did not prespecify these, we examine variables related to how the intervention affected consumers' choices and perceptions of slaughter facilities, their volume of business, and scale of operation.

Table 1 presents descriptive statistics for slaughterhouses based on baseline data for our sample. 81% of facilities process ruminants (cow, sheep, and goat) with the remainder being pig slaughter facilities.<sup>12</sup> The average number of animals slaughtered per day is five (median 4 animals), and the average number of workers is 8.8 (median of 7). Reliable water access is scarce, only 20% of facilities report water being conveyed via pipes, and 69% report that their main water source is a well. Only 22% receive water from municipal sources. While some recommended practices are relatively common (sectioning the carcass while hanging, cleaning and storing intestines separately), others are not the norm (skinning carcass off the floor, preventing intestines or their contents from falling on the floor). Additionally, very little washing water contained chlorine at baseline, and the use of soap to wash hands and knives was close to zero. However, cleanliness is valued by slaughterhouse customers; while most (90%) report choosing a slaughterhouse for its

---

<sup>12</sup> Pigs are slaughtered in separate facilities for religious and cultural reasons.

location, 43% report that cleanliness influenced their choice. Either *Salmonella* or a pathogenic strain of *E.coli* was detected on the carcass sample taken from 24% of slaughter facilities. While pathogen detection does not necessarily mean contamination at a level sufficient to cause illness in every case, this finding does imply a potential public health threat.

Table 2 shows descriptive statistics for meat handlers interviewed at the slaughterhouses at baseline. The mean age is 41.3 and almost all workers (96.4%) are male. The sample is not well educated; for 32%, primary school is their highest completed level of education and 14.5% have completed secondary school. The average years of experience working in slaughterhouses is 11.3. Despite the risks of pathogen transmission from diseased animals, and evidence of elevated prevalence of diseases carried by livestock in this population (Cook, 2015; Cook, de Glanville, et al., 2021; Cook, Gitahi, et al., 2021), only 3% of workers describe illness as an occupational hazard. 50.6% of workers know that washing hands is a way to avoid illness at work, while 76.5% are aware of the importance of personal protective equipment. In general, workers do not have a good sense of where contamination comes from at baseline: 75% report that contamination can come from the floor, but 25% or fewer mention any other source (skin, feces/gut contents, equipment, hands, and clothes). Similarly, fairly low numbers of workers know techniques for reducing contamination of meat at baseline: 50% mention hand washing, 34% knife washing, 64% mention cleaning the floor, 28% mention hanging the carcass, and 38% say the carcass should not be allowed to touch the floor. All other techniques are mentioned in under 5% of cases. 51% of workers report that soap is available for hand washing, but observational data show it is rarely used.

The baseline data also allows us to examine existing levels of microbial contamination. Figures 1 and 2 show the baseline distribution of log CFU coliform and *E. coli* detected in knife, hands, water, and carcass swab samples in panels a, b, c and d respectively. In all figures the red vertical line represents the level above which the contamination levels are judged as unacceptable based on international food hygiene standards.<sup>13</sup> Contamination above one of these thresholds does not necessarily imply the meat is unsafe for consumption. Rather, it signals the possibility that pathogenic organisms, in addition to the indicator organisms enumerated, could be present in sufficiently large numbers to cause illness if the meat is not heated sufficiently prior to consumption. This also implies a significant risk of cross-contamination to other foods.

---

<sup>13</sup> The maximum *E. coli* allowed on beef carcasses is 2.0 log cfu/g (Kenya Bureau of Standards, 2020). No specific limits were found for total coliform count (TCC); hence the limits set for Aerobic Colony Counts (ACC) and *Enterobacteriaceae* on carcasses were adopted for TCC which allowed between 1.5 log cfu/cm<sup>2</sup> to 2.5 log cfu/cm<sup>2</sup> mean logs with 3.0 log cfu/cm<sup>2</sup> allowed in pigs (EC, 2005; NDVQPH, 2010).

Contamination levels are very similar across sample types. In general, these levels are very high, with significant shares over acceptable thresholds. A lower percentage of hand swab observations are over the threshold due to this being set a higher level.

Baseline balance tests for the main outcomes, which are almost all ICW indices, are presented in Appendix Table C2. The sample is well balanced overall. The only exception is that contamination of workers' hands was 0.456 standard deviations lower in the TEM only facilities relative to control facilities (significant at  $p < 0.05$ ). To control for any imbalances at baseline, our analyses all use an ANCOVA specification, controlling for the baseline value of the outcome.

Analyses of treatment effects are conducted using the following regression specification:

$$y_t = \alpha + \beta_1 T1 + \beta_2 T2 + \beta_3 y_0 + \mathbf{X}'_0 \beta_4 + \mathbf{S}' \beta_5 + \epsilon$$

where  $y_t$  denotes the outcome at time  $t$  (midline and endline) with controls for the outcome at baseline ( $y_0$ ), county (stratification bin) indicators ( $s$ ), and a vector of control variables collected at baseline ( $X$ ), selected using PDSLASSO (Belloni et al., 2014). Huber-White standard errors are clustered by meat inspector.  $\beta_1$  is the coefficient on the treatment indicator for the training, equipment, and monitoring (TEM) only group and  $\beta_2$  is the coefficient on the treatment indicator for the TEM + Incentives group. These coefficients measure the average difference between these groups and the control group, measured in standard deviations for most outcomes. We also present tests for the equality of  $\beta_1$  and  $\beta_2$ .

## 4. Results

In this section we present the results based on the above specification. We first examine the impact of the interventions on worker behavior and knowledge, then turn to the impact on microbial contamination, followed by changes in business related outcomes.

Table 3 details changes in worker behavior in response to the program. We note that 92.5% of forms submitted by meat inspectors in the TEM + Incentives group qualified for the incentive payment, and 90.9% of forms in the TEM only group would have qualified. Column 1 shows impacts on our primary outcome in this domain: the hygiene practice index described in the previous section. Columns 2 through 5 display impacts on a set of secondary outcomes which are ICW

indices of hygiene behaviors at different stages of the slaughter process, specifically skinning/flaying, evisceration, sectioning, and cleaning of the stomach and intestines. Column 6 displays an indicator for whether the floor was washed immediately after slaughter. Results from the midline are in the top panel and results from the endline are in the bottom panel. Appendix Table C3 shows similar results for indices constructed based on categories of action (hand washing, knife washing, etc.).

Both the TEM and the TEM + Incentives treatments had large and statistically significant impacts on the hygiene practice index of approximately 0.84 standard deviations at midline. There is no meaningful difference between the treatments in either magnitude or statistical significance. There is evidence of positive impacts of both treatments across the various slaughter stages, with evisceration being the only stage without a statistically significant coefficient (though both coefficients are positive).

At endline (lower panel), the estimated coefficients are positive across the board, but generally smaller and less consistently statistically significant. For the main hygiene practice index, the coefficients are positive for both treatment groups, but statistically significant only for the TEM + Incentives group. The size of the coefficient is roughly 50% of the midline effect at 0.42 standard deviations. The TEM only coefficient (0.24) while not statistically different from zero, is also not statistically different from that of the TEM + Incentives treatment. Across categories at endline there is consistent evidence of statistically significant impacts of one or both treatments at each stage of slaughter, with the exception of floor washing. The results by type of activity in Appendix Table C3 tell a similar story with consistent positive impacts that are mostly, but not always, statistically significant. There is no clear pattern suggesting that results are driven by changes to any particular activity or group of activities. When analyzed in this way there is less evidence that the effects are smaller at endline than midline.

The results in Table 3 suggest that a fairly simple training, equipment provision and monitoring intervention changed worker behavior with or without the inclusion of worker incentives. The estimates show that the results are present at various stages in the slaughter process, and not focused only on, for example, the wearing of new equipment given to the employees. These behavioral impacts show signs of persistence past the period of program implementation when monitoring and incentives had ceased. The results suggest that behavioral change can be achieved with the training, equipment, and soft regulation techniques employed, even without positive incentives for workers. In Table 4 we support these results by examining whether the hygiene

knowledge of the slaughterhouse managers and workers improved. Columns 1 and 3 display the impacts on slaughterhouse manager knowledge at midline and endline respectively and columns 2 and 4 display the same for worker knowledge. These ICW indices include correctly reporting risks and preventative strategies related to illness, injury, and meat contamination. The components of these indices are described in Appendix Table C1c.

The results suggest that the program, both with and without incentives, increased worker and manager knowledge. Manager knowledge increased by between 0.55 and 0.85 standard deviations across treatments at midline and endline. There are no statistically significant differences between treatments and no evidence that the treatment effect declined at endline (in fact the estimated coefficients are higher). Worker knowledge increased by 1.14 and 1.04 standard deviations at midline for the TEM and TEM + incentives groups respectively. These effects did decline somewhat by endline, estimated at 0.66 and 0.72 standard deviations for TEM and TEM + Incentives. Sustained increases in knowledge are present for both the workers implementing the activities and the manager of the facility, suggesting that changes in behavior may be driven at least in part by real changes in understanding of how to improve hygiene during slaughter, an important result given low levels of baseline knowledge. However, because training was bundled with the meat inspector monitoring, we cannot disentangle whether the behavioral changes we observe are related only to changes in knowledge, or to knowledge changes reinforced by the meat inspector monitoring. Though in general the large literature on worker training is mixed, two studies from India suggest that training does not improve the hygiene practices of food vendors in India, either when offered alone (Daniele et al. 2021) or in conjunction with equipment (Brown and Tomassi 2025).

In Table 5 we examine whether these changes in behavior resulted in changes in microbial contamination. The first column presents an indicator for whether either pathogenic *E. coli* or *Salmonella* was identified on the carcass sample. The second column presents the ICW index of contamination on the carcass.<sup>14</sup> In columns 3 through 5 we present the ICW indices for contamination on the knife used to section the animal, the hands of the worker who did this task, and the water used to rinse knives. Midline results are in the top panel and endline results are in the bottom panel. The results in column 1 show that there is no significant change in the presence of pathogenic *E. coli* or *Salmonella* on the carcass sample, though the midline coefficient for TEM only is positive and of meaningful magnitude, but imprecisely estimated. The results in column 2 show

---

<sup>14</sup> Columns 1 and 2 show our primary pre-specified outcomes (in addition to the main hygiene index in column 1 of Table 3).

that at midline, the estimated impacts of the program on the index of coliform and *E. coli* counts are positive. While the coefficient for the TEM + incentives group is small and imprecisely estimated, the coefficient for the TEM only group is 0.61 standard deviations and statistically significant at the 5 percent level, suggesting that the TEM only treatment *increased* contamination of the carcass. However, across the other contamination measures at midline we see only evidence of decreased contamination – all estimated coefficients are negative and these decreases are statistically significant and meaningful in magnitude for the TEM + incentives group for knife contamination and for both treatment groups for water contamination. The results for hand contamination are smaller and not statistically significant. At endline, there are no statistically significant changes in any contamination measure in either direction. The carcass contamination coefficients remain positive in three of four cases, but they are much smaller in magnitude and not statistically significant. The estimated coefficients for the other categories are also small and not statistically significant.

Appendix Table C4 shows the impact of the treatments on the components of the microbial indices, the log coliform concentration in columns 1 through 4 and log *E.coli* concentration in columns 5 through 8. These results show similar patterns to the main ICW index results. Appendix Table C5 shows a different specification for the microbial outcomes – examining whether each coliform or *E.coli* count is above the specified contamination threshold indicated in Figures 1 and 2. These results again look roughly similar to the main microbial results, however there is no statistically significant impact on carcass contamination in any specification. There is evidence of significant reduction in knife contamination at midline and endline and water contamination at midline only.

Together these results suggest that the impacts on behavior and knowledge achieved through provision of training and equipment, and regulatory oversight, do not translate to significant and lasting changes in contamination. There is some evidence of reductions in knife and water contamination at midline, but no robust evidence of sustained changes. The results on carcass contamination, the most relevant outcome for the improvement of public health, are null to positive.

To further explore the impact of the interventions, we examine the reaction of customers (livestock owners and butchers) who use slaughterhouses and other business-related outcomes. This analysis was not included in the pre-analysis plan and can thus be viewed as exploratory. Table 6 shows impacts of the treatments on customers' reported reasons for choosing the slaughterhouse where the interview was conducted. Customers were allowed to report multiple

reasons for their choice of slaughter facility. Here we display reasons that are most closely related to hygiene and to the objectives of the interventions: cleanliness, quality of infrastructure and equipment, and availability of water. The results in this table show some evidence of customers responding to the interventions at midline. The proportion of customers who report choosing the slaughterhouse based on cleanliness increases by 30 and 18 percentage points for the TEM only and TEM + incentives groups respectively, compared to a control mean of 42%.<sup>15</sup> There is also some evidence that those in TEM + incentives are responding to better infrastructure and those in TEM only to increased water availability, however these are estimated in relation to very small control means, 1% and 4% for each variable. At endline there is less evidence that customers are responding to cleanliness, with only a 12 percentage-point increase for TEM + incentives. However, the control mean also increased over this period to 65%, possibly due to an increased awareness of the importance of cleanliness among facility customers due to the intervention, which included the display of posters promoting hygiene behaviors in slaughter facilities.

Next, we examine whether the intervention affected the volume of slaughterhouses' business and scale of operation. In Table 7 we present treatment effects on the log number of animals processed per day and the log number of workers engaged in slaughter. The processing of additional animals and engagement of additional workers are related indications that the hygiene program resulted in increased business for participating slaughterhouses. At midline we find strong evidence of increased numbers of animals processed per day, the coefficients suggesting a 12.2% increase in the TEM only group and a 7.7% increase in the TEM + incentives group. There is a corresponding increase in the number of workers: 6.9% in TEM only and 7.5% in TEM + incentives. These changes are sustained to endline.

Finally, in Table 8 we examine impacts on customer reports at endline only of any changes they had noticed at the facility where they were interviewed since the time of the baseline survey. These outcomes are coded as 1 for positive changes, -1 for negative changes, and 0 if no change was reported. The most widely reported change is in noticing increased use of PPE (column 5), estimated at 45 percentage points higher in both treatment groups relative to control facilities. Given that the program provided PPE to workers, and the use of the new aprons and boots was very visible, this result is logical. There are also differences across treatment groups in the proportion of

---

<sup>15</sup> These estimated treatment effects likely capture a shift among customers who value cleanliness, water, and good equipment to facilities perceived as cleaner, having better water access and better equipment, and away from those perceived as worse on these dimensions, violating the stable unit treatment value assumption. The same is true for outcomes presented in Table 7.

customers who noticed changes in worker hygiene practices, slaughter procedures (columns 3 and 4, statistically significant only for the TEM + incentives group) and slaughterhouse cleanliness (column 6, statistically significantly larger effect for the TEM + incentives group as compared to the TEM only group). We see no changes in consumer perceptions of prices, speed, or infrastructure.

These results suggest that although the intervention did not have a significant impact on the contamination of processed carcasses, consumers responded to the perceived superior cleanliness of intervention slaughterhouses by bringing their animals to these facilities. This indicates that improving slaughter hygiene in a way that is visible to customers can be good for business. However, the increased volume in these slaughterhouses could also provide an explanation for the lack of improvement in carcass contamination and the evidence of increased levels of contamination at midline among TEM only facilities. A higher volume of business and more workers may have meant that despite observed improvements in some of the hygiene practices, the quality of these practices, or perhaps aspects of hygiene not captured through study tools were negatively affected. Newer workers may not all have been well trained, and increased time pressure or crowding in the slaughter area could have led to dirt from animals' hides or the floor coming into contact with meat. More animals passing through a facility also implies additional opportunities for fecal matter from one animal to contaminate that of another.

We investigate this hypothesis by examining how including the log number of workers involved in slaughter in the regressions for the hygiene practice and microbial contamination indices changes the results. These regressions do not include any controls aside from the baseline value of the outcome. The results are in Table 9, with the hygiene practices index in columns 1 and 3 for midline and endline, and the carcass contamination index in columns 2 and 4. Including the log number of workers engaged in slaughter in the regression does not substantially change the estimates for the hygiene practice index. However, when included in the regression for the microbial contamination index at midline, we observe that the number of workers is highly correlated with this outcome and leads to a reduction of more than 50% in both treatment coefficients. The coefficient on TEM only in particular is no longer statistically significant and the coefficient on TEM + incentives is close to zero (0.034 standard deviations). This result suggests that the larger number of workers employed in the T1 slaughterhouses may have contributed to the observed increase in carcass contamination at midline.

## 5. Conclusion

In this paper, we test the impact of a regulatory monitoring intervention, combined with training of workers and provision of basic materials, in slaughterhouses in western Kenya. Worker hygiene practices improved by close to a standard deviation. Microbial contamination of slaughter equipment and washing water was lower in treatment facilities four to five weeks post-training while weekly hygiene inspections were being conducted. However, contamination of carcasses did not decrease, and was in fact significantly higher in facilities assigned to the version of the intervention without incentives than in control facilities.

The lack of impact on carcass contamination was likely due to the limited scope of the intervention. For example, previous work has shown that carcasses of visually dirty cattle have higher microbial counts than clean cattle (Antic, 2018). Introducing a pre-slaughter cleaning step was deemed infeasible in the study setting due to the absence of a piped water supply in most facilities. Customers who brought livestock to be slaughtered noticed improvements in cleanliness and slaughter procedures in treatment facilities. Possibly due to these perceived improvements, the volume of business at treatment group facilities increased. The positive effect on business outcomes indicates the potential for market forces to sustain improvements in slaughter hygiene. However, it may also contribute to the unanticipated increase in contamination as congestion may have resulted in unanticipated reductions in other hygiene practices.

Others have noted that a heavy-handed regulatory enforcement approach could make oversight more difficult by reducing cooperation between regulators and business operators, and could reduce access to fresh food (Alonso Alvarez et al., 2021; Jaffee et al., 2018; Unnevehr & Hirschhorn, 2000). The intervention tested did not use or threaten any regulatory action beyond oversight, and the study was implemented in a setting where the use of punitive enforcement is exceedingly rare. The large impact on worker practices suggests that monitoring alone can be a highly effective regulatory tool. Further, by eschewing material penalties, this approach avoids creating a market for corruption, which has been shown in other contexts to impede effective regulatory control (Oliva, 2015).

In general, outcomes in the subset of treatment facilities where workers could additionally earn hygiene incentive payments were similar to those in which no such treatment was offered. This finding implies that improving hygiene practices in rural slaughterhouses need not be costly. Simply redirecting regulatory intention to this goal may be sufficient to induce significant changes in worker behavior. However, the lack of impact on contamination of meat also indicates that the training and equipment provided were insufficient to achieve the targeted public health objective.

Further research should identify behaviors and technologies that can enable achievement of such impacts.

## References

- Allcott, H., & Rogers, T. (2014). The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation. *American Economic Review*, 104(10), 3003–3037.
- Alonso Alvarez, S., Grace, D., & Nguyen-Viet, H. (2021, June 4). Informal food markets: What it takes to make them safer. *ILRI News*. <https://www.ilri.org/news/informal-food-markets-what-it-takes-make-them-safer>
- Amin, M., & Soh, Y. C. (2021). Does Greater Regulatory Burden Lead to More Corruption? Evidence Using Firm-Level Survey Data for Developing Countries. *The World Bank Economic Review*, 35(3), 812–828. <https://doi.org/10.1093/wber/lhaa007>
- Anderson, M. L. (2008). Multiple Inference and Gender Differences in the Effects of Early Intervention: A Reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American Statistical Association*. <https://doi.org/10.1198/016214508000000841>
- Antic, D. (2018). *A critical literature review to assess the significance of intervention methods to reduce the microbiological load on beef through primary production* (No. FSA Project FS301044). University of Liverpool. <https://www.food.gov.uk/sites/default/files/media/document/the-significance-of-intervention-methods-to-reduce-the-microbiological-load-on-beef-through-primary-production.pdf>
- Antle, J. M. (2000). No Such Thing as a Free Safe Lunch: The Cost of Food Safety Regulation in the Meat Industry. *American Journal of Agricultural Economics*, 82(2), 310–322. <https://doi.org/10.1111/0002-9092.00027>
- Antle, J. M. (2001). Chapter 19 Economic analysis of food safety. In *Handbook of Agricultural Economics* (Vol. 1, pp. 1083–1136). Elsevier. [https://doi.org/10.1016/S1574-0072\(01\)10027-7](https://doi.org/10.1016/S1574-0072(01)10027-7)
- Bedoya, G., Das, J., & Dolinger, A. (2023). *Randomized Regulation: The Impact of Minimum Quality Standards on Health Markets* (Working Paper No. 31203). National Bureau of Economic Research. <https://doi.org/10.3386/w31203>
- Berkel, H., Estmann, C., & Rand, J. (2022). Local governance quality and law compliance: The case of Mozambican firms. *World Development*, 157, 105942-.
- Beyfus, T. A., Dawson, N. L., Danner, C. H., Rawal, B., Gruber, P. E., & Petrou, S. P. (2016). The use of passive visual stimuli to enhance compliance with handwashing in a perioperative setting. *American Journal of Infection Control*, 44(5), 496–499. <https://doi.org/10.1016/j.ajic.2015.12.021>
- Boatema, S., Barney, M., Drimie, S., Harper, J., Korsten, L., & Pereira, L. (2019). Awakening from the listeriosis crisis: Food safety challenges, practices and governance in the food retail sector

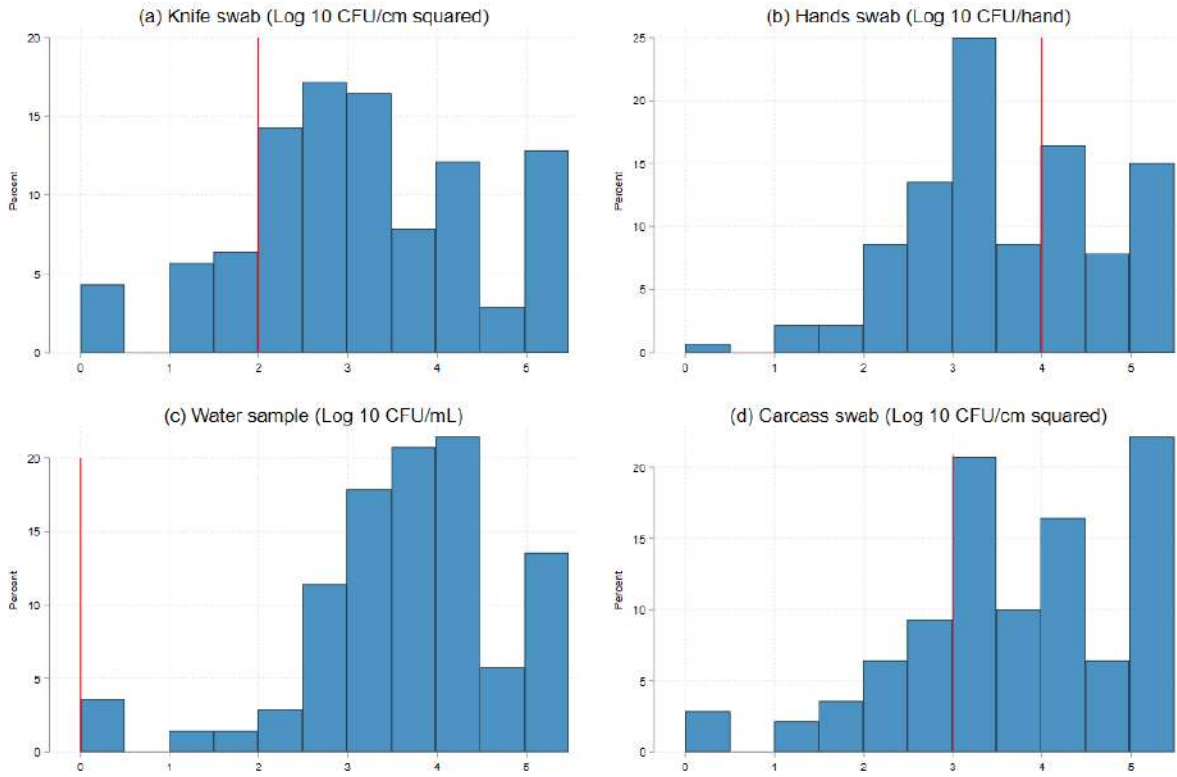
- in South Africa. *Food Control*, 104, 333–342.  
<https://doi.org/10.1016/j.foodcont.2019.05.009>
- Bovay, J. (2023). Food safety, reputation, and regulation. *Applied Economic Perspectives and Policy*, 45(2), 684–704. <https://doi.org/10.1002/aepp.13315>
- Cook, A. J. E. (2015). *Epidemiology of zoonoses in slaughterhouse workers in western Kenya*.
- Cook, A. J. E., de Glanville, W. A., Thomas, L. F., Kiyong’a, A., Kivali, V., Kariuki, S., Bronsvort, B. M. de C., & Fèvre, E. M. (2021). Evidence of exposure to *C. burnetii* among slaughterhouse workers in western Kenya. *One Health*, 13, 100305.  
<https://doi.org/10.1016/j.onehlt.2021.100305>
- Cook, A. J. E., Gitahi, N., Glanville, W. A. de, Thomas, L. F., Kariuki, S., Kang’ethe, E., & Fèvre, E. M. (2021). Prevalence and risk factors for exposure to *Toxoplasma gondii* in slaughterhouse workers in western Kenya. *BMC Infectious Diseases*, 21(1), 944.  
<https://doi.org/10.1186/s12879-021-06658-8>
- Cook, A. J. E., Glanville, W. A. de, Thomas, Li. F., Kariuki, S., Bronsvort, B. M. de C., & Eric Maurice Fèvre. (2017). *Working conditions and public health risks in slaughterhouses in western Kenya* | *BMC Public Health*. <https://link.springer.com/article/10.1186/s12889-016-3923-y>
- Duflo, E., Hanna, R., & Ryan, S. P. (2012). Incentives Work: Getting Teachers to Come to School. *American Economic Review*, 102(4), 1241–1278. <https://doi.org/10.1257/aer.102.4.1241>
- EC. (2005). *COMMISSION REGULATION (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs*. Official Journal of the European Union. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R2073>
- Ezzine-de-Blas, D., Corbera, E., & Lapeyre, R. (2019). Payments for Environmental Services and Motivation Crowding: Towards a Conceptual Framework. *Ecological Economics*, 156, 434–443. <https://doi.org/10.1016/j.ecolecon.2018.07.026>
- Food Safety Inspectorate Service. (2021). *Updated Generic HACCP Model for Beef Slaughter*. United States Department of Agriculture.  
[https://www.fsis.usda.gov/sites/default/files/media\\_file/2021-07/FSIS-GD-2021-0009.pdf](https://www.fsis.usda.gov/sites/default/files/media_file/2021-07/FSIS-GD-2021-0009.pdf)
- Grace, D. (2023). Burden of foodborne disease in low-income and middle-income countries and opportunities for scaling food safety interventions. *Food Security*, 15(6), 1475–1488.  
<https://doi.org/10.1007/s12571-023-01391-3>
- Grace, D., Dipeolu, M., Olawoye, J., Ojo, E., Odebode, S., Agbaje, M., Akindana, G., & Randolph, T. (2012). Evaluating a group-based intervention to improve the safety of meat in Bodija Market, Ibadan, Nigeria | *Tropical Animal Health and Production*. *Tropical Animal Health and Production*, 44, 61–66.
- Greenstone, M., & Hanna, R. (2014). Environmental Regulations, Air and Water Pollution, and Infant Mortality in India. *American Economic Review*, 104(10), 3038–3072.  
<https://doi.org/10.1257/aer.104.10.3038>

- Hanna, R. N., & Oliva, P. (2010). The Impact of Inspections on Plant-Level Air Emissions. *The B.E. Journal of Economic Analysis & Policy*, 10(1). <https://doi.org/10.2202/1935-1682.1971>
- Jaffee, S., & Henson, S. (2024). Promoting Food Safety in the Informal Markets of Low and Middle-Income Countries: The Need for a Rethink. *Food Protection Trends*, 44(5), 376–382.
- Jaffee, S., Henson, S., Unnevehr, L., Grace, D., & Cassou, E. (2018). *The Safe Food Imperative: Accelerating Progress in Low- and Middle-Income Countries*. World Bank Publications.
- Johansson, B., Rask, K., & Stenberg, M. (2010). Piece rates and their effects on health and safety—A literature review. *Applied Ergonomics*, 41(4), 607–614. <https://doi.org/10.1016/j.apergo.2009.12.020>
- Jones, D. C., Kalmi, P., & Kauhanen, A. (2010). Teams, Incentive Pay, and Productive Efficiency: Evidence from a Food-Processing Plant. *ILR Review*, 63(4), 606–626. <https://doi.org/10.1177/001979391006300403>
- Kenya Bureau of Standards. (2020). *Kenya Standard Meat grades and meat cuts-Specification Part 1: Beef grades and cuts* (No. KS EAS 84-1:2020). [https://webstore.kebs.org/index.php?route=product/product&product\\_id=6346](https://webstore.kebs.org/index.php?route=product/product&product_id=6346)
- Krimgold, F., & Moullier, T. (2015). *Building regulation for resilience: Managing risks for safer cities (Vol. 1 of 2)* [Text/HTML]. World Bank. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/326581468337788007>
- Mann, I., Koulikovskii, A., & Matyas, Z. (1984). *Guidelines on small slaughterhouses and meat hygiene for developing countries* (No. VPH/83.56). World Health Organization. <https://www-cabidigitallibrary-org.proxy.library.carleton.ca/doi/full/10.5555/19842249479>
- Meat Control Act, Pub. L. No. Chapter 356, 69 (2012).
- MilliporeSigma. (2020, April). *Instruction Manual, MC-Media Pad E. coli & Coliform*. <https://www.sigmaaldrich.com/deepweb/assets/sigmaaldrich/product/documents/168/693/mc-media-pad-package-insert-ec.pdf?srsId=AfmBOoS-ISOR05WJbqelfLToRVNSVoFdhFTbxJ6CtKtn5tNVvDLzNlr>
- Nagel-Alne, G. E., Murphy, E., McCauslin, B., Hauge, S. J., Schrøder-Petersen, D. L., Holthe, J., & Alvseike, O. (2022). Meat safety legislation and its opportunities and hurdles for innovative approaches: A review. *Food Control*, 141, 109160. <https://doi.org/10.1016/j.foodcont.2022.109160>
- NDVQPH. (2010). *Standard for the microbiological monitoring of meat, process hygiene and cleaning* (No. SOP/VPN 15-Standard for microbiological monitoring of meat 15-03-2010). South Africa National Directorate Veterinary Quarantine and Public Health. [https://www.nda.gov.za/images/Branches/AgricProducHealthFoodSafety/animal-health/importexport/import/vpnsop/015-vpn-15-standard-for-the-microbiological-monitoring-of-meat-process-hygiene-and-cleaning-2010-03-\\_p16835.pdf](https://www.nda.gov.za/images/Branches/AgricProducHealthFoodSafety/animal-health/importexport/import/vpnsop/015-vpn-15-standard-for-the-microbiological-monitoring-of-meat-process-hygiene-and-cleaning-2010-03-_p16835.pdf)

- Ngo, H. H. T., Dang-Xuan, S., Målqvist, M., Nguyen-Thanh, L., Pham-Duc, P., Nguyen-Hong, P., Le-Thi, H., Nguyen-Viet, H., Le, T. T.-H., Grace, D., Lindahl, J. F., & Unger, F. (2023). Effect of light-touch intervention and associated factors to microbial contamination at small-scale pig slaughterhouses and traditional pork shops in Vietnam. *International Journal of Food Microbiology*, 406, 110351. <https://doi.org/10.1016/j.ijfoodmicro.2023.110351>
- Okumu, N. O., Ngeranwa, J. J. N., Muloi, D. M., Ochien'g, L., Moodley, A., Mutisya, C., Kiarie, A., Wasonga, J. O., Watson, J., Amon-Tanoh, M. A., Cumming, O., & Cook, E. A. J. (2023). Risk factors for diarrheagenic *Escherichia coli* infection in children aged 6-24 months in peri-urban community, Nairobi, Kenya. *PLOS Global Public Health*, 3(11), e0002594. <https://doi.org/10.1371/journal.pgph.0002594>
- Oliva, P. (2015). Environmental Regulations and Corruption: Automobile Emissions in Mexico City. *Journal of Political Economy*, 123(3), 686–724. <https://doi.org/10.1086/680936>
- Otoigo, L., Alumasa, L., Majiw, H., Hoffmann, V., Ambler, K., Alice, A., & Cook, A. J. E. (2025). *Formative study on slaughterhouse hygiene in Western Kenya: Summary Report* (p. 6) [Project Note]. IFPRI.
- Ovuru, K. F., Izah, S. C., Ogidi, O. I., Imarhiagbe, O., & Ogwu, M. C. (2024). Slaughterhouse facilities in developing nations: Sanitation and hygiene practices, microbial contaminants and sustainable management system. *Food Science and Biotechnology*, 33(3), 519–537. <https://doi.org/10.1007/s10068-023-01406-x>
- Schwab, B., Janzen, S., Magnan, N. P., & Thompson, W. M. (2020). Constructing a summary index using the standardized inverse-covariance weighted average of indicators. *Stata Joournal*, 20(4). <https://journals.sagepub.com/doi/full/10.1177/1536867X20976325>
- Sheridan, J. J. (Ed.). (1991). *Guidelines for slaughtering meat cutting and further processing*. Food and Agriculture Organization of the United Nations.
- Skaarup, T. (1985). *Slaughterhouse cleaning and sanitation*. FAO. <https://www.fao.org/4/x6557e/X6557E00.htm#TOC>
- Unnevehr, L., & Hirschhorn, N. (2000). *Food Safety Issues in the Developing World*. The World Bank. <https://doi.org/10.1596/0-8213-4770-5>
- Wieck, C., & Grant, J. H. (2021). Codex in Motion: Food Safety Standard Setting and Impacts on Developing Countries' Agricultural Exports. *EuroChoices*, 20(1), 37–47. <https://doi.org/10.1111/1746-692X.12293>
- Winkler-Schor, S., & Brauer, M. (2025). What Happens When Payments End? Fostering Long-Term Behavior Change With Financial Incentives. *Perspectives on Psychological Science*, 20(5), 925–940. <https://doi.org/10.1177/17456916241247152>
- Wood, S., Leoni, S., & Ladley, D. (2023). Comparisons of the effects of individual and collective performance-related pay on performance: A review. *Human Resource Management Review*, 33(4), 100982. <https://doi.org/10.1016/j.hrmr.2023.100982>

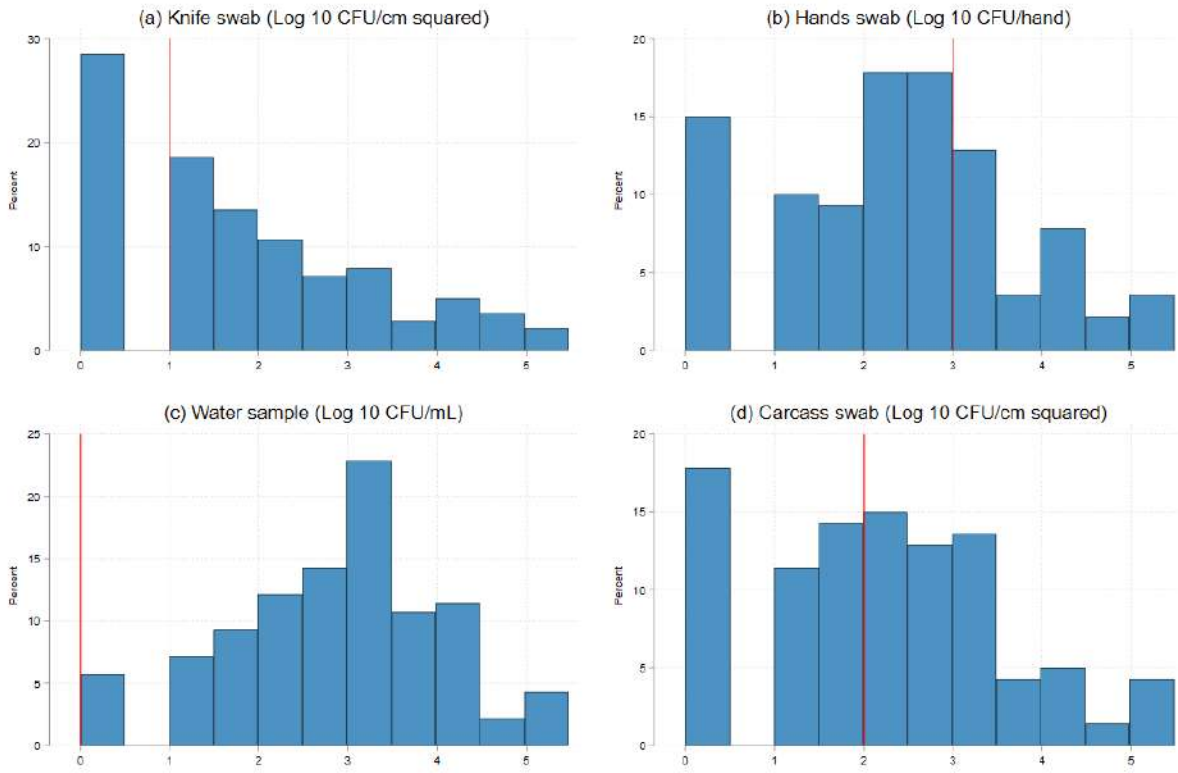
Yoeli, E., Hoffman, M., Rand, D. G., & Nowak, M. A. (2013). Powering up with indirect reciprocity in a large-scale field experiment. *Proceedings of the National Academy of Sciences*, *110*(supplement\_2), 10424–10429. <https://doi.org/10.1073/pnas.1301210110>

**Figure 1: Baseline Coliform Concentrations by Sample Type**



Note: Red lines indicate acceptable limits.

**Figure 2: Baseline *E. coli* Concentrations by Sample Type**



Note: Red lines indicate acceptable limits.

**Table 1: Slaughterhouse Summary Statistics**

	<b>Mean</b>	<b>SD</b>
Share ruminant slaughter facility	0.814	0.390
# of animals processed per day - winsorized	5.229	3.529
# of workers engaged in slaughter & processing activities	8.814	6.445
Detection of either pathogenic E. coli or salmonella on carcass sample	0.243	0.430
Water is conveyed to slaughter area for cleaning via pipe	0.200	0.401
<i>Water source</i>		
Municipal water	0.221	0.417
Private borehole	0.124	0.331
River/ surface water	0.057	0.233
Unprotected/ protected spring	0.036	0.186
Well	0.686	0.466
Rainwater	0.129	0.336
Delivery of water	0.050	0.219
Carcass skinned off the floor (at least on a raised surface)	0.250	0.435
Intestinal contents do not spill on floor	0.243	0.430
Guts do not fall on floor	0.536	0.501
Carcass sectioned while hanging	0.943	0.233
Cleaning of stomach and intestines was done separately from meat	0.754	0.432
Processed meat is stored separately from stomach/intestines	0.809	0.394
Water used to wash knives contains chlorine	0.107	0.310
Share of steps at which all workers washed their hands	0.479	0.341
Share of steps at which all workers used soap	0.016	0.096
Share of steps at which knife was washed	0.746	0.382
Share of steps at which knife was washed using 3-step system	0.025	0.138
Share of workers with clean gumboots	0.734	0.270
Share of workers with clean aprons	0.584	0.335
<i>Reasons for customer choice of slaughterhouse</i>		
Customer chose SH due to convenient location	0.896	0.244
Customer chose SH due to cleanliness	0.428	0.424
Customer chose SH due to customer service	0.327	0.384
Customer chose SH due to price	0.104	0.272
Customer chose SH due to availability of water	0.036	0.130
Customer chose SH due to better infrastructure/equipment	0.029	0.117

*Note: All summary statistics are based on baseline values.*

**Table 2: Meat Handler Summary Statistics**

	Mean	SD
Age	41.273	12.544
Male	0.964	0.187
<i>Highest level of education</i>		
Primary complete	0.323	0.468
Secondary complete	0.145	0.352
Years working in slaughter	11.331	9.318
<i>Worker knowledge about illness</i>		
Describes illness as an occupational hazard	0.031	0.172
Even/greater chance of becoming ill bc. of contact with animals through job	0.456	0.499
Cites as a way of avoiding illness: Wash hands	0.506	0.500
Cites as a way of avoiding illness: Protective clothing	0.765	0.424
Cites as a way of avoiding illness: Not working with an open wound	0.036	0.187
Believes slaughter facility is most likely point of food contamination	0.380	0.486
<i>Cites as source of meat contamination</i>		
Animal skin	0.204	0.403
Feces/ gut contents	0.235	0.424
Floor	0.750	0.433
Equipment/ knives	0.153	0.360
Worker hands	0.172	0.378
Worker clothes	0.094	0.291
<i>Cites as a technique to aovice meat contamination</i>		
Wash hands	0.504	0.500
Wash knives	0.342	0.475
Keep floor clean	0.637	0.481
Hang carcass	0.279	0.449
Don't allow meat to touch floor	0.382	0.486
Separate internal organs	0.046	0.209
Don't work if sick	0.008	0.087
Knows correct knife washing practice (soapy water then rinsed)	0.212	0.409
Soap is always available to wash hands at work	0.508	0.500
Worker paid per animal*	0.839	0.369
Daily wage*	216.229	148.321
Average wage per animal*	143.109	79.109
Hours worked per day*	3.391	1.438

*Note: All summary statistics are based on baseline values, except for variables marked with an asterisk (\*), which were only available at endline and are reported for the control group only.*

**Table 3: Program Impact on Observed Hygiene Practices**

	(1)	(2)	(3)	(4)	(5)	(6)
Hygiene practice index		Index of hygienic practices when skinning/flaying	Index of hygienic practices when eviscerating	Index of hygienic practices when sectioning	Index of hygienic practices when cleaning stomach & intestine	Floor is washed immediately after slaughter
<i>Midline</i>						
TEM only (T1)	0.842*** (0.188)	0.727*** (0.190)	0.204 (0.156)	0.340* (0.184)	0.795*** (0.191)	0.119 (0.083)
TEM + Incentives (T2)	0.836*** (0.158)	0.539** (0.233)	0.176 (0.155)	0.352* (0.188)	0.762*** (0.201)	0.233*** (0.066)
P-value (T1 = T2)	0.974	0.456	0.843	0.941	0.838	0.168
Control mean	-0.000	0.000	0.000	-0.000	0.000	0.714
Observations	138	138	138	138	112	138
<i>Endline</i>						
TEM only (T1)	0.242 (0.205)	0.326 (0.201)	0.516*** (0.169)	0.617*** (0.177)	0.688*** (0.210)	0.157 (0.103)
TEM + Incentives (T2)	0.423** (0.174)	0.417** (0.168)	0.369** (0.157)	0.666*** (0.146)	0.628*** (0.209)	0.092 (0.089)
P-value (T1 = T2)	0.404	0.641	0.341	0.726	0.735	0.517
Control mean	0.000	0.000	-0.000	-0.000	-0.000	0.729
Observations	137	137	137	137	113	137

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

**Table 4: Program Impact on Hygiene Knowledge**

	(1)	(2)	(3)	(4)
	<i>Midline</i>		<i>Endline</i>	
	<b>Index of SH manager knowledge</b>	<b>Index of worker knowledge</b>	<b>Index of SH manager knowledge</b>	<b>Index of worker knowledge</b>
TEM only (T1)	0.546*** (0.153)	1.138*** (0.176)	0.785*** (0.145)	0.657*** (0.128)
TEM + Incentives (T2)	0.758*** (0.161)	1.038*** (0.131)	0.840*** (0.137)	0.724*** (0.131)
P-value (T1 = T2)	0.190	0.487	0.679	0.467
Control mean	0.000	0.000	0.000	-0.000
Observations	138	522	137	512

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . For models (1) and (3), control variables include county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso. For columns (1) and (3), the outcome at baseline as additionally included as a control.*

**Table 5: Program Impact on Microbial Contamination**

	(1)	(2)	(3)	(4)	(5)
	Detection of either pathogenic E. coli or salmonella on carcass sample	Microbial contamination index: Carcass	Microbial contamination index: Knife	Microbial contamination index: Hands	Microbial contamination index: Water
				<i>Midline</i>	
TEM only (T1)	0.115 (0.078)	0.605** (0.252)	-0.320 (0.239)	-0.057 (0.267)	-0.639** (0.282)
TEM + Incentives (T2)	0.032 (0.083)	0.133 (0.186)	-0.462** (0.190)	-0.272 (0.202)	-0.445** (0.216)
P-value (T1 = T2)	0.376	0.043	0.577	0.437	0.508
Control mean	0.184	-0.000	0.000	-0.000	-0.000
Observations	138	138	138	138	138
				<i>Endline</i>	
TEM only (T1)	0.058 (0.085)	0.193 (0.213)	-0.057 (0.261)	-0.043 (0.281)	0.083 (0.238)
TEM + Incentives (T2)	-0.043 (0.080)	0.040 (0.173)	-0.235 (0.203)	-0.135 (0.194)	-0.005 (0.189)
P-value (T1 = T2)	0.243	0.448	0.537	0.760	0.707
Control mean	0.204	0.000	-0.000	-0.000	0.000
Observations	137	137	137	137	137

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

**Table 6: Program Impact on Customer Motivation for Slaughterhouse Selection**

	(1)	(2)	(3)	(4)	(5)	(6)
		<i>Midline</i>			<i>Endline</i>	
		Customer chose SH due			Customer chose SH due	
	Customer chose SH due	to better	Customer chose SH due	Customer chose SH due	to better	Customer chose SH due
	to cleanliness	infrastructure/equipme	to availability of water	to cleanliness	infrastructure/equipme	to availability of water
		nt			nt	
TEM only (T1)	0.304*** (0.077)	-0.001 (0.021)	0.100** (0.049)	0.026 (0.092)	-0.033 (0.057)	0.213** (0.089)
TEM + Incentives (T2)	0.185** (0.086)	0.056* (0.032)	0.034 (0.044)	0.126* (0.074)	-0.047 (0.049)	0.095 (0.069)
P-value (T1 = T2)	0.161	0.111	0.268	0.259	0.789	0.228
Control mean	0.425	0.013	0.037	0.652	0.101	0.072
Observations	225	225	225	210	210	210

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include county (stratification bin) dummies and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

**Table 7: Program Impact on Slaughterhouse Volume**

	(1)	(2)	(3)	(4)
	Midline		Endline	
	Log # of animals processed per day	Log # of workers engaged in slaughter	Log # of animals processed per day	Log # of workers engaged in slaughter
TEM only (T1)	0.122** (0.056)	0.069** (0.035)	0.191*** (0.044)	0.065** (0.029)
TEM + Incentives (T2)	0.077** (0.036)	0.075** (0.034)	0.115*** (0.035)	0.094*** (0.026)
P-value (T1 = T2)	0.422	0.840	0.056	0.344
Control mean	0.463	0.771	0.386	0.754
Observations	138	138	137	137

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

**Table 8: Program Impact on Slaughterhouse Changes Noticed by Customers, Endline**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	<i>Change noticed in...</i>						
	<b>Pricing</b>	<b>Speed of service</b>	<b>Worker hygiene practices</b>	<b>Slaughter procedures</b>	<b>Use of PPE</b>	<b>Cleanliness</b>	<b>Infrastructure</b>
TEM only (T1)	-0.006 (0.070)	0.105 (0.093)	0.119 (0.085)	0.050 (0.056)	0.445*** (0.091)	0.210** (0.083)	-0.049 (0.063)
TEM + Incentives (T2)	-0.001 (0.063)	-0.090 (0.069)	0.192*** (0.071)	0.185*** (0.066)	0.450*** (0.072)	0.361*** (0.073)	-0.032 (0.059)
P-value (T1 = T2)	0.936	0.023	0.441	0.077	0.964	0.028	0.781
Control mean	0.116	0.203	0.130	0.058	0.043	0.594	0.116
Observations	210	210	210	210	210	210	210

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include county (stratification bin) dummies and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

**Table 9: Mediating Effect of Number of Workers**

	(1)	(2)	(3)	(4)
	Midline		Endline	
	Hygiene practice index	Microbial contamination index: Carcass	Hygiene practice index	Microbial contamination index: Carcass
TEM only (T1)	0.827*** (0.188)	0.354 (0.240)	0.431* (0.219)	0.173 (0.226)
TEM + Incentives (T2)	0.840*** (0.159)	0.034 (0.194)	0.543*** (0.193)	0.000 (0.202)
Log # of workers engaged in slaughter	-0.011 (0.285)	0.722*** (0.265)	-0.421 (0.337)	0.209 (0.270)
P-value (T1 = T2)	0.935	0.136	0.625	0.356
Observations	138	138	137	136

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline and county (stratification bin) dummies.*

## **Appendix A: Examples of Project Posters**

# HOW TO GET HYGIENE BONUS.



## GOOD PRACTICE



## BAD PRACTICE

1.



All workers wear PPE



Workers do not wear PPE

2.



Workers wear clean PPE



Workers wear dirty PPE

3.



Sick workers stay at home



Sick workers are allowed to work

4.



Workers wash hands with soap and running water



Hands are washed in a bucket

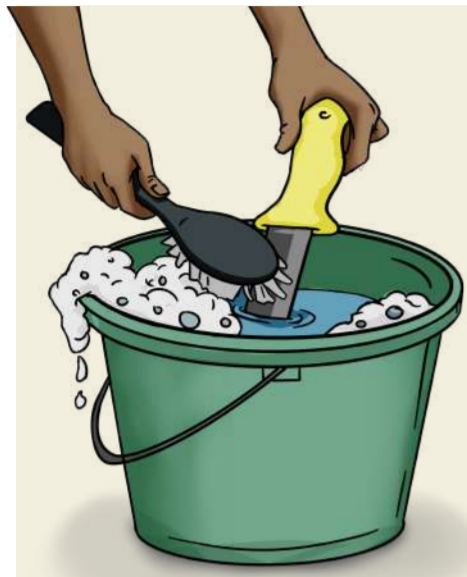


# GOOD PRACTICE

# BAD PRACTICE



5.

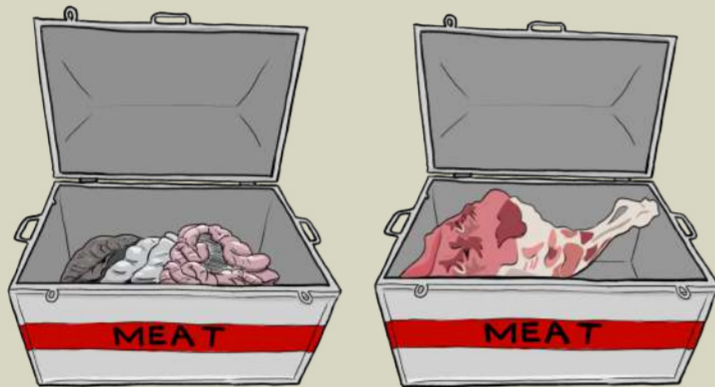


Tools are cleaned in 2 buckets of soapy water and rinsed in running water

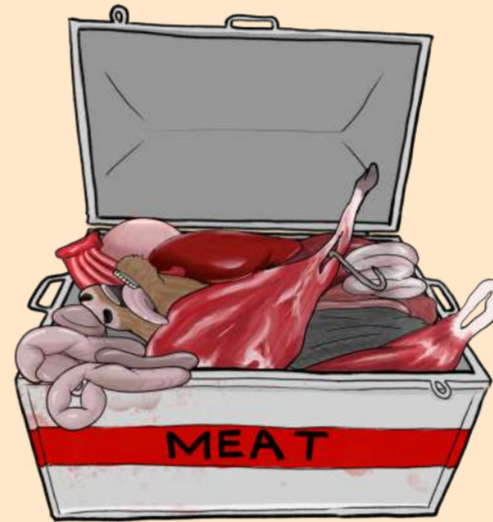


Tools are washed without soap and brush

6.



Offals and meat are stored separately



Offals and meat are stored together

7.



Facility is clean

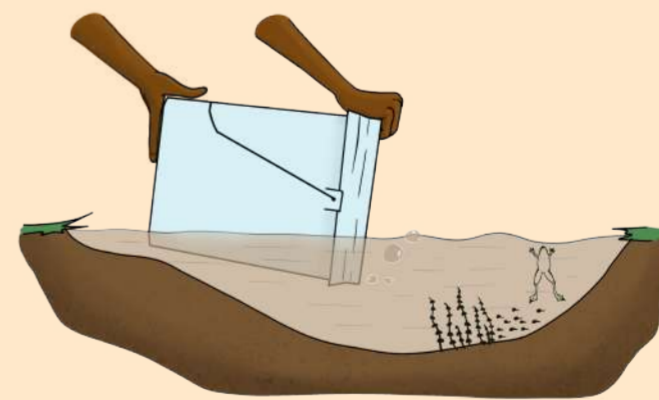


Facility is dirty

8.



Water is collected from trusted sources and treated before use



Water is sourced from untrusted sources

9.



Carcasses are hanging



Carcasses are on the floor

# KNIFE WASHING TECHNIQUE

**01.**  
Remove dirt  
from knife



**02.**  
Wash in first  
bucket with  
soap and water  
with a brush



**03.**  
Wash in  
second bucket  
with soap and  
water with a  
brush



**04.**  
Rinse with clean  
running water



## Appendix B

### Pre-analysis plan: Improving hygiene practices in slaughterhouses in Western Kenya

This plan describes the statistical analysis to be conducted on data from the randomized controlled trial, *Improving hygiene practices in slaughterhouses in Western Kenya*. Analysis of behavioral and biological outcomes may be published in separate papers to reach distinct disciplinary audiences.

#### I. Outcomes of interest

Unless specified otherwise, all outcomes will be measured at the slaughterhouse level.

##### *Primary outcomes*

1. An index of hygiene practices observed at the slaughter facility will be constructed from the following variables, using Anderson's (2008) inverse covariance-weighted (ICW) approach, as implemented by Stata's `swindex` command.<sup>1</sup>
  - a. Skinning/scalding: ICW index of progressive indicators denoting that a carcass is skinned or scalded in 'at least' each of the following conditions, from worst to best: partially off the floor, on a raised surface or cradle, partially hung, hung.
  - b. Handwashing – three separate handwashing variables will be included for each stage of processing (after skinning / scalding, before and after evisceration, before and after sectioning, before and after cleaning of stomach and intestines): (1) ICW index of: (a) any handwashing by any worker involved in that step and (b) any handwashing by all workers involved at that step; (2) workers used running water; (3) ICW index of: (a) any worker involved in that step used soap; (b) all workers used soap.
  - c. Are intestinal contents (waste) prevented from spilling onto the floor?
  - d. Are the guts/tripe prevented from contact with the floor?
  - e. Is the floor washed immediately after slaughter of one animal is complete?
  - f. Is processed meat stored separately from stomach and intestines in/at the slaughterhouse?
  - g. Proportion of workers engaged in slaughter and processing activities who are wearing gumboots that appear to have been clean at the start of the day.
  - h. Proportion of workers engaged in slaughter and processing activities who are wearing aprons or dustcoats that appear to have been clean at the start of the day
  - i. Knife washing – one knife washing variable will be included for each of the following stages of processing: before evisceration, before sectioning. These variables will be constructed as ICW indices of the following indicators: knife was washed, a 2 soapy bucket plus rinse system was used.
  - j. The carcass does not, at any point during the slaughter process, come into contact with the floor.

---

<sup>1</sup> We refer to this type of index below as "ICW index".

- k. The water used to rinse the knives contains residual chlorine.
  - l. None of the workers working at the slaughterhouse are clearly unwell.
2. ICW index of the logarithm<sup>2</sup> of colony-forming units (CFU)<sup>3</sup> of coliforms per cm squared, and the logarithm of CFU E. coli per cm squared, of a carcass swab taken just before sectioning.
  3. Detection of either pathogenic E coli or salmonella on carcass samples.

#### *Secondary outcomes*

4. Log CFU coliforms and (separately) log CFU E coli of swabs or samples collected from each of the following: a carcass swabbed just before sectioning (per cm squared), the knife used to section that carcass (per cm squared), the hand of a worker sectioning this carcass (per hand), and water (per mL) used to rinse equipment.
5. Binary indicators for any contamination with coliforms and (separately) E. coli for each sample type described in outcome 4.
6. ICW indices for each type of non-carcass sample (worker hand, knife, water), combining coliform and E. coli contamination, using the same procedure as for Primary Outcome 2.
7. Separate ICW indices for the hygiene practices described in Primary Outcome 1, for each of the following behaviors:
  - Handwashing
  - Knife washing
  - Contact of carcass and intestines with the floor
  - Separation of meat and intestines (during intestine cleaning and storage)
  - Use of PPE
  - Environmental hygiene (spillage of intestinal contents, washing the floor)
8. Separate ICW indices for the hygiene **practices** included in Primary Outcome 1, for each of the following processing stages:
  - Skinning / flaying
  - Evisceration
  - Sectioning
  - Cleaning of stomach and intestine
  - Cleaning of slaughter area
9. An ICW index of meat handler **knowledge** about the risks of zoonotic and foodborne disease transmission at slaughter and methods of prevention, constructed from the following variables, measured at the worker level.
  - a. Indicates “illness” as a risk faced during their work
  - b. Number of valid practices listed by the worker to reduce the risk they become ill due to contact with animals

---

<sup>2</sup> A value of 1 will be added to all values prior to log-transformation. Base 10 will be used throughout.

<sup>3</sup> A maximum of 300 colonies per plate will be counted, at dilutions of 10, 100, and 1000.

- c. Number of valid sources of meat contamination listed
- d. Number of valid practices avoid the chance that meat becomes dirty listed
- e. Indicates that knives should be washed with soapy water and then rinsed
- f. Number of recommended practices in response to suffering a wound at work listed

10. The same index of knowledge as described above, for the slaughterhouse manager.

## II. Hypothesis testing

We will estimate intent to treat (ITT) effects on the above outcomes. For all outcomes, we will estimate treatment effects period-by-period, in order to examine post-intervention trends, and because we expect impacts on worker practices to differ between the period of active intervention (follow-up 1) and the post-intervention period (follow-up 2).

We will make three different comparisons: T1 (training, equipment and surveillance) versus control, T2 (training, equipment, surveillance and incentives) versus control group, and T1 versus T2.

We will use the following regression specification, where  $y_t$  denotes the outcome at time  $t = \{0,1,2\}$ , to test for impacts at follow-up 1 (during the active intervention period) and follow-up 2 (after the intervention has ended). We will control for the outcome at baseline ( $y_0$ ), stratification bin indicators ( $s$ ), and a vector of control variables that collected at baseline ( $X$ ), selected using PDSLASSO (Belloni et al., 2014) from among those listed below. Huber-White standard errors ( $\epsilon$ ), will be clustered by meat inspector for all outcomes.

$$y_t = \alpha + \beta_1 T1 + \beta_2 T2 + \beta_3 y_0 + X'_0 \beta_4 + S' \beta_5 + \epsilon$$

### *Control variables*

We will employ post-double selection (PDS) lasso as described by Belloni et al. (2014) to select from among the following variables measured prior to the intervention (at baseline unless specified as measured during the slaughter facility census).

- Type of facility (ruminant or pig – from facility census)
- Number of animals processed per day, on average (from facility census)
- Total number of workers who normally work at the facility, and the natural logarithm of this value
- Proportion of workers employed by the facility (as opposed to brought by livestock owners)
- Number of animals processed per day on average, and the natural logarithm of this value
- Number of days the facility is open per week
- Facility water source (set of binary variables)
- All outcome variables as described above (measured at baseline)
- Individual practices (components of outcome 1)
- Individual worker knowledge points (components of outcome 4)
- Individual manager knowledge points (components of outcome 5)

- An indicator for whether the slaughterhouse manager is also a worker
- Number of years the manager has worked in this role, and the natural logarithm of this value
- Educational attainment of manager (set of binary variables)
- Proportion of workers at the facility who indicate that gumboots are required at work
- Proportion of workers at the facility who indicate that soap is available for handwashing
- Proportion of workers at the facility who indicate that they use soap for handwashing
- Party seen by the manager as responsible for ensuring that good hygiene practices are followed during the slaughter process (set of binary variables)
- Indicators for each investment in physical hygiene related infrastructure made by the manager or owner (confirmed by observation)
- Any investments in physical hygiene infrastructure have been made (confirmed by observation)
- Number of distinct investments in physical hygiene infrastructure that have been made (confirmed by observation), and an indicator for any such investments made
- Requirements imposed / actions taken by manager to encourage good hygiene and health practices are followed by workers (set of binary variables)
- Any requirements are imposed / actions are taken by manager to encourage good hygiene and health practices are followed by workers
- Number of requirements imposed / actions taken by manager to encourage good hygiene and health practices are followed by workers
- Soap is observed at handwashing station
- Soap is *either* observed at handwashing station or kept nearby

## References

Anderson, M.L., 2008. Multiple inference and gender differences in the effects of early intervention: A reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American statistical Association*, 103(484), pp.1481-1495.

A. Belloni, V. Chernozhukov, C. Hansen. Inference on treatment effects after selection among high-dimensional controls. *Rev. Econ. Stud.*, 81 (2014), pp. 608-650

## Appendix C: Appendix Tables

Appendix Table C1a: Variable Construction, Hygiene Behaviors

Panel A: Variable components			
Variable number	Variable	Definition	Variable defined for which stages
1	Condition in which carcass is skinned/scalded	ICW index of progressive indicators denoting that a carcass is skinned or scalded in 'at least' each of the following conditions, from worst to best: partially off the floor, on a raised surface or cradle, partially hung, hung.	
	Component 1: Workers wash hands	ICW index of: (a) any handwashing by any worker involved in that step and (b) any handwashing by all workers involved at that step	a. After skinning/scalding b. Before eviseration c. After eviseration d. Before sectioning e. After sectioning f. Before cleaning stomach/intestines g. After cleaning stomach/intestines
2	Handwashing: ICW index of components 1, 2, and 3; one variable for each stage	Component 2: Workers using running water to wash hands = 1 if workers used running water Component 3: Workers use soap to wash hands ICW index of: (a) any worker involved in that step used soap; (b) all workers used soap	
3	Intestinal contents on floor	= 1 if intestinal contents (waste) prevented from spilling onto the floor	
4	Guts/tripe on floor	= 1 if the guts/tripe prevented from contact with the floor	
5	Floor washed after slaughter	= 1 if floor washing immediately after slaughter of one animal is complete	
6	Storage of processed meat	= 1 if processed meat is store seperately from stomach and intestines in the slaughterhouse	
7		Proportion of workers engaged in slaughter and processing activities who are wearing gumboots that appear to have been clean at the start of the day	
8	Wearing of aprons/dustcoats	Proportion of workers engaged in slaughter and processing activities who are wearing aprons or dustcoats that appear to have been clean at the start of the day	
9	Knife washing: ICW index of component 1 (before eviseration), component 1 (before sectioning), and component 2	Component 1: Knife washing by stage ICW index of (a) knife was washed and (b) a 2 soapy bucket plus rinse system was used Component 2: Knife water contains chlorine = 1 if the water used to wash knife contained residual chlorine	b. Before eviseration d. Before sectioning
10	Carcass contact with floor	= 1 if carcass never comes into contact with the floor during the slaughter process	
11	Cleaning of stomach and intestines	= 1 if meat is cleaned seperately from stomach and intestines	

Panel B: Analysis variable construction

Variable name	Components
Hygiene practice index	ICW index of: 1, 2a, 2b, 2c, 2d, 2e, 2f, 2g, 3, 4, 5, 6, 7, 8, 9, 10
By slaughter stage	
Skinning/flaying	ICW index of: 1, 2a
Eviseration	ICW index of: 2b, 2c, 3, 4, knife washed before eviseration, knife washing with buckets before eviseration
Sectioning	ICW index of: 2d, 2e, knife washed before sectioning, knife washing with buckets before sectioning
Cleaning of stomach and intestines	ICW index of: 2f, 2g, 11
Floor washed after slaughter	5
By slaughter activity	
Handwashing	2a, 2b, 2c, 2d, 2e, 2f, 2g, 3
Knife washing	knife washed before eviseration, knife washed with buckets before eviseration, knife washed before sectioning, knife washed with buckets before sectioning
No contact of carcass with floor	4, 10
Separation of meat and intestines	6, 11
PPE	7, 8
Environmental hygiene	3, 5

**Appendix Table C1b: Variable Construction, Microbial Contamination**

<b>Variable</b>	<b>Definition</b>
Coliform counts on carcass	ICW index of the logarithm of colony-forming units (CFU) of coliforms per cm squared, and the logarithm of CFU E. coli per cm squared, of a carcass swab taken just before sectioning
Detection of pathogenic E. coli and salmonella	= 1 if either pathogenic E. coli or salmonella is identified on carcass samples
Coliform counts on worker hands	ICW index of the logarithm of colony-forming units (CFU) of coliforms per cm squared, and the logarithm of CFU E. coli per cm squared, of a swab of the hand of the worker who does the sectioning
Coliform counts on knife	ICW index of the logarithm of colony-forming units (CFU) of coliforms per cm squared, and the logarithm of CFU E. coli per cm squared, of a swab of the knife used for sectioning
Coliform counts in water	ICW index of the logarithm of colony-forming units (CFU) of coliforms per cm squared, and the logarithm of CFU E. coli per cm squared, of a swab of the water primarily used for knife washing

**Appendix Table C1c: Variable Construction, Manager and Worker Knowledge**

<b>Components of Knowledge Index</b>	<b>Definition</b>
Illness as a risk at work	= 1 if indicates illness as a risk faced during work
Practices listed to reduce risk of becoming ill	Number of valid practices listed by worker (manager) to reduce risk of becoming ill due to contact with animals
Sources of meat contamination	Number of valid sources of meat contamination listed
Practices listed to reduce meat decontamination	Number of valid practices listed by workers (managers) to avoid the chance that meat becomes dirty
Knife washing	Indicates that knives should be washed with soapy water and then rinsed
Response to injury at work	= 1 if knows correct response to suffering a wound at work

**Appendic Table C2: Baseline Balance**

	(1)	(2)	(3)	(4)	(5)	(6)
	Control	Training, Equipment, Monitoring (T1)	TEM + Incentives (T2)	Control - T1	Control - T2	T1 - T2
	<i>Mean/(SE)</i>			<i>p-value</i>		
Index of hygiene practices	0.000 (1.000)	0.088 (1.001)	-0.212 (0.876)	0.431	0.646	0.214
Index of hygienic practices when eviscerating	0.000 (1.000)	-0.100 (0.971)	-0.178 (0.959)	0.604	0.285	0.322
Index of hygienic practices when sectioning	0.000 (1.000)	0.142 (1.153)	0.032 (1.180)	0.558	0.727	0.363
Index of hygienic practices when cleaning stomach & intestine	0.000 (1.000)	0.266 (1.091)	0.277 (0.929)	0.175	0.696	0.414
Floor is washed immediately after slaughter	0.816 (0.391)	0.698 (0.465)	0.583 (0.498)	0.419	0.067	0.433
Index of worker knowledge	-0.025 (0.760)	-0.171 (0.836)	-0.005 (0.745)	0.857	0.197	0.234
Index of SH manager knowledge	0.000 (1.000)	0.235 (1.153)	0.328 (1.190)	0.146	0.517	0.348
Microbial contamination index: Carcass	0.000 (1.000)	0.004 (1.107)	-0.072 (0.850)	0.216	0.514	0.623
Detection of either pathogenic E. coli or salmonella on carcass sample	0.265 (0.446)	0.186 (0.394)	0.271 (0.449)	0.888	0.214	0.322
Microbial contamination index: Knife	0.000 (1.000)	-0.293 (1.012)	-0.119 (0.933)	0.272	0.222	0.683
Microbial contamination index: Hands	0.000 (1.000)	-0.456 (1.101)	-0.128 (0.901)	0.742	0.789	1.000
Microbial contamination index: Water	0.000 (1.000)	-0.392 (1.120)	-0.214 (0.980)	0.741	0.629	0.424
Log # of workers engaged in slaughter	0.801 (0.268)	0.876 (0.312)	0.883 (0.279)	0.434	0.686	0.213
Log # of animals processed per day	0.625 (0.238)	0.673 (0.270)	0.625 (0.256)	0.415	0.911	0.314

*The p-values displayed correspond to hypothesis tests on differences in means across the groups. Standard errors are clustered by meat inspector. County (stratification bin) dummies are included as covariates in all estimation regressions.*

**Appendix Table C3: Program Impact on Hygiene Practices, Activity Level**

	(1)	(2)	(3)	(4)	(5)	(6)
	Midline					
	Handwashing index	Knife washing index	No contact of carcass with floor index	Separation of meat & intestines index	PPE index	Environmental hygiene index
TEM only (T1)	0.783*** (0.224)	0.205 (0.177)	0.413** (0.171)	0.432*** (0.165)	0.866*** (0.138)	0.245 (0.202)
TEM + Incentives (T2)	0.978*** (0.221)	0.228 (0.173)	0.536*** (0.173)	0.232 (0.163)	1.044*** (0.139)	0.557*** (0.182)
P-value (T1 = T2)	0.416	0.835	0.525	0.150	0.082	0.118
Control mean	0.000	-0.000	0.000	-0.000	0.000	-0.000
Observations	138	138	138	133	138	138
	Endline					
TEM only (T1)	1.062*** (0.218)	0.445** (0.185)	0.133 (0.274)	0.151 (0.199)	0.969*** (0.191)	0.682*** (0.245)
TEM + Incentives (T2)	0.674*** (0.210)	0.576*** (0.134)	0.210 (0.183)	0.318* (0.176)	1.074*** (0.165)	0.337* (0.204)
P-value (T1 = T2)	0.107	0.364	0.776	0.440	0.393	0.196
Control mean	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
Observations	137	137	137	134	137	137

*Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.*

Appendix Table C4: Program Impact on Microbial Contamination, Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Coliform concentration: Carcass swab (Log 10 CFU/cm squared)	Coliform concentration: Knife swab (Log 10 CFU/cm squared)	Coliform concentration: Hands swab (Log 10 CFU/hand)	Coliform concentration: Water sample (Log 10 CFU/mL)	E. coli concentration: Carcass swab (Log 10 CFU/cm squared)	E. coli concentration: Knife swab (Log 10 CFU/cm squared)	E. coli concentration: Hands swab (Log 10 CFU/hand)	E. coli concentration: Water sample (Log 10 CFU/mL)
<i>Midline</i>								
TEM only (T1)	0.473** (0.198)	-0.415** (0.209)	-0.066 (0.210)	-0.876** (0.360)	0.667** (0.293)	-0.237 (0.271)	-0.000 (0.282)	-0.778** (0.339)
TEM + Incentives (T2)	0.142 (0.143)	-0.224 (0.219)	-0.148 (0.159)	-0.695*** (0.256)	0.139 (0.230)	-0.555*** (0.200)	-0.345 (0.211)	-0.495* (0.268)
P-value (T1 = T2)	0.064	0.445	0.705	0.620	0.059	0.258	0.257	0.422
Control mean	3.281	2.692	3.404	3.480	1.902	1.266	2.116	2.500
Observations	138	138	138	138	138	138	138	138
<i>Endline</i>								
TEM only (T1)	0.354* (0.209)	-0.002 (0.284)	-0.075 (0.204)	-0.007 (0.313)	0.191 (0.250)	-0.064 (0.300)	-0.021 (0.282)	0.126 (0.293)
TEM + Incentives (T2)	-0.061 (0.183)	-0.198 (0.219)	0.016 (0.144)	-0.209 (0.250)	0.257 (0.219)	-0.272 (0.233)	-0.166 (0.197)	0.042 (0.235)
P-value (T1 = T2)	0.026	0.525	0.684	0.522	0.783	0.521	0.628	0.768
Control mean	3.526	2.667	3.405	2.857	2.192	1.356	2.154	1.867
Observations	137	137	137	137	137	137	137	137

Note: OLS regressions on treatment. Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso.

Appendix Table C5: Program Impact on Microbial Contamination, Thresholds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Contamination with coliforms: Carcass swab	Contamination with coliforms: Knife swab	Contamination with coliforms: Hands swab	Contamination with coliforms: Water sample	Contamination with E. coli: Carcass swab	Contamination with E. coli: Knife swab	Contamination with E. coli: Hands swab	Contamination with E. coli: Water sample
	<i>Midline</i>							
TEM only (T1)	0.154 (0.094)	-0.170* (0.091)	-0.053 (0.052)	-0.302*** (0.090)	0.105 (0.073)	-0.175 (0.120)	-0.103 (0.081)	-0.290*** (0.090)
TEM + Incentives (T2)	0.045 (0.084)	-0.136 (0.090)	-0.021 (0.048)	-0.151* (0.077)	0.121 (0.075)	-0.234** (0.095)	-0.088 (0.061)	-0.135** (0.063)
P-value (T1 = T2)	0.309	0.737	0.565	0.113	0.789	0.662	0.865	0.093
Control mean	0.224	0.816	0.959	0.918	0.796	0.673	0.898	0.918
Observations	138	138	138	138	138	138	138	138
	<i>Endline</i>							
TEM only (T1)	0.142 (0.105)	-0.156* (0.090)	-0.032 (0.070)	-0.064 (0.111)	0.028 (0.055)	-0.148* (0.090)	-0.056 (0.082)	0.032 (0.091)
TEM + Incentives (T2)	-0.019 (0.084)	-0.098 (0.077)	-0.040 (0.037)	-0.120 (0.079)	0.006 (0.057)	-0.173* (0.089)	-0.076 (0.058)	-0.026 (0.080)
P-value (T1 = T2)	0.163	0.504	0.911	0.598	0.626	0.798	0.813	0.532
Control mean	0.347	0.857	0.980	0.837	0.918	0.673	0.918	0.776
Observations	137	137	137	137	137	137	137	137

Note: Standard errors in parentheses; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables include outcome at baseline, county (stratification bin) dummies, and a vector of control variables collected at baseline and selected using post-double selection (PDS) lasso. The contamination thresholds are log 2 for knife CFU/cm squared, log 4 for hand CFU/cm squared, any non zero for water CFU/ml, and log 3 for CFU/cm squared. The same numbers for E. coli

## **ALL IFPRI DISCUSSION PAPERS**

All discussion papers are available [here](#)

They can be downloaded free of charge

**INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE**

[www.ifpri.org](http://www.ifpri.org)

### **IFPRI HEADQUARTERS**

1201 Eye Street, NW  
Washington, DC 20005 USA  
Tel.: +1-202-862-5600  
Fax: +1-202-862-5606