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Does 25 cents more per day make a difference? The impact of livestock transfer and development in rural Zambia☆

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ABSTRACT

Analyses of the impacts of asset transfer programs often find statistically significant effects on consumption expenditures that are large in percentage terms but small in absolute value. This study explores the practical significance of such impacts using the case of a livestock transfer program among impoverished households in Zambia. As in other studies, results show that the asset transfers increased household consumption expenditure and dietary diversity. Extending previous work, this paper examines whether the increase in expenditures has been large enough to trigger changes in consumption patterns or in subjective assessment of poverty status. Changes in composition of expenditures, composition of diet, and subjective self-assessment of poverty all suggest a growing sense of security and a practically significant change in welfare for treated households. As transfers included three different types of animals – dairy cows, meat goats, and draft cattle – we are able to discern that the specific nature of the asset transferred influences food security impacts. Examination of change in the composition of consumption shows substantial effects on poverty and food security starting within six months of livestock transfers. Persistence of the impact through the next 18 months of our study period indicates that livestock transfers can have a sustained effect on poverty and food security.

1. Introduction

Programs to transfer productive assets to poor households often intend to place recipients on a new trajectory of higher productivity and reduced vulnerability. In some rural settings, transfer of assets in the form of livestock may be a particularly effective mechanism toward this end as the introduction of animal production can contribute to income, improved diet, and greater food security at the individual, household, and community levels (Hoddinott and Yohannes, 2002; Ruel, 2003; Sansoucy, 1995; Randolph et al., 2007). Recently, a few empirical studies including Rawlins et al. (2014), Banerjee et al. (2015), and Jodlowski et al. (2016) have applied rigorous field experiments and found positive effects on food security and poverty indicators attributable to livestock transfers embedded in multifaceted programs. While these studies find statistically significant effects, it is not clear that the effects are sufficiently large to be considered transformative. Reported impacts on per capita consumption expenditures show increases of about US$0.25 per day or more, but absolute levels of per capita consumption remain near international poverty lines after the transfer. This study seeks to determine whether impacts of this scale affect the composition of consumption or subjective attitudes about poverty in ways that suggest meaningful change in welfare.

Poverty status is often conceptualized with reference to expenditures needed to secure a minimum requirement of food and essential non-food goods and services (Ravallion, 2015). Observing greater consumption of goods that are locally considered discretionary or luxury items can therefore signal a substantive transition beyond poverty into greater economic security. We identify goods as luxuries or necessities based on income elasticities from our baseline sample and examine whether there are shifts in consumption toward luxuries which would signal a qualitative change in economic status despite low total expenditures. Similarly, we examine the change in composition of household diet to understand whether observed increases in household dietary diversity correspond to improved nutritional quality. Finally, we examine whether increased total expenditures and changes in the composition of diet and expenditure correspond to changes in self-perceived poverty and food security status. By looking for variation in these outcomes over three different species of livestock that are transferred (dairy cows, draft cattle, or meat goats) we observe the degree to which specific types of assets influence outcomes for recipients and others in their communities.

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As in Jodlowski et al. (2016) we use the rollout of a multifaceted asset transfer program administered by the NGO Heifer International to identify current and future recipients of livestock transfers. Identification of these two groups is the basis of a quasi-experimental approach to impact assessment in which future recipient groups are the comparison group for current recipients. Other recent work on the impact of asset transfers (Banerjee et al., 2015) uses similar field experiments to assess the impact of multifaceted asset transfer programs. Like other recent studies, this paper also uses the NGO's program rollout to address the selection bias and endogeneity that undermined earlier work. In this paper we first validate the results of Jodlowski et al. (2016), finding that an increase in consumption expenditures of 20–30% (about US$0.25 per capita per day) can be attributed to the livestock donation and capacity building program. Extending Jodlowski et al. (2016) and other studies, we then assess whether the increases in expenditures have been significant enough to qualitatively change consumption patterns. We find evidence of increased consumption of foods that can be considered luxury goods, suggesting qualitatively improved economic status among recipients. We further use subjective self-assessments of poverty and food security to confirm whether an enhanced sense of economic security has emerged. The analysis includes a sample of households that had selected out of participation to indicate the degree to which selection bias could have influenced results had the general population been used as a comparison group, rather than the subset of future livestock recipients.

This paper continues with background on the arguments and evidence concerning livestock transfers in developing countries. We then present our research methods, explaining both the structure of the field experiment and the econometric techniques applied in this impact assessment. This is followed by a presentation of results and conclusions.

2. Background

Livestock may represent a particularly strategic form of asset transfer. In developing countries, livestock provide nutrient-dense animal source foods (ASF) and a stable source of income through sales of milk, meat, manure, draft power or the animals themselves (Randolph et al., 2007; Murphy and Allen, 2003). Moreover, livestock can serve as a store of wealth and as insurance that can be liquidated when needs arise (Sansoucy, 1995; Hoddinott, 2006; Alary et al., 2011). Additionally, increased investment in livestock can diversify income sources, provide continuous employment for men and women, and can serve as an income source for households with very little or no land (Upton, 2004).

Livestock production may represent a pathway to help poor people move out of poverty by providing access to market opportunities, increasing income and improving a household's asset base (ILRI, 2006; Randolph et al., 2007). Animal agriculture may also offer a positive spillover effect on the local community by increasing the availability of nutritious but perishable foods that might not be provided through external markets. As livestock development can affect the local food economy, it could be expected to have a disproportionately strong impact on food security compared to its poverty effect. In addition to the direct provision of ASF, livestock can enhance crop productivity through supply of manure and draft power (Otte et al., 2012). While animal production can divert food crops into feed, livestock may also convert low value, unpalatable and even inedible materials into nutrient dense foods (Smith et al., 2013).

Animal products such as milk, meat, and eggs contribute to enhanced food utilization through their nutrient density. Essential nutrients which are lacking in plant based foods are naturally more bioavailable in animal products (Smith et al., 2013). 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). Adding a small amount of ASFs to staple based diets can contribute to food security by improving the quality of diet substantially (Murphy and Allen, 2003).

Despite the potential contributions of animal agriculture to development, the livestock sector is often neglected in development policy in Africa. Alary et al. (2011) argued that although some African countries consider livestock as an important sector, cereal crops have received far more attention in policy papers, empirical analysis, and policy initiatives. One reason for limited government commitment to livestock development could be the absence of rigorous analysis to quantitatively measure the contributions livestock make.

In the Copperbelt Province of Zambia, ownership of livestock, aside from poultry, has been rare until recently. Despite the natural potential for crop and livestock production, previous reliance on mine employment had left little livestock development. In this context, Heifer International-Zambia (HI-Zambia), has been sponsoring livestock donation with coordinated training to enhance both human and social capital. The core of the program is to transfer pregnant livestock to selected families who will pass on the first female offspring to other project families. The type of animal transferred depends on the environmental and market context, as well as the capacities of the target families. HI-Zambia emphasizes a multifaceted approach that attempts to build the capacities of the individual families they support and of groups of families that embody social capital to provide services to the members after the formal close of the NGO program. Social capital is developed through a coordinated training on various social issues such as sharing and caring, self-help group formation, benefits of collective action, group self-reliance, and business management. Other support includes regular monitoring and evaluation, continued training, establishment of basic veterinary service providers, establishment of cooperatives, and intermediation with marketing agents. In addition, the requirement that beneficiaries 'pass-on' livestock and knowledge reinforces social capital for sustained impact.

3. Research methods

3.1. Data

This research took advantage of the rollout of a livestock donation program by HI-Zambia to establish a field experiment that enabled the measurement of treatment effects. As in Jodlowski et al. (2016) we use the rollout of asset transfers to identify current recipients of livestock and future recipients. Since both current and future recipients are subject to the same selection processes, we avoid problems of selection bias. Moreover, we are able to identify future recipients who are spatially and socially remote from the current recipients and those that are in close physical and social proximity. This distinction allows for identification of spillover effects.

Prior to this research activity, HI-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. All groups selected for eventual support were required to demonstrate appropriate membership with respect to households' capacity and needs, cohesiveness of the group, and other eligibility criteria includ-

ing a commitment to assemble appropriate equipment, construct animal sheds, and make other preparations. The screening implies that the poorest households are ineligible as they may not have resources to maintain the animals while non-poor households are excluded based on asset and income criteria. Since the members of all groups have self-selected to participate, we assume that they are similar to each other in terms of relevant non-observable factors, though they may not be typical of the population at large.

Groups that are selected for inclusion receive support in a sequence that reflects the timing of their application. A queue is formed based on timing of application in order to determine rollout of support across the groups. Some eligible groups receive services in an initial round of donations and other groups, classified as "prospective", must wait until resources are available for more donations. In this study, households from farmer groups in three communities that had been selected to receive livestock donations between November 2011 and January 2012 formed the treatment group for analysis. These groups represented all households in the program area receiving livestock transfers at the time of the baseline survey. In addition, households from two farmer groups from different communities in the same region that had been selected for future support were identified as "Prospectives". These prospective groups were the next groups in line for services. As long as there are no systematic differences between groups based on timing of application, households in "prospective" groups can be used in an impact assessment as a control group for households that receive livestock in the initial distribution. This approach follows suggestions from De Janvry et al. (2010) who note that staggered rollouts can be analyzed similarly to randomized control trials (RCTs) even when they lack explicit randomness.

The second step in the selection process determined which households in the farmer groups selected for services in the first phase of the rollout would receive initial livestock transfers. While all households in the groups receive training and the benefits of enhanced social capital, only a subset of them initially receive donated animals. The specific treatment groups identified through the HI-Zambia rollout are summarized in Table 1.

Households that receive animals in the initial distribution are identified as "Originals". These households receive pregnant animals and are required to pass on the first female off-spring of those animals to other group members, identified as "Pass on the Gift" recipients or "POGs". Key informant interviews with group members indicated that selection of original recipients was random, but the purity of that randomness is not known. The POGs, like the Prospectives, represent future adopters, but their proximity to the Originals implies that they may be subject to spillover effects as well as the benefits of training, neither of which are available to the households in prospective groups. Finally, the analysis identified a group of households in the communities receiving treatment that had chosen not to participate in the farmer groups. These independent households likely differ from the participating households in unobservable ways and are therefore unsuitable as a control group.

Table 1
Treatment and comparison groups.

Group	Treatment	Selection	Services	Location
Originals	Full treatment	Self-selected and screened for participation	Receive services and pregnant livestock at baseline	In treated communities
POG	Partial treatment	Self-selected and screened for participation	Receive immature animals 6–18 months after baseline	In treated communities
Independents	No treatment	Self-selected out of participation	Receive no services	In treated communities
Prospectives	No treatment (comparison group)	Self-selected and screened for participation	Receive no services during period of analysis	In non-treated communities

Data were collected through four survey rounds administered every six months beginning in January 2012 and ending in August 2013. The baseline survey was administered to 324 households and a complete panel of four rounds exists for 300 households. Table 2 describes the baseline survey.

Community 1 and Community 2 did not receive animals or services during the survey period. Households surveyed in the treated villages- Communities 3, 4, and 5- are either Originals, POGs, or Independents. In all cases pregnant animals were delivered and farmers received training well before animals were transferred. Based on the ecological and market conditions of the three villages, group members received either one pregnant dairy cow, two pregnant draft cattle, or seven female meat goats. When cattle were distributed the groups received one bull to share as a group to service the females. A male goat was given to each goat recipient in addition to the seven females. The total value of the asset transfer was similar regardless of the species transferred.

The baseline survey covered 106 Originals, 111 POGs, 67 Prospectives and 40 Independents. Attrition left a panel of 102 Originals, 100 POGs, 66 Prospectives, and 32 Independents. The attrition rate of the full sample is 3.1%, 3.7% and 4.9% in the second, third and fourth survey rounds, respectively. We find no obvious pattern in attrition. The Originals and Prospective groups have fairly low attrition rates, 3.8% and 1.5%, respectively compared to the POGs (10%) and the Independents (20%). Jodlowski et al. (2016) presents a more complete analysis of attrition in this sample and finds no evidence of bias.

3.2. Difference-in-difference (DID) framework

Taking advantage of the panel data available, we use the difference-in-difference (DID) method to measure the impact of the intervention. Combined with fixed effects estimation, the DID approach corrects for endogeneity that may arise from unobserved individual effects (Bertrand et al., 2004). Within the DID framework we are able to accommodate the fixed effects model for normally distributed outcome variables, the poisson model for outcomes measured in count data, and the probit model for binary outcome variables. We use the DID method with household level fixed effects to estimate the effect of treatment on expenditures and revenues.[1] As we have a panel of multiple treatment groups defined by species of animal received across 4 periods, the empirical model (Eq. (1)) includes multiple dummy variables for time and treatment. Eq. (1) is equivalent to the DID model specification for multiple time periods and multiple treatment groups suggested in Wooldridge (2010). We do not include dummy variables for the three treatment groups (Originals, POG, and Independents) in this presentation as time invariant factors do not

[1] This method is similar to the approach used in Jodlowski et al. (2016) but it differs from Jodlowski et al. (2016) by the inclusion of data on independents and by considering POGs as a different treatment group rather than part of the comparison or control. These differences in specification were adopted in order to expose behavioral differences between independents and other groups and because results from earlier study found evidence of a spillover effects in milk consumption on POGs which indicates that POGs would not be appropriately included in the control group when considering consumption of specific food items and food groups, which is the case in this study.

Table 2
Survey characteristics and attrition.

Community	Species	Total	Treatment status			
			Originals	POGs	Independents	Prospectives
Panel A						
1	None	31				31
2	None	35				35
3	Cow	83	31	40	12	
4	Goat	100	51	41	8	
5	Draft	51	20	19	12	
Total		300	102	100	32	66
Treatment status	Round 1	Round 4	Attrition (%)	Panel	Attrition (%)	Attrition
Panel B						
Originals	106	103	2.8	102	3.8	−4
POGs	111	104	6.3	100	9.9	−11
Independents	40	35	12.5	32	20	−8
Prospectives	67	66	1.5	66	1.5	−1
Total	324	308	4.9	300	7.4	−24

Notes. Communities 1 and 2 are comparison groups for this study. These communities were selected for the program but they have not received the program yet. All other communities are treatment communities but not everyone in these communities received animals and training.

contribute to the fixed effects estimation.

$$y_{it} = \alpha_0 + \sum_{t=2}^{4}\beta_t \text{Round}_t + \sum_{t=2}^{4}\delta_t \text{Original}_{it} + \sum_{t=2}^{4}\gamma_t \text{POG}_{it} + \sum_{t=2}^{4}\lambda_t \text{Indp}_{it} + \Pi X + c_i + \varepsilon_{it} \quad (1)$$

In Eq. (1), i indicates the household and $t = 2, 3, 4$ represents the time period for survey rounds after the baseline. Thus, y_{it} is the outcome of interest for household i at time t, $Round_t$ is a time dummy variable equaling 1 for rounds 2, 3, or 4 and 0 otherwise, and $Original_{it}$ is the interaction of ($Round_t$) and the full treatment ($Original_i$). $Original_{it}$ equals 1 for original households in round 2, 3, or 4 and 0 otherwise. Similarly, POG_{it} is the interaction between time dummy ($Round_t$) and the partial treatment (POG_i) and $Indp_{it}$ is the interaction between time dummy ($Round_t$) and households that selected out of participation ($Indp_i$). Although the Independents are not eligible for program participation, we include them in the analysis in order to see how their outcomes differ from those of the comparison group of untreated households that are selected for participation (Prospectives). In Eq. (1): β_t is a time-varying effect; δ_t is a true program effect in that it is the difference in mean difference between original (treatment) and prospective (comparison) households; γ_t is the combined effect of the program's 'Pass on the Gift' initiative and spatial or social spillovers and; λ_t is the effect of program ineligibility but may include a spatial spillover effect as well. Finally, c_i is a household level fixed effect, X is a vector of control variables and Π is a matrix for estimated coefficients for elements of X. In this case, X includes gender and marital status of household head, and binary indicators for positive and negative shocks. Positive shocks include new job, business expansion, new source of income, or large gift in the last 6 months, and negative shocks include serious illness, theft or robbery, loss in business or job, natural disaster, crop failure, or loss of main income source in the last 6 months.

Eq. (1) may be applicable when the outcome under study is represented with continuous data. This condition does not hold for all the variables of interest in this paper. The frequency of consumption of specific food items may reflect how people's consumption behavior changes in response to asset transfer and is therefore of interest here. Consumption frequency is reported in the count of days with consumption per week and is estimated using a poisson regression. Since, estimating the poisson regression with the time-invariant individual effect leads to the incidental parameter problem,[2] we combine the poisson model with the Chamberlin-Mundlak approach (Mundlak, 1978). This correlated random effect approach allows the unobserved effect (c_i) to be correlated with the control variables, x_{it}. We estimate the resulting Eq. (2) by Quasi-Maximum Likelihood (QMLE) method and obtain a consistent estimate of the treatment effect, β.

$$E(y_{it}|x_{it},\bar{x}_i) = \exp\left(\sum_{t=2}^{4}\beta_t \text{Round}_t + \sum_{t=2}^{4}\delta_t \text{Original}_{it} + \sum_{t=2}^{4}\gamma_t \text{POG}_{it} + \sum_{t=2}^{4}\lambda_t \text{Indp}_{it} + \Pi X + \theta\overline{X}\right) \quad (2)$$

where the covariate vector X includes all control covariates, and $\overline{X}$ includes time constant mean of the control covariates. Control covariates include household size, number of children 5 or under, age, gender, and marital status of household head, number of sheep, number of pigs, and dummy variables for positive and negative shocks. In Eq. (2) estimation of the treatment effect on consumption frequency is carried out by regressing consumption frequency on dummy variables for treatment and time as well as control covariates, (x_{it}) and their time constant averages ($\overline{x_i}$) with a constant included in the pooled poisson model. From Eq. (2), $\delta_t = \log(\mu_1) - \log(\mu_o)$ and $\exp(\delta_t) = \frac{\mu_1}{\mu_0}$. The incidence rate ratio, $\exp(\delta_t)$, is interpreted as a count of times the change in the outcome variable differs between the treated and control groups.

Subjective poverty outcomes are measured with binary response variables. Following Wooldridge (2010) and Mundlak (1978), we estimate the treatment effects on subjective outcomes using the pooled probit method.[3] Thus, the correlated random effect approach presented in Eq. (2) is adopted for the probit model to estimate the impact on subjective poverty measures. In particular, we assume that the unobserved effect (c_i) is normally distributed and correlated with the control variables (x_{it}), i.e. $c_i \sim N(\alpha + \theta\bar{x}_i, \sigma_u^2)$. The resulting equa-

[2] Estimating a poisson fixed effects model resulted in loss of 221 observations because outcome variables which equal 0 across all time periods, ($y_{it} = 0\ \forall\ t$) did not contribute to the estimation.

[3] The probit fixed effects model is not available and the logit fixed effects model is not appropriate. Under the logit fixed effect, observations with time invariant outcome i.e. $y_{it} = a\ \forall\ t$ do not contribute to the estimation of causal effect implying the loss of over 300 observations with the logit fixed effect.

tion below gives the consistent estimate of the treatment effect.

$$P(y_{it}|x_{it},\bar{x}_i) = \Phi\left(\sum_{t=2}^{4}\beta_t \text{Round}_t + \sum_{t=2}^{4}\delta_t \text{Original}_{it} + \sum_{t=2}^{4}\gamma_t \text{POG}_{it} + \sum_{t=2}^{4}\lambda_t \text{Indp}_{it} + \Pi X + \theta\overline{X}\right) \quad (3)$$

Similar to Eq. (2), we estimate Eq. (3) by pooling the data and regressing the outcome variable on dummy variables for treatment and time, x_{it}, and $\bar{x}_i$ with a constant included in the pooled probit model.

3.3. Outcome variables

Analyses of the impact of asset transfer programs often focus on consumption expenditures to gauge poverty impacts and dietary diversity to measure household food security effects (Banerjee et al., 2015; Jodlowski et al., 2016). After identifying an impact on expenditures poverty, we examine expenditures by consumption category considering food and non-food aggregates and also considering specific food groups that represent staples and luxury food items in the local economy. Food expenditure includes the value of home produced foods that are consumed by the household economy. Increased consumption of luxury items can be taken as evidence that the treatment has led to a qualitative change in welfare, even if the absolute value of consumption remains low.

Similarly, we estimate an impact on dietary diversity and then examine dietary composition. Dietary diversity is measured as the total count of food groups consumed at home in the past 24 h from a set of 13 possible groups, each containing multiple food items. Our classification of 13 food groups is consistent with FAO's guidelines for household dietary diversity (Kennedy, Ballard, and Dop 2011), but we merged 'other vegetables' with 'green leafy vegetables', 'flesh meat' with 'organ meat', and 'beverages/spices' with 'sweets' reducing the number of groups from 16 to 13. The 13 food groups included are: cereals, white tuber, yellow/orange tuber, vegetables, orange/red flesh fruits, other fruits, meat/chicken, eggs, fish, legumes/nuts/seeds, milk and milk products, oils and fats, and sweets/beverages. We then examine the frequency of consumption of specific food items as another indicator of change in consumption mix and also to assess how any increase in dietary diversity corresponds to consumption of nutrient dense foods. Consumption frequency is measured as the number of days a household consumed food items from a particular food group over the last 7 days.

Increased expenditures on luxury items or increased frequency of consumption of such items is taken as evidence of a qualitative shift in economic status. Absence of such a shift would suggest that any increases in consumption expenditures have not been sufficiently large to alter beneficiaries' sense of economic wellbeing or security. If the change in consumption has been sufficiently large to trigger a greater sense of economic wellbeing, we would expect subjective self-assessment of poverty status to have changed. Therefore we examine whether changes in subjectively reported poverty status are consistent with observed changes in composition of consumption.

Various protocols for eliciting subjective assessments of welfare have been developed (Pradhan and Ravallion, 2000; Gustafsson et al., 2004). Although subjective measures themselves are difficult to validate, they provide a means to confirm whether perceptions of changes in economic status are consistent with the observed changes in consumption patterns (Ravallion, 2012; Carletto and Zezza, 2006). One advantage of these measures is that they implicitly include the utility people receive from community-level or non-market goods, rather than just utility from private consumption. We constructed the subjective measure, 'Feeling Poor', combining two different poverty questions. The first question asks about the self-sufficiency of the household and the second question assesses whether household circumstances are getting better over time. 'Feeling Poor' equals 0 if the respondent thinks the household always had at least enough resources to sustain itself or it is getting better over time. If the respondent thinks the household needs help or the situation is getting worse over time, then 'Feeling Poor' equals 1.

Subjective measures of food security can also suggest whether a household's status has been substantively changed by the asset transfer. There exist well developed methods for eliciting self-perceived food security status such as the Household Food Insecurity and Access Scale developed by USAID's FANTA project (Headey and Ecker, 2012). In this study, a household is classified as feeling food secure if the respondent chooses either of the first two responses from the question: "When you think about what you can feed your household, which of these best describes your situation? (a) Always able to feed my family enough of the foods I want to give them, (b) Always able to feed my family enough food, but not always the variety of foods I want to give them, (c) Usually able to feed my family enough food, but not the variety I want to give them, and (d) Usually unable to feed my family enough food or the variety I want to give them."

4. Results

4.1. Summary statistics

Table 3 presents summary statistics for outcome variables at the baseline.

Salient features of the sample include, first, that households report very low consumption expenditures in the baseline, with mean expenditures levels in most groups well below the $1.25/day international poverty line. Second, food insecurity appears prevalent in the sample, as a large share of expenditures is devoted to food for all groups, consumption of nutrient-dense ASF is rare, and the majority of households report that they do not feel food secure. The last two columns in Table 3 present balance tests based on normalized differences (ND)[4] between the Originals (treatment group) and Prospectives (comparison group) and between the Originals and POGs, respectively. Imbens and Wooldridge (2008) suggest that two groups can be considered different in observables when the value of normalized difference exceeds the threshold level of 0.25.

Based on the normalized difference in baseline values (ND1), Prospective households appear to be slightly better off than the original recipients at the baseline in some dimensions but those differ-

[4] Normalized differences (ND) are calculated as $\Delta X = \frac{\overline{X_1} - \overline{X_0}}{S_1^2 + S_0^2}$ where $\overline{X}_i$ and S_i^2 are sample mean and variance of covariates (X) for treated and control groups. This approach is preferred to the simple *t*-test because it does not vary with sample size.

Table 3
Summary of outcome variables in baseline.

Variable	Originals	POGs	Independents	Prospectives	ND1	ND2
Total expenditure ($/day)	0.96	0.93	0.84	1.37	−0.32	0.03
	(0.695)	(0.585)	(0.584)	(0.957)		
Food expenditure ($/day)	0.51	0.52	0.51	0.72	−0.35	−0.03
	(0.283)	(0.386)	(0.362)	(0.494)		
Livestock revenue ($/day)	0.07	0.12	0	0.032	−0.11	−0.07
	(0.335)	(0.582)	(0)	(0.114)		
Household dietary diversity score	5.765	5.690	5.563	5.64	0.05	0.03
	(1.862)	(1.650)	(1.318)	(1.935)		
Days milk served/week	1.32	1.01	0.75	1.64	−0.09	0.12
	(2.13)	(1.967)	(1.646)	(2.647)		
Days meat served/week	1.01	1.19	0.81	1.23	−0.14	−0.11
	(0.949)	(1.426)	(0.859)	(1.275)		
Feeling poor (1 = Yes, 0 = No)	0.63	0.75	0.81	0.86	−0.37	−0.18
	(0.486)	(0.435)	(0.397)	(0.346)		
Food secure (1 = Yes, 0 = No)	0.37	0.39	0.31	0.38	−0.01	−0.02
	(0.486)	(0.490)	(0.471)	(0.489)		
Observations	102	100	32	66		

Notes. Point estimates are mean; Standard deviations are in parentheses. ND1 and ND2 are Normalize Differences between Originals and Prospectives and Originals and POGs, respectively. All monetary values are in $/day per-capita. The exchange rate used is 1 USD = 5000 Kwacha.

ences should not affect the analysis as long as the explanatory variables are not qualitatively different. Other response variables such as livestock revenue, milk consumption days, meat consumption days, and dietary diversity are not significantly different between treated and control groups. Baseline dietary diversity scores are similar for all groups and all of them consume milk and meat products only about one day per week. Overall, treated and control groups look similar in the baseline survey. Similarly, all the values of normalized difference between the Original and POG groups (ND2) are well below the threshold level. Hence, the POGs and Originals also are similar in observable characteristics, supporting the information from key informant interviews that selection across these two groups was random. Table 4 summarizes characteristics of households, household heads, and assets in the baseline survey. In addition to confirming similarity across the treatment and comparison groups in the baseline, these data reveal the very limited use of livestock in farming systems prior to the intervention.

Ownership of cattle and goats is very low among sample households at the baseline. The values of normalized differences in the fifth column of Table 4 indicate that the Original and Prospective groups are similar in all characteristics but household size. The difference in household size should not affect the analysis because household size is essentially time invariant for the period of our study and not included in the DID framework. The normalized differences in the last column of Table 4 indicate that the Originals and POGs are similar in all characteristics but age of the household head. We find no statistically significant differences in asset ownership in the baseline.

4.2. Impact on consumption expenditure

This analysis begins by estimating the impact of the program intervention on broad measures of poverty over time and across the species of animal transferred. In so doing we document the evolution of the impact at six month intervals and confirm the results of other analyses that used this data set. We then extend previous analysis by examining changes in the composition of consumption and in subjective assessments of wellbeing.

Results concerning consumption expenditures and livestock revenue are presented in Table 5. All outcome variables are log-transformed to smooth their distribution and results are obtained by estimating Eq. (1) with the fixed effects model. Results indicate that 18 months after the livestock distribution, receipt of an animal resulted in a 20% increase in total consumption expenditures which implies an absolute increase of about US$0.20 per day per person. Six and 12 months after the intervention the growth in consumption expenditure is 22% and 26%, respectively. In dollar values, these growth rates imply an absolute increase in per-capita expenditure from $0.96/day at the baseline to $1.18/day after 6 months, $1.21/day after 12 months, and $1.15/day after 18 months. These results confirm (Jodlowski et al., 2016; Banerjee et al., 2015) in that the livestock transfer has a rapid, persistent, and statistically significant impact on consumption, but one that leaves initially impoverished households at low levels of absolute consumption.[5]

Although all animal recipients have moved close to the absolute poverty threshold of $1.25/day, the measured impact still has left the households at a low level of consumption, well below the $2.00/day poverty line. Whether this increase has been sufficient to transform consumption patterns is examined below. As with total consumption, the impact of livestock donation on the value of food consumption is positive, rapid, persistent, and statistically significant. After controlling for other factors, the growth in food expenditure (including the value of home produced foods and gifts) among the Originals is 24% after 6 months, 27% after 12 months and 28% after 18 months. These impacts translate to an increase in per-capita daily food expenditure from $0.51 at the baseline to $0.65 after 18 months. The pattern of growth in livestock revenue suggests the mechanism through which livestock donation increases consumption expenditure. All animal recipients generate income by selling animal products or services.

The growth in livestock revenue came to about 200% over18 months. Daily per-capita livestock revenue increased from $0.07 at the baseline to $0.24 after 18 months of intervention. Despite the growth in income, there is negligible growth in non-food expenditure. This result may be partly driven by the large contribution of home produced animal source foods to consumption. But the failure to diversify increased income into non-food consumption raises questions about how transformative the asset transfer has been. Unlike the originals recipients, the POG and independent households show almost no impact on expenditure growth or livestock revenue.

The POGs do show a statistically significant increase in the value of food expenditures 18 months after the intervention. This impact could reflect spillovers caused by changes in the local food economy due to the increased availability of milk locally. Dairy cow recipients reported selling about one liter of milk per day locally, while five to eight liters was sold daily into a national market through a collection center. Evidence of the spillover effect is not visible among the Independents. Food consumption growth among the POGs and not the Independents may imply a difference in preferences among the two groups or may reflect spillover effects that are social rather than purely spatial.

[5] Results differ slightly from those reported in Jodlowski et al. (2016) primarily because Jodlowski et al. includes POGs in the control group and excludes Independents from the analysis.

Table 4
Summary of household characteristics in baseline.

Variable	Originals	POGs	Independents	Prospectives	ND1	ND2
Household size	7.40	7.08	5.97	5.67	0.45	0.08
	(2.833)	(2.809)	(2.362)	(2.073)		
Number of children 5 or under	1.18	1.29	1.06	1	0.13	−0.08
	(1.009)	(0.935)	(1.045)	(0.911)		
Number of children 6–16	2.40	2.56	2.03	1.79	0.27	−0.07
	(1.643)	(1.748)	(1.534)	(1.398)		
Household head characteristics						
Age	50.53	43.54	42.38	45.12	0.27	0.37
	(12.35)	(12.37)	(12.14)	(14.75)		
Education	2.90	3.10	3.16	2.91	−0.003	−0.09
	(1.432)	(1.570)	(1.868)	(1.296)		
Gender (1=Female, 0=Male)	0.29	0.26	0.31	0.21	0.13	0.05
	(0.458)	(0.441)	(0.471)	(0.412)		
Married (1 = Yes, 0 = No)	0.81	0.89	0.78	0.79	0.04	−0.15
	(0.391)	(0.314)	(0.420)	(0.412)		
Household assets						
Cultivated land (HA)	4.66	3.94	1.91	2.65	0.27	0.05
	(6.545)	(3.802)	(1.371)	(2.921)		
Number of cattle	0.89	0.60	0	0.61	0.10	0.09
	(2.320)	(2.287)	(0)	(1.528)		
Number of goats	0.92	1.60	0.19	1.24	−0.05	−0.10
	(5.762)	(3.370)	(0.896)	(2.327)		
Number of sheep	0.25	0.48	0	0.045	0.15	−0.095
	(1.347)	(1.925)	(0)	(0.369)		
Number of pigs	0.56	0.21	0.75	1.47	−0.08	0.17
	(1.838)	(0.967)	(2.170)	(10.63)		
Own TV (1 = Yes, 0 = No)	0.48	0.38	0.12	0.39	0.12	0.14
	(0.502)	(0.488)	(0.336)	(0.492)		
Own Bicycle (1=Yes, 0=No)	0.86	0.82	0.72	0.86	−0.002	0.08
	(0.346)	(0.386)	(0.457)	(0.346)		

Notes. Point estimates are mean; Standard deviations are in parentheses. ND1 and ND2 are Normalize Differences between Originals and Prospectives and Originals and POGs, respectively.

Table 6 presents the effects on consumption expenditures by species. In this estimation the treatment periods are defined as baseline and post-treatment with post-treatment period consisting of all three follow up rounds. Treatment effects are therefore the average across the effects after six months, 12 months and 18 months. Results indicate that dairy cow recipients increase their total consumption expenditures by about 24% and the value of food consumption by 36% but experience no change in non-food expenditures.

The average consumption expenditure growth in the goat recipients is about 20% with no impact on non-food expenditure. Those who received draft cattle had a 28% increase in total consumption expenditure and 41% increase in non-food expenditures but no change in the value of food consumption. Further calculations show that these changes translate to a growth in total expenditure from $0.98/day to $1.22/day among dairy cow recipients, $0.95/day to $1.14/day among goat recipients, and $0.95/day to $1.22/day among draft cattle recipients. Increase in the value of food consumption (including the value of home production that is consumed) for dairy cow and goat recipients but not for draft cattle recipients suggests that having the option for direct consumption of ASF affects the consumption pattern. The increased consumption of non-food items by draft cattle recipients may signal a qualitative change in consumer behavior; it is not immediately clear whether such a change occurred for meat goat and dairy cow recipients.

Unpacking the food expenditures into specific food items provides insight about the practical significance of the increases in the value of consumption identified above. Examination of specific patterns of consumption can suggest whether households achieve a level of economic security that allows them to diversify their consumption patterns or not. In particular, we can assess whether there has been an increase in consumption of items that are luxuries in the local setting, such as milk, meat, and rice which have income elasticities of demand a 2.4, 2.1, and 2.7, respectively. Maize and cereals, in contrast had estimated income elasticities of 0.7 and 0.9 using baseline data. Further, the analysis can suggest whether the type of product produced by livestock (milk, meat or draft power) influences the consumption pattern of the owner.

Table 7 presents expenditures for individual food items by species of animal received. As expected, dairy cow recipients increased the value of milk and milk products consumed dramatically (by 421% compared to Prospectives), but also increased consumption of sweets and beverages by 91%. Growth in food expenditure among the draft cattle and goat recipients is explained by the growth in rice consumption, which is served as an occasional alternative to the primary staple, maize.

Although the POGs had no growth in food expenditure in aggregate, they consumed significantly higher values of meat (88%) and milk (115%) products after treatment. The results imply that the local food environment has been changed after the intervention as households that did not receive animals are also changing the composition of their food expenditures. Program participants consuming more of rice and sweets and beverages along with animal products suggests that the mechanisms for changes in composition of food expenditures have included market participation as well as direct consumption. Moreover, while growing expenditures on maize indicate greater consumption of the staple that could be consistent with persistent poverty, diversification of consumption into foods that represent luxury items in the local context signals substantive economic transition.

Table 5
Impact on poverty measures over time.

	Expenditures			Livestock revenue
	Total	Food	Non-food	
Original 2	0.224**	0.236**	0.166	2.417***
	(0.103)	(0.116)	(0.145)	(0.662)
Original 3	0.261***	0.267**	0.287**	2.485***
	(0.0969)	(0.116)	(0.134)	(0.728)
Original 4	0.200*	0.279**	0.0252	1.790**
	(0.115)	(0.117)	(0.174)	(0.768)
POG2	0.0183	0.0790	−0.0185	−0.195
	(0.109)	(0.125)	(0.145)	(0.517)
POG3	0.0722	0.0691	0.140	−0.341
	(0.0991)	(0.119)	(0.140)	(0.634)
POG4	0.148	0.307**	−0.0876	−0.890
	(0.122)	(0.130)	(0.175)	(0.697)
Independent 2	0.155	0.0477	0.300	1.135***
	(0.146)	(0.160)	(0.211)	(0.350)
Independent 3	0.121	−0.0187	0.374*	0.621
	(0.139)	(0.161)	(0.225)	(0.552)
Independent 4	0.151	0.174	−0.292	0.327
	(0.163)	(0.174)	(0.412)	(0.624)
Observations	1200	1200	1200	1200

Notes. Standard errors in parentheses.
Dependent variables are log of expenditures and livestock revenue. Both expenditures and revenue are in Kwacha per-capita per week. The full specification of the estimated model is:

$$\ln y_{it} = \beta_0 + \sum_{t=2}^{4}\beta_t Round_t + \sum_{t=2}^{4}\delta_t Original_{it} + \sum_{t=2}^{4}\gamma_t POG_{it} + \sum_{t=2}^{4}\lambda_t Indp_{it} + \Pi X + c_i + \varepsilon_{it}$$

where X = (dummy variables for female head, marital status, positive shock, negative shock).
Original_i,POG_i and Independent_i for i = 2, 3, 4 are 'treatment' dummies. For example, Original 2 equals 1 for all Originals in the second survey round, and Original 4 equals 1 for all Originals in the final round and 0 otherwise.
Level of significance:

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

4.3. Impact on diet

Table 8 presents the impact of the intervention on dietary diversity and frequency of consumption of specific foods by animal species transferred. Results indicate that recipients diversify their diet by about one more food group per day ($e^{0.20} = 1.2$). These impacts on aggregate dietary diversity are similar to those reported in Jodlowski et al. (2016). To further understand the significance of this increase in dietary diversity, we estimate the impact of the program on the consumption frequency (days per week) of specific food groups using the model specified in Eq. (3).

The estimated coefficients are log difference of expected consumption frequencies or simply a percentage change. As expected, milk consumption among the treated households has increased over time. All groups except the Independents increased milk consumption frequency by two to five days per week. Compared to the Prospectives, the dairy cow recipients consume milk and milk products about 5 ($e^{1.57} = 4.9$) more days per week. The meat goat and draft cattle recipients did increase consumption frequency by about 2 more days per week compared to the Prospective group and POGs have a significant but smaller increase confirming the spillover effect shown in the expenditures data (Table 8).

Table 6
Impact on poverty measures by animal species.

Recipients	Expenditures			Livestock revenue
	Total	Food	Non-food	
Dairy Cow	0.241**	0.363***	−0.0780	7.009***
	(0.116)	(0.117)	(0.188)	(0.650)
Meat goats	0.202*	0.220*	0.203	−0.437
	(0.104)	(0.121)	(0.144)	(0.682)
Draft cattle	0.277**	0.208	0.413**	1.667**
	(0.125)	(0.132)	(0.196)	(0.702)
POG	0.0795	0.152	0.0102	−0.478
	(0.0903)	(0.104)	(0.124)	(0.548)
Independent	0.142	0.0677	0.127	0.709*
	(0.128)	(0.139)	(0.235)	(0.429)
Observations	1200	1200	1200	1200

Notes. Standard errors in parentheses.
Dependent variables are log of expenditures and livestock revenue. Both expenditures and revenue are in Kwacha per-capita per week. The full specification of the estimated model is:

$$\ln y_{it} = \beta_0 + \sum_{t=2}^{4}\beta_t \text{Round}_t + \delta_1 \text{Cow} + \delta_2 \text{Goat} + \delta_3 \text{Draft} + \gamma \text{POG} + \lambda\ \text{Independent} + \Pi X + c_i + \varepsilon_{it}$$

X is a vector of covariates, i.e. X = (dummy variables for female head, marital status, positive shock, negative shock).
Cow, Goat, Draft, POG, and Independent are treatment dummy variables equal to 1 for the specific treatment in the follow-up rounds and zero otherwise (eg. Cow equals 1 for all cow recipients in all follow-up rounds and zero otherwise).
Level of significance:

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table 7
Impact on various food expenditures by animal species.

Recipients	Rice	Meat	Milk	Oil	Sweets/ beverages	Maize
Food expenditures						
Dairy cow	0.433	0.478	4.210***	0.456	0.911**	1.119**
	(0.926)	(0.488)	(0.765)	(0.453)	(0.413)	(0.486)
Meat goat	1.253*	0.805	1.070	0.307	0.278	0.0441
	(0.657)	(0.648)	(0.654)	(0.363)	(0.262)	(0.226)
Draft cattle	2.298***	0.716	0.836	0.242	−0.119	0.187
	(0.828)	(0.724)	(0.954)	(0.393)	(0.278)	(0.258)
POG	0.528	0.878*	1.152**	0.286	−0.0328	0.650***
	(0.643)	(0.481)	(0.522)	(0.281)	(0.223)	(0.247)
Independent	0.915	0.327	0.287	0.466	0.273	0.910*
	(0.801)	(0.727)	(0.673)	(0.367)	(0.417)	(0.487)
Observations	1200	1200	1200	1200	1200	1200

Notes. Standard errors in parentheses.
Dependent variables are log of food expenditures. All expenditures are in Kwacha per-capita per week.
Level of significance:

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

The results on milk consumption imply that animal recipients are consuming more milk because either they have new home production, or they now have enough income to buy milk, or milk has become more available in their community. Community level data show that milk has become more affordable as increased milk availability has driven down the local milk prices from 5000 kwacha per liter in the baseline to 3000 kwacha per liter in the final round. Over the 18 month period, the local milk price fell further in cow recipient villages, to 2300 kwacha per liter. Reasons behind the Independents not taking advantage of the milk spillover could be economic, social, or

Table 8
Impact on food security measures by species.

	HHDDS	Consumption frequency				
		Milk	Meat	Cereal	Oil	Sweets/beverages
Dairy cow	0.200***	1.570***	0.0362	−0.00343	0.0340	0.189***
	(0.0470)	(0.0801)	(0.107)	(0.0490)	(0.0501)	(0.0548)
Meat goat	0.00814	0.685***	0.339***	−0.00206	−0.0301	0.0664
	(0.0432)	(0.0878)	(0.0863)	(0.0425)	(0.0446)	(0.0505)
Draft cattle	0.207***	0.765***	−0.0258	0.0201	0.0244	0.150**
	(0.0550)	(0.105)	(0.125)	(0.0566)	(0.0588)	(0.0646)
POG	0.0566	0.478***	0.0191	−0.000172	−0.0138	0.0314
	(0.0352)	(0.0800)	(0.0796)	(0.0363)	(0.0378)	(0.0433)
Independent	−0.0283	−0.147	−0.129	−0.0127	−0.0131	0.0326
	(0.0505)	(0.123)	(0.111)	(0.0482)	(0.0503)	(0.0573)
Observations	1199	1199	1199	1199	1199	1199

Notes. Standard errors in parentheses.
Dependent variable in the first column is household dietary diversity score (HHDS) and rest of the dependent variables are number of days a food item is consumed in last week (counts). Results are obtained from the pooled poisson regression.
Level of significance:
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

cultural. While the local market appears to be saturating with milk, the bulk of production is sold into the national market through collection centers where the price remained stable throughout the period.

None but the goat recipients increased consumption of meat (2 more days per week) suggesting no evidence of income and price effects on meat consumption among other animal recipients. The intervention has no impact on the frequency of cereal or oil consumption, which were generally consumed daily in the baseline. Dairy cow and draft cattle recipients consumed sweets and beverages one more day per week as a result of treatment. This growth in non-nutritious food intake is much smaller than the growth in milk consumption, implying that the impact on dietary diversity is primarily from increased consumption of nutritious food items. The increase in ASF consumption may be a combination of both income and price effects. Spillover effects in ASF consumption seem limited to POGs (who are consuming milk and meat more frequently) and do not reach to the Independents. Overall, the results indicate a gradual shift from staple foods to more luxury food items.

4.4. Subjective assessment of poverty and food security

Subjective measures of poverty and food security reinforce the impression that households who received animals have achieved a level of security despite their fairly low absolute consumption expenditures. Table 9 presents the impact on the subjective assessment of poverty and food security over time.

Since the response variables ("Feeling Poor" and "Food Secure") are binary, the treatment effect on subjective measures is estimated with the pooled probit model.[6] Results indicate that the predicted probability of "feeling poor" among the treated households has decreased over time. All animal recipients are less likely to feel poor after treatment but the POGs report no change relative to the Prospectives while the independent households claim to feel poor with increased frequency.

[6] Full specification of the pooled probit model includes all time dummy variables, the following controls and their time averages. Controls: household size, kids age 5 or under, age of head, female head, married, number of sheep, pigs, chickens, positive shock, and negative shock.

Table 9
Impact on poverty and food security measures.

	Feeling poor	Food secure
Dairy cow	−1.360***	0.594***
	(0.270)	(0.169)
Meat goats	−0.339**	0.0677
	(0.155)	(0.149)
Draft cattle	−0.694***	0.181
	(0.239)	(0.196)
POG	0.153	−0.0868
	(0.129)	(0.127)
Independent	0.425**	−0.283
	(0.167)	(0.176)
Observations	1200	1200

Notes. Standard errors in parentheses.
Both dependent variables are binary. Feeling poor equals 1 if people are feeling relatively worse and 0 if feeling same or better. Food secure equals 1 if people feel food secured and 0 if they feel otherwise. Results are obtained from the pooled probit regression.
Level of significance:
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Although dairy cow recipients are feeling less poor and more food secure, those who received goats or draft cattle report feeling that they are less poor but no more food secure. Results suggest that even though all treated groups perceive themselves to be better off than the control groups do, draft cattle and meat goat recipients may be less affected than dairy cow recipients. It also suggests that the regular flow of milk from the dairy cows probably contributes to a feeling of food security. The diminished sense of wellbeing among the Independents may reflect material changes not captured elsewhere in this analysis or a subjective feeling of dissatisfaction compared to the improved status of others in the community who have received asset transfers.

5. Conclusion

Rigorous analyses have shown that multifaceted interventions blending asset transfers and other services can have statistically significant impacts on consumption expenditures among impoverished rural households (Jodlowski et al., 2016; Bannerjee et al., 2015). This

paper explored the practical implications of those statistically significant effects by examining the impacts on the composition of consumption and subjective attitudes of program participants. In so doing the paper assesses the behavioral and attitudinal impacts of the changes in expenditures. Taking advantage of differences in the forms of asset transfer (species of animal donated), the analysis yields insights into how specific types of assets may have divergent impacts on composition of consumption.

Results indicate that livestock transfers to extremely poor households coupled with coordinated training on animal management and other themes can increase consumption expenditures, provide additional sources of income, improve dietary quality, and make people feel more prosperous and food secure. As a result of the program, the value of food consumption grew by as much as about 35% and total consumption expenditure by about 25%. However, the increases in expenditures that were observed left most households near or below the absolute poverty line, raising questions about the practical significance of the measured impacts. We find that observed changes in composition of food expenditures suggest that the treated households have achieved a new level of financial and food security, despite low absolute levels of consumption. The modest absolute change in expenditures (about 25 cents per person per day) has triggered a substantial qualitative change in the consumption mix and in perceptions of food security and poverty. Results indicate that livestock donation with complementary services can be an effective tool against hunger and poverty.

Some of the changes in composition of consumption suggest ways in which transfers of livestock may have different effects from other asset transfers. Transfers of livestock that produce food encourage direct consumption of such foods, while transfer of other livestock assets (draft cattle) encourages non-food consumption by the beneficiaries. This result suggests an opportunity to skew expected consumption growth toward food if that were desirable from a policy perspective. Furthermore, growth in the value of milk consumption and in the frequency of milk consumption by the POG households who did not receive livestock donation suggests that the transfers have altered the local food markets in a way that implies community-wide benefits. While a cash transfer could have inflationary impacts on perishable, nutrient dense food items and thereby negatively affect consumption among non-recipients, the transfer of livestock that produce such foods has the opposite effect. Against these potential benefits, transfer of specific assets like livestock implies higher costs of transfer and continued programmatic support and imposes rigidity in programs that could hamper effectiveness. Results suggest, however, that mastery of the details associated with transfers of specific assets can yield practically significant impact.

The pattern of food expenditures growth raises some questions about measurement of impacts in practice and particularly the use of dietary diversity or cereal consumption as an outcome measure. Household dietary diversity measurement normally treats cereals as a food group, thereby pooling rice, maize and other grain consumption. In this case, increased access to food at the household level manifested itself in increased purchase of rice shifting the diet away from maize. This change marks enhanced household food security, but would not be captured in either a household dietary diversity score or in a "revealed preference" approach to food security presented in Jensen and Miller (2010) which considers declining share of expenditures to cereals as a marker of increased food security. In areas where large shares of the population consume a single staple crop, the scope and scale of substitution among cereals in the diet may have important implications for assessing the likely nutritional impact of income growth as well as identifying economic effects.

The growth in consumption of sweets and beverages as a result of the program also raises concerns. That increased access to food manifests itself in greater consumption of bottled beverages and sweets presents a reminder that household food security may not necessarily translate into improved individual nutrition. The observed pattern of consumption may well reflect a larger problem of limited consumer options in rural communities. Low levels of market development in rural Africa mean that an incremental $0.25/day can be spent in very few ways in the local community. If the evolving patterns of consumption reflect limited range of consumer items available, the longer term impact of rising incomes may be to attract a broader array of consumer products into communities, resulting in greater diversification of consumption. If this is the case, public investment to facilitate market development could be a key component to ensuring that any level of income growth allows consumers to exercise purchasing power effectively. Similarly, there may be scope for nutrition education and communication to promote diversification into more nutritious diets as income growth allows changes in composition of consumption.

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