Is There More than Milk? The Impact of Heifer International's Livestock Donation Program on Rural Livelihoods: What We Learned from a Field Experiment in Zambia

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Abstract

This study evaluates the impact of Heifer International's livestock donation program in the Copperbelt Province in Zambia. Using a panel data of 300 households and 4 survey rounds, this analysis assesses the impact of dairy cow, meat goat, and draft cattle donation programs on poverty and food security measures. The impact on consumption expenditures and livestock revenue are estimated with a difference-in-difference method, and the impact on dairy/meat consumption frequency is estimated with a pooled poisson regression. A probit model is used to estimate the effects on subjective measures of poverty and food security. Results show that the impact of the program has increased significantly over time and animal recipients are relatively feeling better. By the fourth round, all animal recipients have seen a significant increase in consumption expenditure, livestock revenue, and frequency of dairy/meat consumption. However, no significant impact exists on household asset ownership and growth. Although all the animal recipients have increased milk consumption, meat consumption has gone up among the goat beneficiaries only. While all three animal species contribute to increase consumption expenditures among animal recipients, only the draft cattle and dairy cow programs help increase revenue from livestock products. Likewise, the meat goat and dairy cow programs have contributed to food security through improved dietary diversity.

Key Words: *livestock donation, poverty, consumption expenditure, food security, dietary diversity, milk consumption*

1 Introduction

According to the Food and Agricultural Organization (FAO), worldwide about 842 million people lived under poverty or were undernourished in 2013 (FAO, 2013). While the world is fighting against the tragedies of hunger and extreme poverty, promoting animal agriculture is sometimes deemed to be an effective way forward (Alary, Corniaux, and Gautier, 2011). Among other interventions, international animal donation programs have long been a popular way of transferring resources from developed countries to the families in need in developing countries. More importantly, the introduction of animal production in poor communities can contribute to household income, improved diet, and food security in individual and household levels (Alary, Corniaux, and Gautier, 2011; Randolph et al., 2007; Ruel, 2003b; Hoddinott and Yohannes, 2002; Sansoucy et al., 1995). Livestock's share of agriculture GDP is about 33% and it has been increasing every year. FAO estimated that about 1 billion of the world's poorest population directly relies on livestock for their livelihood issues (Otte et al., 2012). In developing countries, animal production engages about 600 million smallholder farmers and another 1.3 billion people are employed in the livestock value chain globally (Thornton, 2010). Animal products can contribute to higher and more reliable farm incomes and also provide a good source of protein, calories, vitamins, and micronutrients (Alary, Corniaux, and Gautier, 2011; Randolph et al., 2007; Hoddinott, 2006; Ellis and Freeman, 2004). Although the physical and economic sustainability of agriculture depends on agro-ecological conditions, animal husbandry can thrive in wide array of climate and conditions because different species and breeds are suited to different ecological conditions.

Despite these benefits, livestock production can have negative impact as well. High labor demand may keep women from other activities and draw children out of school to tend livestock. Allocation of household resources to livestock production can make other sector unproductive and animals may spread zoonotic diseases and environmental contamination (Otte et al., 2012; Randolph et al., 2007). In addition, it can reduce the availability of food by increasing feed demand, divert plant-based calories to feed, lead to poor sanitation, and contribute to income growth only among relatively well-off households that have necessary resources to maintain animals(Otte et al., 2012; Kennedy, Ballard, and Dop, 2011). So, it is of paramount importance to evaluate livestock donation programs to better understand the net impact of animal production on rural livelihoods.

Heifer International has been involved in livestock donation programs since 1944. Heifer's livestock donation programs are always complemented by extensive training in livestock production, leadership, gender equality, and environmental protection. In the past 70 years, Heifer has reached more than 106 million people in 125 countries (Heifer International). However, only a few studies have looked at the net impact of such programs on the target communities (Rawlins et al., 2014). In many cases existing studies have been undermined by methodological weaknesses and structural problems arising from selection procedure. Recently, Rawlins et al. (2014) evaluated the impact of Heifer's livestock donation program in Rwanda and found that dairy cow donation significantly increased milk consumption and dietary diversity score as well as child nutritional outcomes. However, their study uses cross-sectional data with no long-term tracking and it is mostly silent about the possible impact on livelihood issues such as consumption expenditures, socio-economic status, and food security outcomes. The current study, motivated by Rawlins et al.'s results, attempts to address the limitations in two ways. First, this study tracks households for 2 years with a pre-intervention and 3 follow-up surveys. The second improvement comes from the realization that the impact of livestock donation could go beyond milk or meat consumption and nutritional outcomes.

In this study, I evaluate the impact of Heifer International's livestock donation program in the Copperbelt Province in Zambia. The choice of research site is guided by two important factors. First, rural poverty in Zambia is one of the worst in Africa with 67% of population still living below the poverty line. In addition, some previous studies call for more public investment in livestock and related services for smallholder farmers in the Copperbelt Province (Lubungu, Chapoto, and Tembo, 2012). In the Copperbelt Province, Heifer has donated three different species of livestock, dairy cows, meat goats, and draft cattle, based on ecological conditions of target communities. Therefore, the analysis can uncover the impact of the program by animal species. First, it assesses the temporal impact of the program on poverty reduction, food accessibility and food security and then the cumulative impact by animal species is evaluated. The objectives are relevant to the program under investigation because Heifer International's motto is "Ending Hunger and Poverty Worldwide". The first objective, poverty reduction, is assessed by looking at household expenditures and the growth in asset ownership. The impact on food accessibility and dietary quality is investigated using dietary diversity scores, and frequency of consumption of specific nutrient dense foods such as milk and meat.

2 Relevant Literature

2.1 Livestock's Role in Poverty Reduction

A number of development agencies and governments have been increasingly involved in livestock donation programs as an effort to address the crisis of hunger and poverty worldwide. However, there is a dearth of literature on monitoring and evaluation of such programs. In Africa, livestock sector is often neglected in designing poverty reduction strategies. Although some countries consider livestock as an important sector, cereal crops have received far more importance in policy papers and empirical analysis (Alary, Corniaux, and Gautier, 2011). Alary, Corniaux, and Gautier (2011) investigated the livestock's role in poverty reduction by conducting a case study in Mali. They found that livestock keepers benefit from increased farm productivity via access to manure, draft power, and income and food security. In developing countries, livestock serves as a strategic asset for poor people because Animal Source Food(ASF) can help in livelihood improvement by contributing to food supplies and stable source of income (Murphy and Allen, 2003; Randolph et al., 2007). Moreover, livestock can be sold for an urgent need for cash and can serve as insurance that can be liquidated when needs arise (Alary, Corniaux, and Gautier, 2011; Hoddinott, 2006). In rural areas where financial markets are rarely available, livestock keeping may serve as a financial instrument, saving tool and capital investment (Sansoucy et al., 1995).

Ellis and Freeman (2004) looked at poverty reduction strategies and rural livelihood options in four African countries, Kenya, Malawi, Tanzania, and Uganda. They documented that low household income in rural areas are directly related to low livestock ownership, small land holdings and high reliance in food crops. On the other hand, they found the households with diverse livestock holding had better socio-economic status. Another study by Kristjanson et al. (2004) showed that increased investment in livestock is one way to diversify income sources which not only provides a pathway out of the poverty, but contributes to economic sustainability in poor communities. For women, who represents 70% of the worldâĂŹs poor, livestock provides a continuous employment(DFID, 2000). In addition,livestock can serve as one of the few options available to smallholders and landless (Upton, 2004). Likewise, livestock production can contribute to stabilize the source of household income through direct sales of animals or animal products such as milk, meat, manure and draft power (Alary, Corniaux, and Gautier, 2011). In essence, livestock production can help poor people move out of poverty by providing access to market opportunities, increasing income and improving household asset base (Randolph et al., 2007; ILRI, 2006).

2.2 Poverty Measures

Although the introduction of livestock production can play an important role in poverty reduction (Alary, Corniaux, and Gautier, 2011; Randolph et al., 2007), determining appropriate measures of poverty status is not straightforward. In developed countries, household income is a generally preferred measure of poverty but collecting such data in developing countries is costly and subject to measurement error (Sahn and Stifel, 2003; Vyas and Kumaranayake, 2006; Barrett, Carter, and Little, 2006; Carter and Barrett, 2006). The income based measures fail to include non-market "commodities" such as level of education, life expectancy, child mortality rate, access to health care, school, and other public services. As a consequence, income variables are not appropriate to use as measures of household poverty (Barrett, Carter, and Little, 2006; Vyas and Kumaranayake, 2006; Carter and Barrett, 2006). It has been suggested in the literature that a household's current welfare status is well represented by the current level of consumption rather than the current level of income (Headey, 2008). In developing countries, aggregate consumption expenditure in household level is preferred because a large share of household income comes from self-employment and household production. Moreover, the sources of income in rural communities may vary by seasons but the consumption expenditure generally does not (Sahn and Stifel, 2003). In fact being poor is not just having low income but it is about not having adequate household consumption as well. In that sense, welfare measures based on consumption expenditure are appropriate (Headey, 2008). However, Alary, Corniaux, and Gautier (2011) demonstrated that the role of livestock in poverty reduction is better understood by a dynamic method that combines expenditure and asset based approach.

In recent years, alternative measures of poverty such as asset index and subjective measures have also become popular (Barrett, Carter, and Little, 2006; Sahn and Stifel, 2003). The quantitative measures often disregard the cultural values of the society and heavily rely on standards of collective welfare (Alary, Corniaux, and Gautier, 2011). On the other hand, asset based measures use the possession of household assets, rather than income, which determines the socio-economic status of households. Initially, Carter and May (1999) mentioned the importance of ownership of household productive assets as a potential poverty reduction tool. Their argument is that asset ownership insulates household from chronic poverty because assets can be converted to cash in the event of adversities. Moreover, holding of productive assets such as farm tools and equipment, financial, social and human capitals provides sustainable source of income, and potentially a pathway out of poverty (Barrett, Carter, and Little, 2006). Carter and May (1999) laid out the theoretical framework behind asset based poverty measures. Many researchers have used data for household assets, tools, infrastructure, and other household characteristics, which reflect living standard, to construct such measures (McKenzie, 2005; Barrett, Carter, and Little, 2006; Carter and Barrett, 2006). Unfortunately, no unanimity exists on how to use such information to measure welfare accurately. Several approaches have been suggested in the literature but Principal Component Analysis (PCA) has been increasingly used to construct an asset index (McKenzie, 2005; Vyas and Kumaranayake, 2006). Construction of the asset index by using PCA approach is described in the data section.

2.3 Livestock's Role in Food Security

FAO defines four pillars of food security to be food availability, access, stability, and utilization. Animal production directly leads to greater availability of ASF and also provides access to food via increased household income (Kennedy, Ballard, and Dop, 2011). In other words, livestock production contributes to food security either by increasing food supply or by generating revenue to purchase other nutrient-dense foods and goods and services (Smith et al., 2013; Otte et al., 2012; Alary, Corniaux, and Gautier, 2011; Randolph et al., 2007; Murphy and Allen, 2003). For example, revenue from animal products and by-products can be used to buy staple diets. On the other hand, provision of manure, draft power and labor supply helps to increase farm productivity and eventually food supply (Smith et al., 2013). Moreover, animals convert low value, unpalatable and even inedible materials to nutrient dense foods and increase food supply (Smith et al., 2013). Animal products also help to avoid seasonal food unavailability. For example, milk and meat products can be stored for longer period of time and small animals can be slaughtered when need arises (Sansoucy et al., 1995). Stability of animal products is more pronounced than crop production as the latter is more vulnerable to weather, disease outbreaks, and land availability (Kennedy, Ballard, and Dop, 2011; Randolph et al., 2007). For poor households, livestock keeping serves as a risk reduction strategy which helps buffer household shocks from crop failure due to disease outbreaks, droughts, and natural calamities (Kennedy, Ballard, and Dop, 2011).

The fourth and final pillar of food security, utilization, focuses in the quality of diet and nutritional-well being (Kennedy, Ballard, and Dop, 2011). Animal products such as milk, meat, and eggs are high quality nutrient dense foods and provide about 13% of the energy and 28% of the protein requirement, globally(Smith et al., 2013; Kennedy, Ballard, and Dop, 2011). Six micronutrients that are critical for human physiology, calcium, vitamin A, B12, iron, zinc, and riboflavin are primarily obtained from ASF. For example, 100 gm of beef is more than enough for the entire day of protein, vitamin B12 and zinc requirement (Murphy and Allen, 2003). Deficiency of these nutrients may cause anemia, stunting, wasting, rickets, night blindness, and other problems. However, the essential nutrients which are lacking in plant based foods are naturally more bioavailable in animal products (Smith et al., 2013). Therefore, adding a small amount of ASFs to staple based diets can contribute to food security by improving the quality of diet substantially. For example, in a study from rural Kenya, Murphy and Allen (2003) documented that school kids provided with 2 snacks containing ASF were in better nutritional status than the kids with 3 vegetarian snacks per day.

2.4 Dietary Diversity as a Measure of Food Security

Dietary diversity is usually measured by a score called dietary diversity score(DDS). DDS is a good measure of food security because it represents dietary variety, indicates increased access and acquisition of micronutrients and can be assessed both at the household and individual level (Hoddinott and Yohannes, 2002). Indeed, dietary diversity score (DDS) in household level serves as a good measure of the accessibility of varieties of food and the economic ability of the household to access food (Kennedy, Ballard, and Dop, 2010). Therefore, dietary diversity score is an indicator of food security and socioeconomic status in household level (Hoddinott and Yohannes, 2002; Hatløy et al., 2000). Hoddinott and Yohannes (2002) conducted a multi-county analysis on association of dietary diversity score with food security and socioeconomic status (SES). They used per-capita consumption as a proxy for socio-economic status and per-capita energy availability as a proxy for food security. Their results showed that dietary diversity score is positively associated with socio-economic status and food security in household level. Similar results were reported by Hatløy et al. (2000). The positive association implies that dietary diversity usually results from household's tendency to consume non-staple high quality foods rather than consuming more varieties of staple foods, when income increases (Ruel, 2003b).

Usually, DDS is measured by counting a number of food groups consumed over a period of time. However, the length of reference period is not unique and can vary 1 to 15 days (Ruel, 2003a). Many previous studies have used 24-hr recall, while some others have used 7-days recall (Kennedy, Ballard, and Dop, 2011; Rawlins et al., 2014; Savy et al., 2005; Ruel, 2003b). A series of papers by FAO (Kennedy, Ballard, and Dop, 2010, 2011) chose 24-hr recalls over other measures arguing that it likely has less recall error and makes easier for respondents to remember what they ate. Some other studies used 3 or 7-days and in some instance a month long recalls depending on food items. The problem with shorter recall period is that it does not reflect the true habitual diet while longer reference periods are subject to recall errors (Savy et al., 2005). In addition to the reference period, the choice of appropriate food groups also remains largely subjective and depends on research objectives. For example, if DDS is used to measure household's economic access to food, food items that require economic resources to acquire are included (Kennedy, Ballard, and Dop, 2011).

3 Data and Research Methods

Data come from household surveys administered to rural farming households in the Copperbelt Province of Zambia over four rounds beginning in January 2012. Survey were administered every six months from January 2012 to July 2013. The research method took advantage of the roll out of the livestock program of Heifer Program International (HPI) in Zambia to establish a field experiment that enabled the measurement of treatment effects. Prior to the HPI program, livestock ownership, aside from keeping of poultry, was rare in the Copperbelt Province. Despite the natural potential for crop and livestock production, previous reliance on mine labor for income had left little livestock development. Prior to this research activity, HPI in Zambia identified a number of farmer groups from communities in the Copperbelt Province which were eligible to receive livestock and associated services. However, limited resources dictated that only a subset of those farmer groups and communities would receive animals in the next few years. Among the eligible set of communities, three received animals between November 2011 and March 2012 and the other two will not receive animals before

November 2014.

The baseline survey was administered to 324 households and a complete panel of four rounds of data exists for 300 households. Surveyed households are classified into 4 groups. Those households which received animals in the initial distribution are called "Originals". Within the treated villages, all original recipients are surveyed, but not all members of the farmer groups receiving Heifer support are given animals in the initial round. Other households, which are scheduled to receive the female offspring from animals given in the first round, are called "pass on the gift" (POG). POG households are considered to be similar to the Original households in that both groups applied and were accepted into the program. However, the POG households are subject to spillover effects as they live in close proximity to the Originals and therefore do not serve as counterfactuals for the full effect of the program. A third group is identified as "Independents" and consisted of households that are not interested and self-selected out of the program. These households are examined in order to identify how representative the original and the POG households are. Households in a fourth group are called "Prospectives" and consisted of households in community groups that are eligible to receive animals but will not be served until after 2014. These households form a control group as they are similar to treated groups in terms of unobservables while their spatial remoteness insulates them from spillover effects. In all cases pregnant animals were delivered as well as support services. Based on the ecological and market conditions of the communities, group members received either one dairy cow, or two draft cattle, or seven meat goats. Analysis can therefore identify impacts by species. Table 1 presents a detail description of baseline survey.

Table 1: Number of households surveyed by community and treatment groups in baseline survey

			Treatment Status			
Community	Species	Total	Original	POG	Independent	Prospective
Chembe	-	31	-	-	-	31
Kamisenga	Cow	87	31	42	14	-
Kanyenda	Goat	115	54	49	12	-
Kaunga	Draft	55	20	20	15	-
Mwanaombe	-	36	-	-	-	36
Total		324	105	111	41	67

3.1 Selection Procedure

There is a two fold of selection procedure. First, households (farmers) form groups and the groups applied to the livestock donation program. Each group is expected to be homogeneous because the groups are required to demonstrate appropriate membership with respect to household's capacity and needs. Then HPI Zambia selected farmers groups based on economic status of group members and other eligibility conditions. Other eligibility criteria includes a commitment to assemble appropriate equipment and construct a shed should the animal(s) be received. This implies that both tails of the income distribution are ineligible because the poor do not have resources to maintain the animals and the rich are already well off. Once the groups are selected, they are identified as Prospectives(late recipients), Originals (early recipients) and POGs (recipients of second generation animals). Limited resources dictated that not all eligible households receive animals. Although the Heifer program identified the control groups(Prospectives) explicitly, there is no clear explanation on how the treated households are classified into Originals and POGs. In fact, this procedure has more do to with the selected groups rather than the HPI staffs. All treated groups are asked to decide themselves on who gets the animals now and who gets the second generations later. But, even the HPI staffs are unaware of the exact selection procedure. It is expected that each group had its own selection criteria, but this information is unknown to neither Heifer staffs nor the surveyors. Thus, the selection of households into the treatment was not completely random. A selection bias may exist because the second set of selection process is unknown. This study controls for the selection bias by employing unobserved effect models such as fixed effects.

3.2 Response Variables

The introduction of animal production can contribute to dietary diversity and improved dietary quality directly from improved food availability and indirectly through increased income. Various outcomes are relevant to the analysis of the impact of the livestock donation program. The basic approach of this analysis is to measure the impact of household's treatment status on outcomes of interest. This study assesses the impact on food security and poverty measures.

- *Food security measures*: dietary diversity, frequency of dietary intakes, subjective assessment.

Outcome variables relevant for food security measures are straightforward to construct. Dietary Diversity Score (DDS) for a household is the total number of food groups consumed in the household in the past 24 hours or 7 days. During surveys, each respondent is asked if her/his household consumed any food items from pre-determined thirteen different food groups. If a household consumes at least a food item from a particular food group and ends up consuming food items from z different groups, then DDS for that household is z. Frequency of food intakes are number of days a household consumed particular food items over the last 7 days. This study uses 'milk days' and 'meat days' as response variables and they directly come from the survey question: "In the past week, how many days did people in your household consume *–food item–*?". As the variables are count data a Poisson regression will be used in estimating causal effects. Subjective assessment of food security is a binary variable which equals 1 if the respondent thinks her/his household is able to feed the entire family without any help and 0 otherwise. The impact on the subjective measure of food security will be estimated by using a Probit regression.

- *Poverty measures*: household expenditures and revenues, asset index, and subjective assessment.

Household expenditures and revenues consist total expenditure, food expenditure, and revenue from livestock products. All three variables are in Kwacha per-capita and directly computed from observed data. Total expenditure is simply a summation of value of household consumption which includes all food and non-food goods consumed and services used by the household last week. All gift items received and consumption that came from own production are also included. All items with no reported values are valued at local market prices. Items which do not have both reported value and market prices, such as clothes and gifts, are assigned a value of 1 just to represent their consumption/use. Food expenditures are calculated by summing up the values of home food consumption which includes own production, purchases, and gifts as well. Data on food away from home (FAFH) are not available. Livestock revenue is also a summation of value of livestock products such as milk, meat, manure and hiring out of draft animals. First, household level values are divided by household size to convert to per-capita values. Then, all of them are log-transformed because of high degree of skewness. Since zeros can't be log-transformed, 1 is added to all the variables with a value of zero before transformation. Subjective assessment of poverty is a binary variable, which equals 1 if the respondent thinks her/his household needs help or feels relatively poor, and 0 otherwise. The last outcome variable for poverty assessment is asset index. Unlike the subjective measure, a good asset index is much more complicated to construct and difficult to interpret. A fairly common way of constructing asset index is to use principal component analysis (PCA). As a check on the asset index I will use the reported value of household assets and tools as a response variable. For consistency, both baseline and the final round assets will be valued at final round unit values reported by the respondents.

3.2.1 Asset Index: a measurement of socioeconomic status

Asset index will be constructed using Principal Component Analysis (PCA). PCA is a type of factor analysis which assumes all of variation in underlying variables is accounted for by factors. In other words, each observed variable is a linear combination of hypothetical source variables. That is

$$X_i = \sum_{j=1}^{k} a_{ij} C_j$$

where X_i is observed variable score, a_{ij} is the weight of variable X_i on factor j and C_j is a hypothetical value of underlying source variable j. Note that a_{ij} is given by the eigenvector of the correlation matrix. The basic idea of PCA is that the principal components (Y_i) are linear combinations of observed variables. That is

$$Y_i = \sum_{j=1}^{k} \alpha_{ij} X_i$$

The weights (α_{ij}) are mathematically determined to maximize variance of principal components, Y, subject to the constraint $\sum_j a_{ij}^2 = 1$. One of the important feature of PCA is that subsequent components are uncorrelated with previous components and hence the former explain less but additional variation in data (Vyas and Kumaranayake, 2006). PCA also assumes that there are as many components as the original variables. Components are ordered such that the first principal component accounts for the largest amount of variation in the original data. Since the number of observed variables and components is equal, selection of the components is largely subjective. A commonly used approach is that a component with eigenvalue greater than unity be retained. However, many previous studies have used the first component as a measure of socio-economic status (Vyas and Kumaranayake, 2006; McKenzie, 2005; Houweling, Kunst, and Mackenbach, 2003). In fact, the first component explains the maximum variation among household assets being used. It also gives a higher weight to the assets with high standard deviation. For example, if only a few households own a TV, it gets very high weight and if everybody owns a bicycle it gets the least weight. So, the first component represents inequality and discrimination among households (Vyas and Kumaranayake, 2006; McKenzie, 2005). Mathematically, the first principal component is:

$$Y_1 = \alpha_{11} X_1 + \alpha_{12} X_2 + .. + \alpha_{1p} X_p \quad (1)$$

where Y_1 is the first principal component, α_{ij} is a weight for the i^{th} component and the j^{th} variable, and X_i is an observed variable.

3.3 Summary Statistics

Summary statistics on selected response variables from baseline survey are presented in Table 2. Prospective households have higher expenditure per-capita, higher revenue from livestock product sales, and consume milk more frequently than other households. This is consistent with the Heifer's selection criteria in that

Table 2: Description of Response Variables by Treatment Status

Variables	Total	Originals	POGs	Prospectives
Total Expenditure	36537.2	33513.3	34954.9	47616.7
	(27082.1)	(24291.0)	(26281.4)	(33268.3)
Food Expenditure.	19947.9	17725.1	19757.9	25192.7
	(14424.8)	(9958.3)	(16334.6)	(17202.7)
Livestock Revenue	949.5	569.3	733.4	2416.0
	(6524.9)	(3321.6)	(7121.9)	(10163.1)
Dietary Diversity	5.685	5.790	5.676	5.612
	(1.751)	(1.905)	(1.613)	(1.907)
Milk Days	1.247	1.295	1.117	1.716
	(2.181)	(2.103)	(2.070)	(2.707)
Meat Days	1.086	1.010	1.216	1.194
	(1.185)	(0.946)	(1.404)	(1.282)
Asset Index	-1.29e-09	0.460	-0.140	0.0367
	(1.855)	(2.117)	(1.755)	(1.664)
Asset Value(million)	0.381	0.490	0.329	0.365
	(0.737)	(1.064)	(0.584)	(0.321)
Feeling Poor (1=yes, 0 else)	0.787	0.676	0.784	0.881
	(0.410)	(0.470)	(0.414)	(0.327)
Food Secure (1=yes, 0 else)	0.367	0.371	0.378	0.373
	(0.483)	(0.486)	(0.487)	(0.487)
Observations	324	105	111	67

Coefficients are mean; Standard deviations are in parentheses; All monetary values are in Kwacha per-capita

Prospective households are selected to receive animals in the future based on needs and economic status of group members. However, the value of expenditures between treated and control groups are not significantly different. So is the case for livestock revenue and food expenditures. Dietary diversity score is pretty much the same for all groups and all of them consume milk and meat products only about a day per week. So, both treated groups and their counterfactuals look very similar in the baseline survey. Table 3 presents summary statistics of household characteristics. In many instances, a household comprises of multiple houses because

Table 3: Description of Demogrpahic Variables by Treatment Status

Variables	Total	Originals	POGs	Prospectives
Household size	6.682	7.429	6.928	5.627
	(2.676)	(2.763)	(2.762)	(2.059)
Number of kids 5 or under	1.170	1.190	1.270	1.015
	(0.970)	(1.001)	(0.943)	(0.913)
Number of kids 6 to 16	2.241	2.419	2.450	1.776
	(1.618)	(1.622)	(1.741)	(1.391)
Household Head Characteristics				
Age	45.54	50.15	42.61	44.96
	(13.41)	(12.49)	(12.22)	(14.70)
Education	3.009	2.923	3.128	2.894
	(1.478)	(1.446)	(1.546)	(1.291)
Female(%)	0.262	0.286	0.252	0.209
	(0.441)	(0.454)	(0.436)	(0.410)
Married(%)	0.833	0.829	0.874	0.791
	(0.373)	(0.379)	(0.333)	(0.410)
Observations	324	105	111	67

Point Estimates are mean; Standard deviations are in parentheses

of the joint family structure in the region. Number of rooms per person is presented to represent crowding. On average, two persons share a room in a house, a household has two houses, and 75% of houses have dirt floor. Household size is fairly large,about 7, 26% households are female headed, 83% household heads are married, and each household has a child of age five or under. On average treated households have two more members than controls, their heads are at least 40 years old, and the heads are generally literate but not educated well. Table 4 presents asset ownership and distribution by treatment status. All groups appear to have similar asset base except the number of chickens and land size. The Prospective households have more chickens and the treated groups have slightly bigger size of cultivated land. A significant difference in demographics and nontreatment characteristics between treated and control groups can be problematic for further analysis. One can always look at the normalized differences to assess this issue.

Table 4: Description of Asset Variables by Treatment Status

Variables	Total	Originals	POGs	Prospectives
Cultivated land, HA	3.629	4.630	3.822	2.643
	(4.615)	(6.457)	(3.678)	(2.899)
Value of tools (millions Kw)	0.481	0.756	0.358	0.404
	(1.074)	(1.781)	(0.324)	(0.520)
Value of assets(millions Kw)	1.865	2.653	1.783	1.353
	(4.420)	(6.519)	(3.851)	(1.169)
Number of sheeps	0.244	0.248	0.450	0.0448
	(1.333)	(1.329)	(1.838)	(0.367)
Number of pigs	0.630	0.543	0.189	1.448
	(4.977)	(1.814)	(0.920)	(10.55)
Number of chickens	13.70	13.42	11.26	21.93
	(27.76)	(16.07)	(9.113)	(55.56)
Number of houses	1.778	1.905	1.946	1.552
	(1.002)	(0.904)	(1.190)	(0.875)
Number of rooms per person	0.647	0.658	0.561	0.771
	(0.457)	(0.457)	(0.306)	(0.608)
Floor(1=dirt, 0 else)	0.755	0.676	0.820	0.712
	(0.431)	(0.470)	(0.386)	(0.456)
TV (1=yes, 0 else)	0.380	0.467	0.387	0.388
	(0.486)	(0.501)	(0.489)	(0.491)
Bicycle(1=yes, 0 else)	0.821	0.838	0.820	0.866
	(0.384)	(0.370)	(0.386)	(0.344)
Observations	324	105	111	67

Coefficients are mean; Standard deviations are in parentheses

3.4 Normalized Differences

Program evaluation based on natural experiment is not uncommon in economic literature. However, many such evaluations are conducted by using observational data. Observational data serve well in estimating causal effects when treatment (W_i)and outcome (y) are independent conditional on observed covariates (X) i.e. $W_i \perp y \mid X_i$

(Rosenbaum and Rubin, 1983). In addition, identification of treatment effects requires that there are both treatment and control groups for all possible value of covariates, i.e. $0 < Pr(x) < 1$, $\forall X$. This is called an overlap assumption and it may be used to make sure control groups exist for every covariates. Imbens and Wooldridge (2008) showed that the overlap assumption can be tested by employing Normalized Differences. i.e. $\Delta X = \frac{\bar{X}_1 - \bar{X}_0}{\sqrt{S_1^2 + S_0^2}}$, where $\bar{X}_i$ and S_i^2 are sample mean and variance of covariates (X) for treated and control groups, $i = 0, 1$. As Imbens and Wooldridge (2008) suggests, a value of normalized difference greater than 0.25 implies a potential problem with regression methods in estimating treatment effects. Table 12 in Appendix presents normalized differences between Originals and Prospectives groups. Mostly, the Normalized Differences are below or around the threshold level, 0.25. This means that there exist control and treated groups for all the observables and hence regression based estimation approaches are appropriate.

4 Econometric Models

4.1 Difference in Difference (DD)

In program evaluation with panel data, causal relationships are usually estimated by Difference-in-Difference(DD) estimation method. DD is a good identification tool in that it compares difference in outcomes of interest on treatment and control group before and after the policy implementation (Bertrand, Duflo, and Mullainathan, 2004). Moreover, DD approach is not only simple to estimate, but it corrects for endogeneity problem that may arise from unobserved individual effects. The simplest form of DD model entails two groups and two time periods:

$$y_{ist} = \beta_0 + \beta_1 D_t + \beta_2 P_{ist} + c_i + \varepsilon_{ist} \tag{2}$$

where i denotes individual, t denotes time period, and s denotes group, c_i is an individual effect which controls for potential self-selection problem, y_{ist} is an outcome of interest for group $s = 0, 1$ at time $t = 0, 1$, D_t is time dummy which equals 1 if t=1, P_{ist} is a program dummy, equals 1 if s=1 and t=1. Note that the individual specific effects c_i are removed by averaging out within each group s at time t. In equation (2), β_0 captures any time-invariant difference between groups and β_1 captures the time varying differences. In other words, β_1 is the time effect on control group and β_1 + β_2 is the time effect on treated group. Since, β_2 is the time effect on treatment minus time effect on control, this is the true causal effect of the policy intervention. The most important assumption is that β_2 would be zero if treatment were not applied. That is, $E[\varepsilon_{ist} \mid P_{st}] = 0$.

An unbiased estimate of the true program effect, β_2, is obtained by estimating equation (2) either by fixed effect(FE) or taking first difference(FD) over time and estimating by OLS. Equivalently, employing difference-in-difference technique in equation(2) also gives an unbiased estimate of β_2. [1] The basic DD framework can be extended to the case of multiple time periods and groups as well (Imbens and Wooldridge, 2008). In the context of this study, since there are four time periods and three different groups, the DD framework is extended as follows [2].

$$y_{it} = \beta_0 + \sum_{t=1}^{4} \beta_t Round_t + \beta_2 Program_{it} + \beta_3 PassonGift_{it} + \Pi X + c_i + \varepsilon_{it} \tag{3}$$

where $Program_{it}$ is a dummy which equals 1 if a household i received animals, $PassonGift_{it}$ is also a dummy which equals 1 if household i is a POG household and $t > 1$. Finally, $Round_t$ is a time dummy which equals 1 if subsequent rounds, and X is a vector of control variables mentioned above in Tables 3-4. However, many demographic variables in this context are time invariant and therefore are not included in the fixed effect estimation. Since there are multiple groups and periods, interpretation of coefficients gets trickier. In equation (3), β_t is simply a time-varying effect, and β_2 is a true program effect in a sense that it is the difference in mean difference between original and prospective households. Similarly, β_3 is the spillover effect as well as the effect of Heifer's “Pass on the Gift" program. Equation (3) is used to estimate the treatment effect on total expenditures, food expenditures, livestock revenue, asset values, dietary diversity scores, and asset index. As described in the data section, the first four variables (expenditures,revenue and asset value) are in log and the last two variables(dietary score and asset index) are in levels. In log-linear models, the estimated coefficient can be interpreted as a percentage change in outcome between treated and control groups. For example, if y_{it} is $log(Expenditure)$ in equation (3), then $\beta_2 = log(\mu_{y1}) - log(\mu_{y0})$, where μ_{y1} and μ_{y0} are average conditional expenditure for treated and control group, respectively. Therefore, when $Program_{it}$ changes from 0 to 1, the outcome y_{it} changes by $100\beta_2\%$.

4.2 Pooled Probit Model

Casual effect on binary response variables with unobserved individual effects are best estimated by probit and logit models. With panel data, a fixed effect probit estimation is not available and fixed effect logit model is not

[1] $E[DD] = E[(\bar{y_{11}} - \bar{y_{10}}) - (\bar{y_{01}} - \bar{y_{00}})] = E[\Delta\bar{y_1} - \Delta\bar{y_0}] = E[[(\beta_0 + \beta_1 + \beta_2) - \beta_0] - [(\beta_0 + \beta_1) - \beta_0]] = \beta_2$

[2] For notational convenience the subscript s is suppressed hereafter

appropriate because observations with $y_{it} = 0$ are dropped out and do not contribute to the estimation of causal effect. If observed covariates (X) are strictly exogenous conditional on the unobserved effect (c_i), i.e. $D(y_{it} \mid x_{i1}, x_{i2}, ..., x_{iT}, c_i) = D(y_{it} \mid x_{it}, c_i)$, then the response probability is $P(y_{it} \mid x_{it} c_i) = \Phi(Program_{it}\beta + X\Pi + c_i)$. Φ is the cumulative density function, and $D(y_{it} \mid .)$ is conditional distribution function of y_{it}. Although β can be estimated by using maximum log-likelihood estimation, it is not identified because of c_i, the incidental parameter problem. The unobserved effect (c_i) must be controlled for to achieve identification. Since probit fixed effect model is not available, a poled probit model with Chamberlin-Mundlak approach is used. With this specification, c_i is allowed to correlate with x_{it} and c_i is normally distributed, $c_i \sim N(\alpha + \bar{x}_i\theta, \sigma_u^2)$ (Mundlak, 1978). While the vector of covariates, X usually contains time dummies, it's average $\bar{X}$ never does. So, the probability response function becomes

$$P(y_{it} \mid x_{it}, \bar{x}_i) = \Phi(\alpha + Program_{it}\beta + X\Pi + \bar{X}\theta) \tag{4}$$

Estimating equation (4) by pooled probit method gives a consistent estimate of β. In this study, I apply equation (4) to the binary response variables, subjective measures of poverty and food security, to estimate the treatment effects on these variables. In particular, the subjective variables are regressed on $1, x_{it}$, and $\bar{x}_i$ with pooled probit model. Note that x_{it} includes all treatment dummies, all control covariates mentioned in Tables3-tab3b and time dummies, and $\bar{x}_i$ includes time constant mean of control covariates only. Since the coefficients of interest come from program (binary) variables, the coefficients are interpreted as difference in predicted probabilities of outcome between treated and control group.

4.3 Pooled Poisson Model

Poisson distribution is a discrete probability distribution which fits the data with number of events (count) occurring randomly and independently over time. If γ is the poisson parameter and X is a vector of covariates then $\gamma = exp(X\lambda)$ gives a poisson distribution. The unknown parameter λ can be consistently estimated if we have data on the outcome (count) variable, y_{it}, i.e. $E(y_{it} \mid x_{it}) = exp(x_{it}\lambda)$. Under the assumption of strict exogeneity of X, λ is consistently estimated by maximum likelihood methods. However, if unobserved effect c_i is present and the covariates are strictly exogenous conditional on c_i i.e. $E(Y_{it} \mid x_{i1}, x_{i2}, ..., x_{iT}, c_i) = E(y_{it} \mid x_{it} c_i)$, then estimating λ along with c_i leads us to the incidental parameter problem. Hausman, Hall, and

Griliches (1984) developed a fixed effect poisson model that takes care of the c_i term but it comes at a cost. All observations with $y_{it} = 0$ are dropped out and do not contribute to the estimation of λ. So, as with the pooled probit case mentioned above, allowing c_i to be correlated with X and estimating the resulting equation by Quasi-Maximum Likelihood (QMLE) method gives a consistent estimator of λ. Mathematically, let the mean response function be $E(y_{it} \mid x_{it} c_i) = exp(Program_{it}\beta + X\lambda + c_i)$ and the unobserved effect c_i be $c_i = \alpha + \bar{X} + u_i$. Then, a consistent estimate of β is obtained by estimating equation(5) by pooled QMLE, poisson in this case.

$$E(y_{it} \mid x_{it}, \bar{x}_i) = exp(\alpha + Program_{it}\beta + X\Pi + \bar{X}\theta) \tag{5}$$

In this study, implementation of equation(5) to estimate the average treatment effect on frequency of milk and meat consumption per week is rather straightforward. Specifically, milk days or meat days are regressed on $1, x_{it}$, and $\bar{x}_i$ with pooled poisson model. All the regressors are exactly the same as mentioned in pooled probit case. However, interpretation of the estimated coefficients on program variables is different. With poisson regression, the coefficient on program variable is the difference in logarithmic mean response function between treated and control groups. That is, $\beta = log(\mu_1) - log(\mu_0)$, and $\exp(\beta) = \frac{\mu_1}{\mu_0}$. Note that μ_1 and μ_0 are conditional mean for treated and control groups, respectively. Intuitively, a small change in x_{it} leads to 100 β% change in the outcome variable. $\exp(\beta)$ is also called an Incidence Rate Ratio(IRR) and can be interpreted as a number of times the impact on treated group is bigger than that of control group.

5 Estimation and Results

There are many ways to look at the impact of the livestock donation program on poverty and food security outcomes mentioned in Table2. The first part of the analysis presents the estimates of the cumulative impact of the program. In addition, it attempts to uncover the pattern of evolution of the impact over time. In fact, coefficient on interaction of program and the 4th round dummies gives the cumulative impact. Similarly, coefficients on program and 2nd and 3rd round dummies reveal the pattern of evolution of the cumulative impact. As a robustness check and to better understand the overall effect of the program, the cumulative impact of individual species will also be estimated. In this case, coefficients on interaction of individual animal species and round dummies give the impact of the program by species after 18 months of livestock donation.

5.1 The Cumulative Impact

5.1.1 Consumption Expenditures and Livestock Revenue

The impact of the livestock donation program on total expenditures, food expenditures, and livestock revenue are presented in Table 5. As mentioned before, all three response variables are log-transformed because they are highly skewed in levels. Results in Table 5 are obtained by estimating equation(3) with a fixed effect model. Acquiring livestock is expected to help increase livestock revenue and consumption expenditure as well. Livestock recipients not only have access to animal source foods but can use the increased revenue to consume more and healthy foods as well as other goods and services. So, the impact on consumption expenditure and revenue from livestock products can be considered to be a part of the overall impact on household poverty status. Results indicate that, over the 18 months after animal donation, animal recipients increased their total expenditure by 28.9% as compared to the non-recipients. Interestingly, the increase in total expenditure exhibits a pattern with 17.7% and 27.1% increase after 6 months and 1 year, respectively. Similar pattern exists in food expenditure as well. In particular, livestock recipients increased their food expenditures by 27.5% after a year and 42.3% after 18 months of receiving animals.

Results from Table 5 are depicted in Figure 1. In the figure, y-axis is the estimated coefficient in percentage terms and x-axis is the program dummies over time. Each bar graph is accompanied with a vertical line, a 90% confidence interval. So, the impact is not significant whenever the confidence interval includes zero. For example, all but the first bar for food expenditure includes zero indicating no impact on food expenditure in the first 6 months of the program. The evolution of the cumulative impact on food and total expenditure growth is clearly visible from Figure 1. The growth in consumption expenditure is evident from the data as shown by the density function in Figure 5 in the Appendix. Unlike the expenditures, value of livestock revenue among

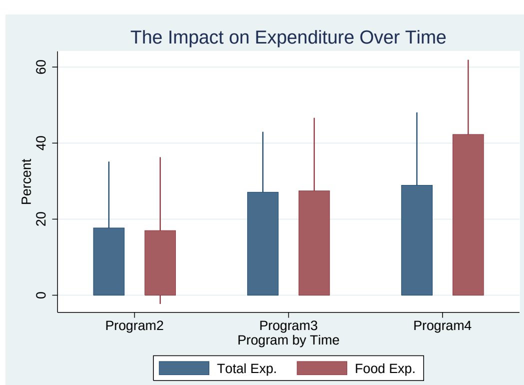

Figure 1: Consumption Expenditure Over Time

Table 5: Consumption Expenditure and Livestock Revenue

	Fixed Effect Model		
	Total Expenditure	Food Expenditure	Livestock Revenue
Program2	0.177*	0.170	3.453***
	(0.106)	(0.117)	(0.692)
Program3	0.271***	0.275**	3.079***
	(0.0962)	(0.116)	(0.731)
Program4	0.289**	0.423***	2.988***
	(0.116)	(0.119)	(0.678)
POG2	-0.00604	0.0371	0.401
	(0.111)	(0.125)	(0.441)
POG3	0.0769	0.0755	-0.243
	(0.0988)	(0.119)	(0.555)
POG4	0.235*	0.447***	0.850
	(0.125)	(0.132)	(0.520)
Observations	1068	1068	1068

Dependent variables: Log of per-capita expenditure and revenue (Kwacha)

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

recipient households has increased in a decreasing rate as compared to the control households. Although the livestock revenue of recipient households increased in decreasing rate i.e. 345% after 6 months, 308% after a year, and 299% after 18 months, none of them are statistically different from each other. The decreasing pattern of the impact on livestock revenue could be explained by the fact that the households are selling less and consuming more livestock products over time as indicated by the huge increase in food expenditure. As expected, the POG households do not have significantly higher revenue than the control groups, but they do increase their consumption expenditures after 18 months. This increase could potentially be coming from a spillover effect. As most of the households are far from the nearest market, animal products are distributed locally. The spillover effect in this case might all be governed by increased milk availability. For example, the cow recipients could be distributing milk as a gift, in exchange for labor, and even selling for cash.

5.1.2 Dairy/Meat Consumption and Dietary Diversity

Table 6 presents results on the effects of the livestock program on food consumption pattern and dietary diversity. Since the dietary diversity equation is estimated with a fixed effect model, the estimated coefficients are the average treatment effects (ATE). The first column in Table 6 indicates that the treated group consumed at least one more food group compared to the control group. Note that the bigger magnitude of ATE in round 3 could be driven up by the seasonality effect because the third round of survey was administered in January (rainy season in Zambia). Naturally, more varieties of food items are available in the rainy season.

The effects on milk and meat consumption frequency are estimated with a pooled poisson model specified in equation(5). So, the estimated coefficients are log difference of expected consumption frequencies between treated and control group, or simply a percentage change. As expected, milk consumption among the treated households has increased in increasing rate over time (Figure 2). In particular, after18 months of animal donation the treated and POG households increased their milk consumption by 128% and 85%, respectively. This also means that the treated group consumed milk about 4 times, ($e^{1.28} = 3.6$), more days than the control group and the POG households did so by 2 times, ($e^{0.85} = 2.3$), more. Unlike the impact on milk consumption, frequency of meat consumption did not significantly increase until the fourth round of survey. This is clearly visible from Figure 2. In particular, no confidence interval lines for the milk coefficients include zero, but 0 is within the interval for the first two coefficients on meat days. More importantly, the treated households significantly increased their meat consumption frequency (43%) by the fourth round of survey. This result

Table 6: Dietary Diversity and Consumption Frequency

	Fixed Effect	Pooled Poisson	
	Dietary Diversity	Milk Days	Meat Days
Program2	0.579**	0.807***	0.0399
	(0.291)	(0.118)	(0.134)
Program3	1.110***	1.039***	0.135
	(0.269)	(0.123)	(0.125)
Program4	0.755***	1.278***	0.435***
	(0.280)	(0.143)	(0.132)
POG2	0.159	0.188	-0.289**
	(0.301)	(0.129)	(0.142)
POG3	1.007***	0.459***	-0.0821
	(0.270)	(0.132)	(0.129)
POG4	0.420	0.853***	0.251*
	(0.325)	(0.149)	(0.134)
Observations	1068	1056	1056

Dependent variables: dietary score, dairy and milk consumption days per week (count)

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

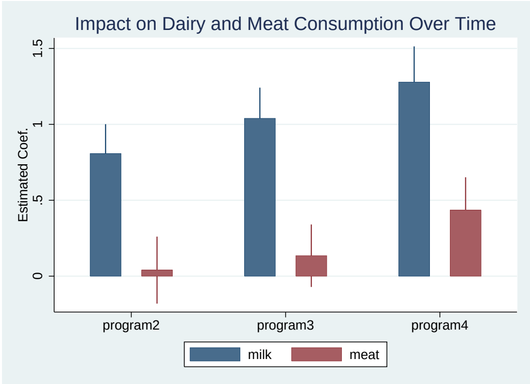

Figure 2: Dairy and Meat Consumption Over Time

indicates that the impact on meat consumption may be coming from the income effect. Also, it could be that the primary goat recipients have started slaughtering the second generation male goat in about 18 months of the program.

5.1.3 Alternative Measures of Poverty and Food Security

Table 7 presents results on the subjective assessment of poverty and food security. Since the response variables are binary, treatment effect on subjective measures is estimated with a pooled probit model, equation(4). Results indicate that the predicted probability of "feeling poor" among the treated households has been significantly decreased over time. "Feeling poor" is a binary response which equals 1 if the respondent thinks her household needs help or is relatively poor.

Table 7: Poverty and Food Security

	Pooled Probit	
	Feeling Poor	Food Secure
Program2	-0.725***	0.415*
	(0.234)	(0.213)
Program3	-0.482**	0.0586
	(0.246)	(0.221)
Program4	-0.603***	0.263
	(0.234)	(0.211)
POG2	0.181	-0.0597
	(0.218)	(0.217)
POG3	0.287	-0.169
	(0.230)	(0.225)
POG4	0.0750	-0.0503
	(0.222)	(0.210)
Observations	1056	1056

Dependent variables: Respondent's feeling about household poverty and food security (binary)
Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

Results imply that animal recipients either do not need further help or are feeling better than before. In contrast, the POG households feel otherwise and may need further help. The results make a perfect sense in that those who received livestock are expected to feel better over time. The second column in Table 7 presents estimated impact on food security status. Clearly, neither group is feeling food secured at 5% level of significance. After 6 months into the program, animal recipients appear to feel as if they are food secure. However, they feel otherwise afterward. The initial feeling of food security could just be an immediate response to the positive shock from acquisition of animals which fades away with time. Moreover, food security is a long run phenomenon so it takes long time to realize whether a household is food secured. The other side of the problem is that the subjective measures are what the respondent feels about the entire household. Unfortunately, the respondent is not always the decision maker or head of the household and it's not clear whether she is aware of the household's status.

The estimated impact on household asset growth[3] is presented in Table 8. First column presents the impact on asset index constructed by using PCA approach. Asset index in this case is the first principal component which represents socio-economic status of the households. Results indicate that the livestock donation program does not have any impact on household asset growth measured by asset index. This implies no significant impact on socio-economic status of animal recipients compared to the control group. This also indicates that animal recipients may not be spending a significant amount of the livestock revenue on asset accumulation. More importantly, poor households invest more on food consumption rather than entertainment and assets accumulation. In general, a sustainable change in the socio-economic status is a long-run phenomenon and the results imply that 18 months may be too short to achieve this. However, there are some caveat with the asset index approach. For example, the PCA method ignores all but the first component which describes only about 24% variation in asset data. To check the validity of this approach, I use the actual value of assets reported by the respondents during the final round. Unit values of each asset type were calculated based on the reported values and assets in the baseline were valued at the unit values. Results from this approach are presented in the second column of Table 8 and largely confirm with the results from asset index approach.

5.2 The Impact by Animal Species

Results from the first part indicate that the livestock donation program has positively impacted household expenditures, revenue, dairy and meat consumption, and household dietary diversity. Since three different species of livestock were distributed to the same general area, identification of the impact by animal species may provide a further insight for policy recommendation. While the impact grows over time, it is not clear from the

[3] Note that asset data are available for the baseline and the final survey rounds only

Table 8: Asset Index and Value of Assets

	Fixed Effect	
	Asset Index	Asset Value
Program4	0.0879	0.0257
	(0.213)	(0.135)
Pog4	-0.109	-0.0307
	(0.212)	(0.134)
Round 4	-0.232	-0.317**
	(0.249)	(0.157)
Observations	542	544

Dependent variables: Asset index and log value of assets
Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

first part of the results that whether the impact differs by the species of animal donated. In an effort to check the robustness of the previous results, this part of the analysis identifies the cumulative impact of receiving a particular animal species. The effect of the donation program on consumption expenditures and livestock revenue

Table 9: Impact on Expenditures and Revenues

	Fixed Effect		
	Total Expenditure	Food Expenditure	Livestock Revenue
Cow	0.261**	0.402***	8.101***
	(0.117)	(0.115)	(0.752)
Goat	0.224**	0.238*	0.534
	(0.104)	(0.122)	(0.491)
Draft	0.283**	0.250*	2.110***
	(0.124)	(0.130)	(0.647)
POG	0.102	0.187*	0.332
	(0.0902)	(0.102)	(0.424)
Observations	1068	1068	1068

Dependent variables: Log of per-capita expenditure and revenue (Kwacha)
Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

is estimated by the fixed effect model presented in equation (3). Again, all three dependent variables in Table 9 are log-transformed. Results indicate that all animal species contribute to a significant increase in consumption expenditure. In particular, the cow beneficiaries increase their household expenditures by about 26% and food expenditures by 40%. Those who received draft cattle saw a 28% increase in consumption expenditure and 25%

increase in food expenditure. The goat recipients, on the other hand, increased their food and non-food expenditures by about 23%, proportionately. In case of the cow and goat beneficiaries, the increase in consumption expenditures could be primarily coming from the increase in food expenditures. However, the results indicate that the draft recipients are spending less on food than on non-food consumption. The expenditure growth among cow and draft cattle recipients may be explained by the huge increase in livestock revenue, 810% and 211%, respectively. Cow beneficiaries are probably selling milk and manure and the draft keepers might have been hiring out draft cattle. Unlike dairy cow and draft cattle, the meat goat recipients probably have no animal products for sale because goats produce very little milk and manure. It could be too early for meat sale because the beneficiaries are not allowed to slaughter the heifer goats and they have to give away the second generation females. As a result, there is no increase in livestock revenue for the goat recipients. So, the expenditure growth among goat recipients appears to be solely governed by the growth in food expenditure (Figure3). It could also be coming from an expected future revenue from selling goat meat. In Table 10, the species specific impact of

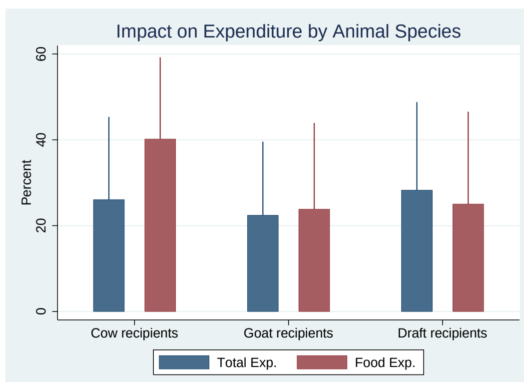

Figure 3: Estimated Impact of Animal Speices on Consumption Expenditures

the livestock program on food security measures, dairy and meat consumption frequency and dietary diversity, are presented. Dietary diversity is modeled with a fixed effect model and consumption frequency is modeled with a pooled poisson regression. Results indicate that cow and goat recipients diversify their diet with at least one more food items but the draft beneficiaries see no significant increase in diet diversity. As expected, milk consumption frequency goes up for all groups with cow beneficiaries leading the way over the goat and draft recipients (Figure4). Specifically, as compared to the Prospectives, the dairy cow recipients consume milk and milk products about 158% more days per week followed by the goat and draft recipients with 65% and 49% more days, respectively. Interestingly, milk consumption among the POG households went up by 49% more days compared to the control groups. This result implies that the livestock donation program contributed to

Table 10: Milk and Meat Consumption Days

	Fixed Effect	Pooled Poisson	
	Dietary Diversity	Milk Days	Meat Days
Cow	1.123***	1.578***	0.0452
	(0.333)	(0.0804)	(0.107)
Goat	1.156***	0.654***	0.324***
	(0.290)	(0.0890)	(0.0877)
Draft	0.474	0.479***	-0.0396
	(0.369)	(0.114)	(0.127)
POG	0.723***	0.479***	0.0128
	(0.233)	(0.0803)	(0.0799)
Observations	1068	1068	1068

Dependent variables: dietary score, dairy and milk consumption days per week (count)
Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

the increased milk availability in the treated villages. The meat consumption frequency, however, is increased for the goat beneficiaries only. This is clearly visible in Figure 4 as the meat confidence interval for cow and draft groups include zero as well. Compared to the control group, goat recipients consume meat 32% more days per week. Since the goat recipients do not have a significant increase in livestock revenue, positive impact on meat consumption might have been coming from off-farm income or slaughtering of the second generation male goats. The question of whether the animal recipients are feeling better and food secure is evaluated with a

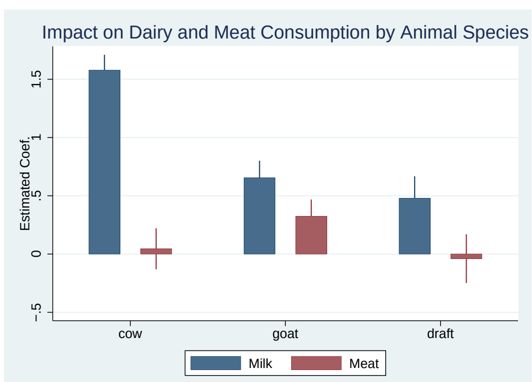

Figure 4: Estimated Impact of Animal Speices on Dairy/Meat Consumption

pooled probit model. In the first column of Table 11, significant negative coefficients on animal dummies mean that the animal recipients are not feeling poor. The POGs, however, are indifferent about their status before and after the program. In case of the food security question, none but the cow beneficiaries are feeling food secure.

Table 11: Impact on Poverty and Food Security Measures

	Pooled Probit	
	Feeling Poor	Food Secure
Cow	-1.359***	0.590***
	(0.271)	(0.169)
Goat	-0.355**	0.0847
	(0.157)	(0.150)
Draft	-0.669***	0.182
	(0.240)	(0.197)
POG	0.154	-0.0923
	(0.130)	(0.128)
Observations	1068	1068

Dependent variables: Respondent's feeling about household poverty and food security (binary)
Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

The results suggest that even though all animal holders are feeling better than the control groups, all but the dairy cow owners still need help to feed their families the varieties of food they want to.

6 Conclusion

This analysis provides some insights on the impact of Heifer International's livestock donation program in Zambia. The results are not only encouraging for charitable organizations and other institutions being involved in poverty and hunger reduction, but they improve our understanding of how rural households respond to positive asset shock. The results indicate that animal donation programs help increase household expenditures, provide an additional source of income (livestock revenue), improve dietary quality and dietary diversity, help increase consumption of animal products, and make people feel happier. Overall it is evident that, the impact has been continuously growing over time and it generally differs by the livestock species. In particular, the livestock donation program in the Copperbelt Province helped increase livestock revenue by about 300% overall, 810% among the dairy cow recipients and 211% among the draft cattle holders. In addition, food expenditures went up by as much as about 40% and total expenditure went up by about 25%. Animal recipients diversified their diets with at least one more food group and all of them are not feeling poorer than before as compared to the control groups. After 18 months into the program, everybody in the animal donation villages increased milk consumption giving us an evidence of spillover effect. In particular, the cow recipients lead the way with 158% more days of milk followed by the goat and draft recipients with 65% and 48% more days, respectively. Meat consumption, however, went up only among the goat beneficiaries implying that cow and draft keepers apparently had no income effect in terms of meat consumption. Despite the positive impacts on consumption expenditures, revenue, dietary quality and consumption frequencies, there is no evidence of positive impacts on household asset growth. Asset growth is a long run process and the period of time this study covers may not be long enough for significant asset accumulation. Moreover, when poor households have additional source of income they usually divert it to food consumption rather than asset accumulation.

Overall, the results indicate that the introduction of animal production in rural areas not only provides an access to nutrient dense foods, but it contributes to poverty reduction by providing additional sources of household income leading to a growth in consumption expenditures. This implies that livestock donation may serve as an effective tool against hunger and poverty. Additionally, the results provide an empirical evidence that a livestock donation program can provide a lot more than milk and meat. In essence, the results imply that it would be worthwhile to incorporate livestock donation programs in national and international policies associated with hunger and poverty reduction.

This study can be improved in many ways. Although the study tracks beneficiary and non-beneficiary households for about 18 months after the intervention, this period probably is not enough to see the impacts on asset accumulation, food security, and other soci-economic changes. One could track the households for a longer period of time and perform the similar analysis. In addition, one could look at the asset portfolio in greater detail, track children from livestock recipients and other households and look at their anthropomorphic and other achievements over time.

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7 Appendix

Tables

Table 12: Normalized Differences between Treated and Control Groups in baseline survey

	Mean		$\frac{\bar{X}_1 - \bar{X}_0}{\sqrt{S_1^2 + S_0^2}}$	N	
Variables(X)	Prospectives	Originals	Normalized Difference	Prospectives	Originals
Household size	5.627	7.429	0.463	67	105
Age of head	44.955	50.152	0.260	67	105
Education of head	2.894	2.923	0.015	66	104
Female headed hhs	0.209	0.286	0.125	67	105
=1 married, =0 not	0.791	0.829	0.067	67	105
# of kids 5 or less	1.015	1.190	0.129	67	105
# kids 6 to 16	1.776	2.419	0.288	67	105
# kids in school	1.493	2.095	0.288	67	105
Cultivated land, HA	2.643	4.630	0.270	67	105
Value of hh tools (millions)	0.404	0.756	0.187	67	105
Asset index	0.038	0.657	0.185	66	104
Value of hh assets(millions)	1.353	2.653	0.193	67	105
number of houses	1.552	1.905	0.270	67	105
numbers of rooms per person	0.771	0.658	-0.147	67	105
=1 dirt floor,=0 other floor	0.712	0.676	-0.055	66	105
Numbers of sheeps owned	0.045	0.252	0.148	67	103
Numbers of pigs owned	1.448	0.570	-0.082	67	100
Numbers of chickens owned	21.925	13.680	-0.141	67	103

Figures

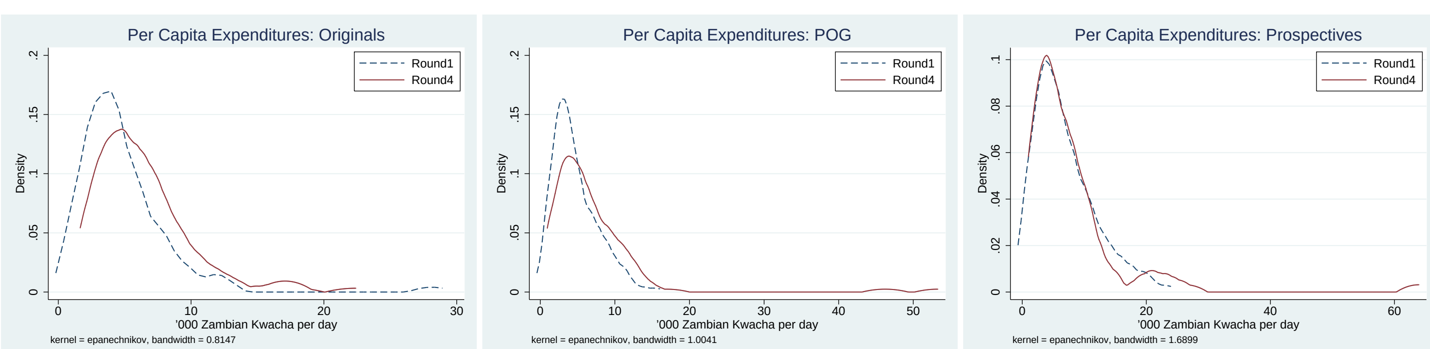

Figure 5: Per Capita Expenditure ('000 Kwacha)