



# Milk in the Data: Food Security Impacts from a Livestock Field Experiment in Zambia

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**Summary.** — Smallholder livestock ownership has potential to enhance food security by raising incomes of the poor and by increasing the availability of nutrient-dense foods. This paper exploits the staggered rollout of livestock distribution by Heifer International in Zambia to identify the effects of livestock using statistically similar treatment and control groups in a balanced panel of households. Results indicate that livestock ownership improves dietary diversity through both direct consumption of animal products produced on farm and through increased consumption expenditures. Further results indicate that expanded livestock ownership alters the local food economy to influence food consumption by households lacking farm animals.

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**Key words** — livestock, dietary diversity, Sub-Saharan Africa, Zambia, food security, asset transfers

## 1. INTRODUCTION

Livestock ownership is increasingly promoted in food security strategies because farm animals can provide nutrient-dense foods, regular income, and other benefits. Nonetheless, little empirical work actually demonstrates a causal link between livestock ownership and food security (FAO, 2012). Measuring the effectiveness of livestock in alleviating poverty and food insecurity is undermined by endogeneity: those households that have livestock likely differ systematically from those that do not. We use unique panel data from the rollout of a Heifer International livestock program in Zambia to identify the causal effect of livestock ownership on dietary diversity and consumption expenditure. We further explore the mechanisms through which livestock affects household food security by considering the impact of livestock ownership on income and on the consumption of specific food groups among livestock owners and other community members.

As with any agricultural technology, identifying an appropriate control group for households who adopt livestock is complicated by selection bias. Those who choose to adopt are fundamentally different from those who choose not to adopt, making non-adopters invalid as a control for adopters. Recent reviews of research on the impact of livestock on food security, nutrition, and poverty note that existing studies suffer from an absence of control groups and endogeneity problems associated with selection bias (DFID, 2014; Leroy & Frongillo, 2007). In this article, particular features of the Heifer International livestock donation program allow us to identify current and future recipients of farm animals. We use future adopters of livestock as a control group for current adopters and collect baseline data on livestock recipients and comparable non-recipients. We use a difference-in-differences approach controlling for time-invariant household characteristics to compare outcomes for the recipients against those who have selected into the program, but have not yet received animals. This approach follows suggestions from de Janvry, Dustan, and Sadoulet (2011) who note that selection bias can be overcome in part through utilization of staggered

rollouts, which can be analyzed similarly to randomized control trials (RCTs) even when they lack explicit randomness. Using households who have selected into the program as controls and applying household fixed effects addresses concerns of endogeneity more completely than existing research (DFID, 2014). We run several placebo tests to rule out systematic pre-treatment differences among the groups and other possible confounding factors that could drive our results.

Our analysis uses panel data from Zambia covering 300 households over four rounds, spanning 18 months from the distribution of donated animals. To our knowledge, this work is one of the first studies to use a balanced panel of data to examine the effects of livestock on expenditure and food security. While we expect to see a direct impact of donated livestock through increased availability of animal products, we also expect an indirect effect on food security through increased revenue, which can be used to access a wider variety of foods. Moreover, we anticipate potential spillover effects throughout communities as perishable animal products become more available due to increased local production. The timing, scale and mechanisms of these effects may vary by animal species.

We find significant effects on household outcomes for recipients of dairy cattle, meat goats, and draft cattle. The receipt of livestock triggers increases in dietary diversity and in consumption expenditure per capita. In all specifications, expenditure per capita has a positive and significant effect on dietary diversity, implying that livestock ownership affects dietary diversity through two channels: first, through the direct impact

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of ownership on access to animal sourced foods, and second, indirectly, through the increase in total consumption expenditures allowed by livestock ownership. As one might expect, the direct increase in dietary diversity is driven by milk consumption and is largest in magnitude when dairy animals are distributed. We further find that non-recipients living in communities with recipients also experience increased milk consumption. In our setting, we find the benefits from livestock, particularly dairy cattle, are large. When we compare the size of effects from the livestock gift to those expected from an equivalent gift of cash, we find that the cash gift would have to yield an annual return of nearly 70% to generate the same effects on dietary diversity as the average gift of livestock. Thus, our findings imply that livestock can have an impact on food security beyond what would emerge from a cash transfer of similar scale and that livestock development may affect the local food economy to enhance food security of non-recipients as well.

This paper extends the existing literature by providing causal inference and by distinguishing mechanisms through which livestock affects outcomes. One recent article that employs quasi-experimental methods to study the impact of livestock uses a cross-sectional household survey to investigate the effects of a Heifer International livestock donation on various biometric outcomes for children and on food consumption patterns (Rawlins, Pimkina, Barrett, Pedersen, & Wydick, 2014). Using propensity score matching (PSM) to designate a control group, Rawlins *et al.* find significant impacts of dairy cow ownership on dietary diversity, but no effect from owning goats. Rawlins *et al.* acknowledge that because they are limited to cross-sectional data and have no baseline, they cannot attribute these results to the introduction of livestock as the effects may be driven by unobservable household characteristics.

Alary, Corniaux, and Gautier (2011) use an income-based approach to evaluate the contribution of livestock to poverty reduction in Mali. They find that livestock contributes “significantly” to a household reaching the poverty line in an agricultural system in which livestock are prevalent. They are able to characterize the complex role livestock plays in agricultural systems and the relationships, both direct and indirect, between livestock and poverty reduction. However, the observational nature of their data limits their ability to identify causal impacts of the animals. A number of studies have analyzed programs for training and asset transfer (often in the form of cattle), but those analyses largely focus on income effects, expenditures, time allocation, and household bargaining outcomes of the program instead of food security or dietary diversity *per se* (Bandiera *et al.*, 2012; Banerjee, Duflo, Chattopadhyay, & Shapiro, 2011; Banerjee *et al.*, 2015; Das *et al.*, 2013; Krishna, Poghosyan, & Das, 2012). Further, they do not address the specific mechanisms of livestock on food security, or use research settings involving the introduction of livestock into a market in which they are otherwise absent. The context and data for this paper allow us to explore specific effects of livestock on food security in a region with historically low rates of large animal ownership.

## 2. DATA

### (a) *The Heifer International Program*

Heifer International projects operate in rural communities in Zambia with the following structure. Community groups must first form and organize themselves to submit applications to one of Heifer International’s Zambia offices and achieve eligibility

for assistance from the organization. Eligibility for individuals in approved groups is contingent on participation in training activities and on initial investments in animal facilities at their homes, as well as payments into a community insurance fund. Households are also screened to remove the non-poor from the pool of livestock recipients. Thus, households in groups that are eligible for Heifer assistance are neither the most poor in Zambia, nor are they wealthy. In absolute terms, they are certainly poor, with 72% of the participating households in our survey living on less than US\$1.25 per person per day. Moreover, participant households have demonstrated a willingness to participate in organized groups with the purpose of access to livestock. Thus they have self-selected and may not be typical of all households in terms of their preferences, abilities, or other unobservable factors. Even if eligible participants are different in some ways from the average Zambian household, eligible households are similar to *each other* in that they all performed the same process of self-selection.

Within a group served by Heifer International, some households receive livestock in an initial distribution. We refer to these households as originals. Other group members receive the female offspring from the initially donated animals; these households are referred to as Pass-on-the-Gift (POG) households. Due to the limited supply of pregnant animals and other capacity constraints, animals are not initially distributed to every eligible group. Households in unserved groups (referred to as prospectives in this paper) may be a control for those in served groups, while POG households (in served groups that do not receive animals initially) are another control, albeit an incomplete control that is subject to potential spillover effects. Thus, original recipients, POGs and prospective households have self-selected to participate with Heifer International, but only the original recipients receive animals in the initial distribution. Original recipients and POGs live in the same communities and prospective recipients live in others. A final category of surveyed households is the independents, who were not interested in, or incapable of, participating in the Heifer International program, but live in the same communities as the original recipients and POGs.

Prospectives, POGs, and originals are all eligible to receive an animal through Heifer International. The selection of original beneficiaries among the eligible households is known to have been random in one community, and is assumed to have been random in other communities where the process was not observed. While eligibility to receive an animal is endogenous and based on self-selection, actual receipt can be considered exogenous. We examine the assumption of random allocation between originals and POGs through a series of robustness and validity tests. In the initial models, POGs and prospectives are pooled together as the control group on the assumption that spillovers within the treated communities are modest over the time frame considered. In a later specification, we explicitly test for spillovers from the originals to the POGs, using the prospectives as the control. We additionally look for anticipatory behavior on the part of the POG households, which could contaminate them as a control for the households that received livestock. Because POGs are very likely to receive livestock within 18 months to 3 years of the initial animal distribution but prospective households are only eligible to receive livestock in the future, we expect that any anticipatory behavior would be stronger in the POGs than in the prospectives. We test for anticipatory behavior first by comparing livestock expenditure for POGs to that of prospectives and by treating the POGs as treated and re-running the regressions on the outcome variables. In both cases we see no evidence of anticipatory behavior.

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