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# Cash Transfers and Management Advice for Agriculture

## Evidence from Senegal

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## INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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# Cash Transfers and Management Advice for Agriculture: Evidence from Senegal

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**Abstract:** This study analyzes impacts of large, one-time cash transfers and farm management plans among farmers in Senegal. Farmers were randomized into groups receiving advisory visits, the visits and an individualized farm plan, or the visits, the plan, and a cash transfer. After one year, crop production and livestock ownership were higher in the transfer group relative to the group that only received visits. Livestock gains persisted after two years. Results suggest that the plans increased crop production in year one, but there is no other evidence that the plans were effective when not accompanied by a transfer.

**Keywords:** Cash transfers, management training, agriculture, livestock

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## 1. Introduction

Approximately 1.5 billion people in less developed countries live in smallholder households, and in sub-Saharan Africa and Asia such households produce 80 percent of food (FAO 2012). Yet in many countries, a large gap exists between potential agricultural productivity and realized productivity (e.g. Gollin, Morris and Byerlee, 2005; Suri, 2011). Although many programs aimed at reducing rural poverty seek to diversify farmer income, increasing smallholder production remains a key component of improving farmer livelihoods. Programs that seek to reduce the productivity gap must address the multiple constraints faced by smallholders, including poorly functioning land and labor markets, as well as constraints related to risk, capital, and information (Jack 2011).

In this paper, we focus on a project to help farmers alleviate two of these types of constraints: capital and information. Although increased access to credit is a common approach to relieving capital constraints, a recent review of the literature on microfinance and its impacts on agriculture suggests mixed impacts of microcredit programs and no impact of microsavings programs (Stewart et al. 2010; Banerjee et al. 2015). Information constraints are most often addressed with technical advice provided through agricultural extension; however, rigorous evaluations of group-style extension programs find little evidence of impacts on anything but farmer knowledge (Waddington and White 2014). In addition, recent programs providing more individualized farmer instruction have continued to show only modest impacts (see, for example, Kondylis, Mueller, and Zhu 2017).[2] In this paper we examine a new approach to alleviating these

[2] Other recent relevant work has sought to maximize the impact of extension services by understanding the role of social learning in technology adoption (BenYishay and Mobarak, forthcoming; Beaman, BenYishay, et al. 2015). This paper takes a different approach, focusing instead on directed, tailored management advice for farmers.

constraints by evaluating the impacts of a two-year program that combined a large, one-time cash transfer and farm management advice for smallholder farmers in Senegal.

This program's goal was to increase production among poor farmers to a level at which they could consistently sell meaningful amounts of excess output. To implement the program, we partnered with the Fédération des Organisations Non-Gouvernementales du Sénégal (FONGS). The project had three main components. First, all participating farmers received monthly advisory visits from an animateur. Animateurs are farmers from the general area trained by the implementing organization; they are not professional extension workers. These visits centered on farm management advice. Second, at the beginning of the season, farmers completed a farm management plan with their animateur to assist them in better managing their resources and completing activities according to a schedule. Third, farmers received a large, one-time transfer of 100,000 CFA francs (approximately US$200), timed near planting. Although the transfer was not conditioned on farmer behavior, farmers were told the funds were for investing in their farms and implementing the management plan. The cash transfer was only given in the first year, whereas the advisory visits and the farm plan were administered for two consecutive years. The program objective was to provide intensive support for a predetermined period and leave farmers sustainably better off.

To evaluate the additive impacts of the farm management plan and the cash transfer, we conducted a cluster randomized control trial in which 600 households were randomly allocated at the animateur level to receive either the advisory visits only, the advisory visits plus the farm management plan, or the advisory visits and farm plan plus the cash transfer.[3] The research design

[3] There was almost a one-to-one correspondence between villages and animateurs—specifically, 109 animateurs worked across 120 villages.

allowed us to disentangle the effects of receiving only the farm management plan from receiving the plan and the transfer.

After one year of implementation, we observed large, positive impacts on agricultural outcomes among farmers who received both the cash transfer and the farm management plan. Data from a midline survey demonstrated large differences in the gross value of agricultural output (GVAO) and in GVAO per hectare relative to the group only receiving advisory visits. Households in the cash transfer group also owned substantially more livestock after one year. These impacts are large compared with the advisory visits only group and the size of the transfers: the increase in GVAO was approximately US$560 (compared with the US$200 transfer) and was 57 percent of the mean GVAO in the group that only received advisory visits. These same figures for livestock were US$830 or 36 percent of the value of average livestock holdings in the advisory visits only group. Other results suggest that impacts were a result of increased investments in agriculture; in particular, we found large increases in the use of chemical fertilizer and reported agricultural expenditures. Overall production was also significantly higher for households in the management plan only group (approximately US$400 more than the advisory visits only group), but there were no corresponding increases in livestock or other evidence of increased agricultural investment. To the extent that the plan increased crop production in the first year, the mechanisms through which those increases occurred appear to be different than the mechanisms through which the cash transfer impacted production.

Following the second year of implementation, endline results did not show continued impacts on crop production among the cash transfer group. The differences in fertilizer use and agricultural expenditures between cash transfer recipients and households receiving only advisory visits were no longer statistically significant. However, large and robust increases in livestock

ownership and agricultural equipment for those who received transfers persisted into the second year. The difference in livestock value compared with the advisory visits only group was US$750 at endline, corresponding to a 32 percent increase. As in the first year, there was no robust evidence of positive impacts on livestock or other assets for those who received the management plan but no transfer. Data collected at endline suggests the management plan was salient for households and was successful in encouraging some households to engage in planning activities between advisory visits. At the same time, farmers report that implementation of the management plan could be improved, while also highlighting their need for capital in addition to services like the management plan.

Cash transfers are an increasingly common element of development programs. They were first popularized in Latin America as conditional programs to provide incentives to enroll children in school and to improve child health (Fiszbein and Schady 2009). Outside of Latin America, programs without conditions are increasingly widespread, particularly due to the expense in monitoring whether beneficiaries are meeting the conditions.[4] The cash transfer in the Senegal program can be characterized as a framed or labeled transfer, in which conditions were not enforced but in which recipients were encouraged to use the funds for a specific purpose, agricultural investments and implementation of their farm plans. Benhassine et al. (2015) found that framing can be an effective and simple method for directing transfer funds in the context of education. Our results suggest that framing can also be effective in the agricultural sector.

Although a large literature exists on the impacts of cash transfers, very few studies have examined transfer programs with a primary goal of increasing agricultural productivity. However, in light of increasing interest in the use of social protection for agriculture (FAO 2015), a number

[4] Examples of unconditional cash transfers and their impacts include Baird, McIntosh, and Özler (2011) and Haushofer and Shapiro (2016).

of studies have examined the impact of cash transfers with different core goals on agricultural outcomes. These papers, including studies of the Malawi Social Cash Transfer Programme, PROGRESA (Programa de Educación, Salud, y Alimenación) in Mexico, and Zambia's Child Grant Programme, have all found positive but modest impacts of transfers on agricultural investments or production (Handa et al. 2015; Boone et al. 2013; Gertler, Martinez, and Rubio-Codina 2012; Covarrubias, Davis, and Winters 2012; Todd, Winters, and Hertz 2010; Veras Soares, Perez Ribas, and Issamu Hirata 2010). Yet these programs all differ from the Senegal project in that they included small, regular transfers intended to provide continued income support, as compared with a lump sum payment intended to increase income and reduce the need for long-term support. Recent work in Kenya has found that lump sum transfers are more likely to be spent on investments than monthly transfers (Haushofer and Shapiro 2016), suggesting that households are liquidity constrained and lump sum transfers are likely to be better suited for stimulating investment than smaller transfers spread over time.

Two existing studies examine large transfers for agriculture with differing results. Karlan, Osei, Osei-Akoto, and Udry (2014) investigate the impacts of a large cash grant to farmers in Ghana and compared the impact of cash grants with the impact of grants of weather insurance. The authors found modest effects of the cash grant on agricultural investment and output compared with the robust impacts of the insurance grant. These results suggest that, at least in that context, farmers are more constrained by risk than by capital. However, our context differs from the Ghana study in important ways. First, the farmers in our study were much better off at baseline, with both landholdings and harvest value much higher in our sample. Second, farmers in this study lived in households more than twice as large, on average, and may therefore have alternative strategies to

manage risk.[5] Finally, the grants in this study were accompanied by additional support services, which may have allowed them to be used more effectively. In contrast to the Karlan et al. (2014) study, Beaman, Karlan, Thuysbaert, and Udry (2015) found that cash grants had large impacts on investment and production for farmers in Mali. Importantly, these returns were heterogeneous and near zero for farmers who did not choose to borrow but positive in the general population. This heterogeneity between and within contexts highlights the importance of careful study of these programs in a variety of situations.

Beyond the context, the principal way in which this study is different from Karlan et al. (2014) and Beaman et al. (2015) are the support services that were combined with the cash transfer. These additional services (the BAA, the advisory visits, and the farm management plan) were developed from the viewpoint of the small farm as a business and were intended to provide farmers with the tools needed to better manage their farms. If farmers can better manage their limited resources, productivity may increase. This idea is a departure from standard agricultural extension programs, which tend to provide only technical advice. There is a parallel, though, to the large development literature on business training for small firms. Management practices have been found to matter for small firms (McKenzie and Woodruff 2015), but evaluations of programs that teach these practices typically do not find large impacts on a firm's profits (for a review, see McKenzie and Woodruff 2013).

Viewing farms as small businesses also links this project to the literature on cash transfers for firms. A number of studies have found large short- and medium-term impacts of cash grants on firm profits and survival (de Mel, McKenzie, and Woodruff 2008, 2012). Other projects have combined cash grants with business training. De Mel, McKenzie, and Woodruff (2014) found little

[5] For example, a primary strategy of households in this area is the seasonal migration of male household members to urban areas.

impact of a business training program for women in Sri Lanka. When the program was combined with a cash grant, profits went up initially, but the increases were not sustained. Similarly, very poor, conflict-affected women in Uganda showed an increase in business income from a project that included cash and business skills training (Blattman et al. 2016).

The Senegal program's support services and time-limited implementation period are also similar to a group of graduation models for the ultra-poor that combined an asset grant (typically livestock) with different types of training, some consumption support, and access to savings and health services. A comprehensive evaluation of these programs in six countries found a variety of positive impacts, including increased consumption and improved food security. Livestock revenue increased substantially (most asset transfers were livestock), and agricultural income went up modestly (Banerjee et al. 2015). However promising the results, impacts varied widely across countries, highlighting the importance of understanding why these programs work by unpacking their different elements. We contribute to the literature on graduation programs by examining a program directly targeted at agricultural productivity that provides cash, rather than in-kind, transfers.[6] In addition, the research design employed in this study allows for some differentiation of the different program elements—specifically, focusing on the impact of the cash grant relative to the other program components.[7]

The paper proceeds as follows. Section 2 describes the program and implementation in more detail, and Section 3 describes the data and the empirical strategy. Section 4 presents the

[6] Some evaluations of graduation-style programs have given cash, but those programs were focused on income diversification opportunities rather than primarily on agriculture (Blattman et al. 2016).

[7] An evaluation of a program in South Sudan compares a graduation program with asset transfers to a large cash transfer. However, it is not clear whether any differences result from the differences in modality or the support services. In addition, civil unrest in the region interrupted program implementation, thus limiting the scope for comparison across treatment groups (Chowdhury et al. 2016). In addition, ongoing work by Ambler, de Brauw, and Godlonton (2017) explored different modalities of alleviating credit constraints (inputs versus cash) and the complementarity of services and transfers.

results at midline, and Section 5, the results at endline. Section 6 provides a discussion, Section 7 describes a cost-benefit analysis of the program, and Section 8 concludes.

## 2. Project Description

### *A. Treatment Details and Randomization*

This project was implemented by FONGS, an umbrella group of 31 autonomous farmer associations operating in 35 of Senegal's 45 departments. Eight associations participated in this project, covering five regions, all in the "peanut basin," a zone of central and western Senegal with a long history of rainfed food production centering on groundnuts. From each association, 15 villages were chosen to participate, and 5 households in each village were selected, for a total of 600 households.[8] Each association selected households on the basis of socioeconomic diversity and willingness to participate. Villages were each assigned to an animateur, and each animateur (and his/her households) was then randomly allocated into one of three treatment groups.

***Group 1: Advisory Visits Only***

Project participation began with the administration of the basic agricultural assessment (BAA), a tool developed by FONGS to collect information about a household's production and expenses. It was used both to track farmer progress, and to help farmers better understand their financial situation. The BAAs were administered by animateurs, individuals from the local area (though not usually from the same community as the farmers) trained by FONGS to administer the project. Animateurs are similar to community health workers (but with a focus on agriculture), who have been shown to contribute to improved health outcomes in a variety of low-income countries (see, for example, Perry, Zulliger, and Rogers 2014). Appendix Table A.1 shows some

[8] Although the associations are generally geographically distinct, there are some cases of overlap. Because the associations operate autonomously, in two cases, two associations selected the same village for implementation. Therefore, 2 villages had 10 project households, but each group of 5 was served by a different association and animateur.

basic characteristics of the animateurs working on this project. They were mostly male, fewer than half had a high school education, and on average they had more than 13 years of experience working as animateurs. After implementation of the BAA, households in this first group received monthly advisory visits from the animateur. These visits provided farmers with an opportunity to discuss any issues with their farm. Animateurs were trained to help with questions related to farm management but did not receive training to provide technical agricultural advice. Themes covered in these visits included agricultural decision making, information regarding inputs, and household budgeting. In some cases, animateurs assisted farmers by linking them with other services, such as technical support or credit access. These visits and the BAA administration were designed by FONGS to be household activities involving as many family members as possible, as one goal of the visits was to increase the participation of all household members in household decision making. The advisory visits continued for two agricultural seasons; two additional BAAs were administered following harvest in both the first and second seasons.

***Group 2: Advisory Visits and Farm Management Plan***

Farmers in Group 2 received the same services as farmers in Group 1, but they also received an extra visit from their animateur to develop a farm management plan at the beginning of the agricultural season, using a tool specifically developed for this purpose. The management plan focused on improving productivity by helping farmers better manage their resources. The animateur would guide several household members to think through the challenges faced in managing their farm, as well as the consequences of those challenges. Household members would then plan for when activities would occur and the amount and timing of necessary expenditures, effectively committing the household to improvement. Different from a typical business training exercise, this process guided households to think through their particular situation, anticipate

issues, and proactively devise solutions. Animateurs were encouraged to use the subsequent monthly advisory visits to refer to the plan and monitor progress. Farm management plans were completed for two seasons.

***Group 3: Advisory Visits, Farm Management Plan, and Cash Transfer***

Farmers in Group 3 received all the services described for Group 2, as well as a large cash transfer of 100,000 CFA (approximately US$200).[9] The transfer was roughly equal to 15 percent of GVAO at baseline. The cash transfer was distributed shortly after implementation of the extension plan and was timed near the beginning of the season to help farmers implement the main goals outlined in the farm plan. Although the transfer was not conditioned on any specific farmer behavior, it was heavily framed for agricultural investment and implementation of the farm management plan. Cash transfers were a one-time, lump-sum benefit administered only during the first season of implementation.

Randomization occurred at the animateur level to ensure that no animateur had to administer more than one treatment and to ensure that elements of the management plan were not included in interactions with farmers in the advisory visits only group. Animateurs assigned to administer only the advisory visits were not invited to the trainings in which the management plan was discussed. In general, each animateur worked in a single village, meaning that there was close to a village-level randomization. However, because 11 animateurs managed 2 villages, there were 109 total animateurs at the start of the project. Animateurs were assigned to villages prior to

[9] When the transfers occurred, the exchange rate was 488 CFA to US$1 .

randomization.[10] Randomization was stratified by association and number of villages per animateur.[11]

### *B. Project Timeline*

Project implementation occurred in the 2014/2015 and 2015/2016 agricultural seasons. Figure 1 shows the timeline of events. The project began with administration of the baseline BAA in June 2014. Following that, the management plans were completed in July 2014, and the cash transfers were administered in early August 2014. Monthly advisory visits were conducted between August 2014 and January 2015. The midline survey was completed in May 2015. In the second year, the farm management plans were completed in June and July of 2015. Monthly advisory visits took place from July 2015 to May 2016. The endline survey was completed in April 2016.[12]

## 3. Data, Balance, and Empirical Strategy

### *A. Data Sources*

This paper takes advantage of two main sources of data: FONGS-collected BAA data at baseline and researcher-supervised household surveys at midline and endline. The BAA collects

[10] There is only one case in which the initial assigned animateur-village-treatment was not respected. Two animateurs switched villages to allow an animateur more able to travel to work with a village that was further away. They carried their assigned treatment with them to their new villages. Over the course of the project, households were assigned new animateurs when existing animateurs left the project. When this occurred, each household's initial treatment status was maintained. This happened in 16 villages; all but 3 changes happened after the midline BAA. In one case, the change was temporary due to a maternity leave; in another, a second change occurred because the new assigned animateur was from the wrong treatment group.

[11] To maximize the efficacy of the work done by the animateurs, two randomized SMS text interventions were conducted with animateurs during the project's second year. In the first intervention, designed to boost the impact of the farm management plans, selected animateurs received monthly text messages reminding them to refer to the plans and to use them as a tool during their monthly visits. In the second intervention, intended to emphasize household participation in the advisory visits, selected animateurs received monthly messages reminding them to include as many household members as possible in their visits. The messages were sent between November 2015 and April 2016. Analysis of the impact of these treatments on several measures of farmer behavior suggest that they had no impact. Results are available upon request.

[12] Advisory visits continued after endline data collection to support FONGS's goal of continued engagement with farmers; the data collection was scheduled closer to harvest but after the majority of crop sales in order to more accurately measure agricultural production.

information on agricultural production, livestock, credit, and migration. It also includes some information on expenditures. In contrast to a traditional survey, the entire household is encouraged to participate, and the data collection is meant to be a learning experience for the family.[17]

Although the BAA data are useful, externally collected data are essential for a valid assessment of program impacts, as implementer-collected data may suffer from several measurement biases. Therefore, we use the BAA only as baseline data.[18] The research team conducted a midline survey with 239 households and an endline survey with the full sample. The midline survey was conducted with only a subsample of participants to reduce the overall time burden of project participation on respondents. The sample of respondents for the midline was randomly selected (at the village level) and stratified by association and treatment; 48 villages were included in the sample, which is 2 villages per association-treatment cell. All 5 households in each selected village were interviewed.[19]

Attrition between data collection rounds was negligible: 239 of a targeted 240 households were interviewed during the midline survey, and 598 of 600 households were interviewed during the endline survey. The missing households from the survey data in both years were due to household-level refusals.

### *B. Balance Tests*

[17] The research team assisted FONGS with redesigning the BAA to more effectively record responses and ensure accurate data entry.

[18] Project timing and the preferences of FONGS did not allow for a baseline survey to be conducted. Given that the baseline BAA was collected before the project began, concerns about a host of measurement biases are less of a concern and should be limited to external validity issues. Although no survey data are available for comparison at baseline, a comparison of the midline and endline BAA data with the midline and endline surveys shows that BAA data are similar to the survey data, especially when the question formats are comparable.

[19] To incorporate organizational capacity building into the data collection, FONGS animateurs served as enumerators for both the midline and endline surveys. At midline, the best animateur from each association was selected, and at endline, the two best were selected. In only 25 cases at midline (and none at endline) was the survey conducted by the animateur who was also responsible for working with the respondent family. The animateurs were closely managed by an external team of supervisors, at a ratio of one supervisor to every two enumerators. The survey training and all management were conducted by the research team.

It is first important to show that randomization of the treatments was successful in creating comparable treatment groups. Table 1 displays the results of balance tests for the full sample.[20] Columns 1 through 3 show means of selected baseline variables for the three treatment groups. Columns 4, 5, and 6 show the p-values for the pairwise tests of equality between the treatment groups, and column 7 shows the p-value for the test that averages among all three groups are equal to one another. Overall, the three groups appear to be well balanced, with very few p-values less than 0.10. There is some evidence that households in Group 2 are smaller and less likely to be female-headed. Thus, regressions will control for baseline characteristics (household size, whether household head is polygamous, whether household head is female, and whether the household head has any education) to mitigate any baseline differences between the treatment groups.[21]

Because the midline survey was only conducted with a subsample of participating households, it is important to verify that the households that participated in the midline survey were comparable to households that did not. Given the random selection of households by the research team in conjunction with negligible attrition rates, no large differences are expected. Table 2 presents the average of baseline characteristics (collected in the baseline BAA before project implementation began) according to whether the household was in the midline sample. Column 1 presents the overall average for the whole sample; column 2, the average for households not in the midline sample; column 3, the average for households in the midline sample; and column 4, the p-value for the test of equality between the two groups. Overall, the samples are quite similar, with only 4 (number of adults in household, number of females in household, GVAO per hectare, and total value of agricultural expenditures) out of 21 variables exhibiting p-values below 0.05.

[20] Results of balance tests for the midline sample are comparable and shown in Appendix Table A.2.
[21] Results are robust to the exclusion of the control variables.

Table 2 can also be used to examine summary statistics. Almost all household heads are male, and only 33 percent have some schooling. More than 40 percent of the sample is polygamous, and the average household size is 16, half of which are children. It should be noted that the study used a definition of *household* that encompasses extended families, both monogamous and polygamous, living together in family compounds.[22] Families cultivate an average of 8.5 hectares on which they grow an average of three crops. GVAO is approximately US$1,460, approximately 40 percent of which was sold. Livestock ownership is important, with families owning around 3.6 tropical livestock units on average, valued at approximately US$2,270.[23]

To better understand the profile of project participants, we compare their characteristics with data from a representative sample of agricultural households in Senegal's peanut basin. We use the Enquête de Suivi de la Pauvreté au Sénégal (ESPS) 2011, which includes the most recent national data available, and compare measures available in the baseline BAA and the ESPS survey. The comparison is presented in Appendix Table A.3. Our households are roughly similar to the ESPS households on many demographic measures, though household size in our sample is much larger. Note that this difference may at least partly be due to the expansive definition of *household* used in our study. Households are also fairly similar on many agricultural measures, including crop diversity and production. However, our study households report higher sales and livestock ownership, suggesting that they are likely somewhat better off than the average agricultural household in the area.[24]

[22] We opted to use this definition of *household* as it is the one used by FONGS and is the relevant unit with respect to the project given how FONGS thinks about its project activities.
[23] Tropical livestock units provide a convenient way of standardizing different animals with a single measure that expresses the total amount of livestock owned.
[24] These agricultural measures come from different seasons; therefore, a direct comparison is difficult due to differences in weather conditions.

*C. Empirical Strategy*

We examine the impacts of the program by exploiting the randomized implementation and estimating ordinary least squares regression models relating outcomes to treatment indicator variables. We examine the impact of the project on various agricultural outcomes using the following model, run separately at midline and endline:

$$Y_i = \alpha + \beta_2 T_{2a} + \beta_3 T_{3a} + \delta Y_{i0} + \gamma X_i + \delta_e + u_{ia}$$

where *i* indexes households, *a* indexes the animateurs, , and *e* indexes the enumerators. $Y_i$ is the outcome variable. $T_{2a}$ and $T_{3a}$ are indicator variables for treatment Groups 2 (advisory visits and management plan) and 3 (visits, management plan, and cash transfer), respectively. $\beta_2$ and $\beta_3$ represent the average difference between outcomes for farmers in that treatment group relative to Group 1. Regression tables also report a test for equality of $\beta_2$ and $\beta_3$. $Y_{i0}$ is the baseline value of the outcome in question, included when available. $X_i$ is a vector of baseline control variables included in all specifications that includes the household size, whether the household head is polygamous, whether the household head is female, and whether the household head has any education. $\delta_e$ represents enumerator fixed effects corresponding to the particular survey year.[25] Standard errors are clustered by animateur, the unit of randomization.

Each regression table follows a similar structure, with results from the midline presented in the top panel and results from the endline in the bottom panel. To limit the influence of outliers, all continuous outcome variables are winsorized at the 99th percentile. All money values are expressed in U.S. dollars.[26]

[25] In the midline survey, there was only one enumerator per association, so enumerator fixed effects are equivalent to association fixed effects. In the endline survey, there were two enumerators per association.

[26] Exchange rates were determined by the rate on the first of the month in the month a data collection exercise began. The baseline exchange rate was 482 CFA to US$1, the midline exchange rate was 586 CFA to US$1, and the endline exchange rate was 581 CFA to US$1.

## 4. Results after One Year

The first step in the analysis of program impacts is to understand the immediate short-run effects of both the cash transfers and the farm management plans. We examine a range of outcomes related to the project's core goal of increasing agricultural production, including both crop production and livestock measures. We then examine some indicators related to the driving mechanisms of these short-term effects.

### *A. Impacts on Crop Production*

Given that the primary goal of this program is to increase agricultural production, we begin by directly addressing this question. Table 3 shows the results for production in kilograms of the five main crops: groundnuts, millet, sorghum, maize, and manioc (columns 1 through 5, respectively). Column 6 presents a summary measure (the GVAO) that includes all crops grown by the household.[27]

Across all outcomes, we see some evidence of differences between Group 2 (advisory visits and management plan) and Group 1 (advisory visits only). Coefficients are consistently positive, but only statistically significant (at the 10 percent level) for the aggregate measure. The coefficients for the cash transfer group are positive across crops, with the exception of manioc, and statistically significant for millet and maize. The cash transfer treatment also has a large and statistically significant impact on the aggregate GVAO measure. The average GVAO of Group 3

[27] GVAO was calculated using a method similar to that for constructing consumption aggregates outlined in Deaton and Zaidi (2002). For households that sold all of their production, the total sales value of their production was used for that crop's value. For households that sold part of their production, the unit price for that crop was used to estimate the value of unsold production, which was then added to the value of sales for that crop to estimate the total value for that crop. For households that did not sell any of their production for a certain crop, their crop value was estimated by using the median at the lowest available level of geographical aggregation possible (village, district, department, region, full sample). Because prices vary by whether the crop was shelled or unshelled, for crops that had the reporting option of shelled and unshelled, we distinguished between these options at each level (village, district, department, region, full sample) when calculating crop value for the midline survey. In the BAA (but not the midline), price was sometimes reported even if a crop had not been sold. Prices are used any time they are reported.

households is about US$560 (57 percent) higher than the Group 1 mean in the midline data. This result is striking, as it suggests a large return on the US$200 transfer, representing strong evidence that farmers face a liquidity constraint.[28] The impact on GVAO for Group 2 households is also large, at approximately US$410. However, though the coefficients for the cash transfer group are consistently larger than those for the management plan only group, we are typically unable to reject that they are equal, with the exception of maize production. Appendix Table A.4 shows a similar pattern for crop sales.

To further study the treatment effects, Figure 2a plots the cumulative distribution function (CDF) of the GVAO measure by treatment group, with the cash group distribution clearly shifted to the right. The distribution for Group 2 (management plans only) is shifted to the right of Group 1 only at the top of the distribution. Two way Kolmogorov-Smirnov test statistics, which test whether the empirical distributions come from the same underlying distribution, suggest that data from the cash transfer group do not come from the same distribution as the advisory visits only group and the farm management plan group (p-values $< 0.001$), while we cannot reject the hypothesis that the management plan group and the advisory visit only group come from the same distribution (p-value = 0.265). In sum, the midline results convincingly show that the households that received both the cash transfer and the management plan experienced a large increase in crop production after one season, and that change took place throughout the distribution of households, while the evidence for the group only receiving the management plan is more mixed.

Next, we examine changes in land productivity, as measured by GVAO per hectare (Table 4). Because the crop-specific yields can only be calculated for households that cultivated a particular crop, we limit the crop-specific analysis to only those crops that are grown by a large

[28] Section 7 describes the detailed cost-benefit analysis used to estimate program returns.

majority of farmers in our sample—that is, groundnuts and millet. Groundnuts and millet were both grown by 95 percent of households at baseline, and we find no evidence that treatment affected selection into growing these crops. The results for groundnuts and millet are presented in columns 1 and 2, respectively, and the total GVAO per hectare is presented in column 3. The coefficients for the management plan only group are negative or close to zero and insignificant, despite the evidence of increases in production (see Table 3). There is, however, evidence that the transfer increased productivity in the first year. The coefficients for the cash transfer group are positive in all three columns and statistically significant at the 10 percent level for the aggregate GVAO per hectare measure in column 3. The result is economically significant, suggesting an increase of 36 percent over the yields in the advisory visits only group.

*B. Impacts on Livestock Ownership*

As a final production-related outcome, we examine the impacts of the program on livestock ownership (Table 5). Recall from Table 2 the importance of livestock holdings for farmers in this sample; the total value of livestock owned exceeded GVAO at baseline. Columns 1 through 6 present results for the six main animals owned by households (cows, sheep, goats, poultry, donkeys, and horses). Columns 7 and 8 present two aggregate measures: the number of tropical livestock units and the total livestock value. Tropical livestock units provide a convenient way of standardizing different animals with a single measure that expresses the total amount of livestock owned. An exchange ratio is applied to each animal so that different animals of different average size can be described using a common unit.[29]

The midline results in Table 5 provide convincing evidence that the cash transfer treatment led to large increases in livestock holdings. The coefficients on most types of livestock are positive

[29] Exchange ratios used to convert number of animals into livestock units are as follows: 0.7 for cattle, 0.5 for donkeys, 0.2 for pigs, 0.1 for sheep or goats, 0.01 for poultry, and 0.01 for rabbits.

(and statistically significant for cows, poultry, and horses). The aggregate measures show large and statistically significant increases: the cash transfer treatment led to a 29 percent increase in tropical livestock units and a 36 percent increase in total livestock value. This increase is true across the distribution, as shown in Figure 3a. The transfer group distribution is significantly different both from Group 1 (p-value = 0.001) and Group 2 (p-value = 0.013). In contrast to the crop production results, there is no evidence of an increase in livestock holdings for households in Group 2. Although coefficients for the aggregate measures are positive, none are significant and the coefficients for sheep, goats, poultry, horses, and tropical livestock units are statistically significantly larger in the transfer group relative to the management plan group. Households in the transfer group made large investments in livestock; these investments included both livestock that can be viewed as a separate enterprise for sale or by-products (such as poultry and cows) and livestock that are tools in the process of agricultural production (such as horses).

### *C. Discussion of Production Results and Mechanisms*

The treatment given to farmers in the management plan and cash transfer group appears to have had a positive impact on production-related outcomes in the first year, increasing total production and increasing livestock holdings. These results are large compared with the levels in the advisory visits only group. These robust impacts compare with some evidence of impacts on crop production, and no impacts on livestock ownership from the management plans alone. The cash transfer is successful in inducing large increases in agricultural production in the short run, in contrast to the modest impacts found in Ghana (Karlan et al. 2014) but comparable to those measured in Mali (Beaman et al. 2015). The complementary aspects of the program (the advisory visits and the management plan) that did not accompany the cash grants in Ghana may be one reason for the effective use of the cash transfers. It was not possible in our setting to study the

impacts of the cash transfer without the supporting activities; however, we can use the detailed complementary data collected during the midline survey to examine potential mechanisms behind these increases in crop production and livestock ownership.

To understand the mechanisms behind the production increase, we examine the impact of the cash transfer on expenditures and assets (Table 6). In examining expenditures specifically related to agriculture, transfer group farmers have statistically significantly higher agricultural expenditures, suggesting that they invest more in agriculture than farmers who received advisory visits only (column 1). The US$107 increase in expenditures is a 36 percent increase over the mean expenditure level in Group 1. This sizable increase represents approximately half the provided transfer. There is no evidence of increases in this measure among farmers in the management plan group.

Next, we present the results for the impact of the treatment on the value of assets owned, split by agricultural and nonagricultural (Table 6, columns 2 and 3) and total assets (column 4). The coefficient estimates are all positive (in both Groups 2 and 3) and statistically significant at the 10 percent level for the transfer group for agricultural equipment (column 2) and total assets (column 4). These results are complementary to the increase shown in work animals in Table 5, and the overall increase in agricultural expenditures. The results suggest the cash transfer was used to make investments in inputs and equipment, contributing to the increase in agricultural production. Increased investment in agriculture is limited to the transfer group; agricultural expenditures are significantly higher for the transfer group compared to the management plan group and while the coefficients for Groups 2 and 3 are not statistically different at conventional levels for the agricultural equipment value, the coefficient on Group 2 is only US$11 compared to US$93 for Group 3, and the p-value for equality is 0.12.

The impact of the cash transfer on total household expenditures is displayed in columns 5 (total), 6 (food only), and 7 (nonfood only).[30] We estimate positive but not statistically significant coefficeints on total expenditures and food expenditures among Group 3 households. Nonfood expenditures increased by 26 percent in the transfer group, which is significant at the 10 percent level; this result is also statistically different from the management plan group. It is important to note that the midline survey did not use a 12-month recall for most nonagricultural expenditure questions: all 76 food items are based on a 7-day recall, and 46 out of 55 nonfood items are based on a recall period between 7 days and 3 months. As such, the survey does not capture the majority of nonagricultural expenditures that may have occurred in the short term after receiving the cash transfer in August 2014. If this increase in nonfood expenditure had been driven directly by the transfer, households would have had to save the transfer for a period of several months before spending it.

This analysis of expenditures suggests that investments in agriculture other than equipment may be a key mechanism driving the production increases in the transfer group. To investigate this hypothesis further, we examine agricultural input use to understand how farming practices might have changed. The midline survey captured detailed, crop-level data on chemical fertilizer, nonchemical fertilizer, and pesticides. Table 7 shows the findings for overall usage of chemical fertilizer, amount of chemical fertilizer used, use of nonchemical fertilizer, and use of pesticides. There is a 17 percentage point increase in the probability that farmers in the transfer group used chemical fertilizer, an increase of 42 percent over fertilizer use in Group 1. The coefficient on the amount of fertilizer used is large and positive, but not statistically significant. There is no increase

[30] We focus on total consumption expenditure instead of a per capita measure because household size is defined expansively in our survey to match the definition used by our partners. This definition may include people who are not consuming meals with the family. In addition, this measure of household size is likely to be less precise, introducing error into the denominator of a per capita measure.

in the use of nonchemical fertilizer or pesticides or any impacts for the management plan group. The data in this table suggest that the cash transfer has an impact on the extensive margin of fertilizer use. Use of chemical fertilizer is much lower in the advisory visits only group (44 percent) relative to nonchemical fertilizer (67 percent) and pesticides (87 percent). This difference in the advisory visits only group provides one explanation for why the transfer group farmers chose to invest in chemical fertilizer instead of other inputs. There is no impact of the management plan alone on fertilizer use. Appendix Table 5 explores fertilizer use by crop and shows that the increase in fertilizer use can be attributed to increased use on groundnuts and millets by those in the transfer group.

Taken together, the results provide strong evidence that farmers used the cash transfer to invest in agriculture generally and in chemical fertilizers specifically, resulting in increased production and larger stocks of livestock. In the midline survey, farmers were specifically asked what they spent the cash transfer on, which can be used to check whether farmers reported using their transfer to invest in agriculture. Figure 4 displays the frequencies that families reported spending their transfer (primary and secondary use) in a number of categories. Although the most common category overall is household expenses, fertilizer purchase is also frequently reported, as are seed purchases and investment in agricultural equipment. Thus, there is strong evidence that farmers used the transfer to invest in their farms, complementing the regression results described earlier. While Table 3 provides some evidence of an increase in crop production associated with the management plan only, there is no evidence of the mechanism through which that increase operated, suggesting that these farmers may have employed strategies independent of increased investment. This question will be further addressed in Section 6.

## 5. Results after Two Years

## 5. Results after Two Years

This project provided intensive support services and large cash transfers that are cost effective for program implementers only if impacts can be sustained across time. Because farmers did not receive transfers in the program's second year, examining the second-year impacts is the first step in a long-term analysis. The endline results are presented in the bottom panels of the regression tables presented in the previous section.

The main endline results for crop production do not show the same robust increase for the transfer group as at midline (Table 3). The coefficients, though largely positive (except for groundnuts and sorghum), have large standard errors and are small compared with the midline results. Overall, there is little evidence of continued increased crop production for the cash transfer group, and the CDFs of GVAO by treatment group (Figure 2b) are not statistically different from one another. The results for productivity in Table 4 follow a similar pattern and are too noisy to draw any conclusions. Similarly, there are no clear impacts of the management plan only on crop production or productivity.

Although agricultural production varies from year to year, investments made in livestock and durable assets should persist in the absence of major negative shocks. First, we examine livestock holdings at the endline (Table 5). There is robust evidence of an increase in livestock for the transfer group. Coefficients on variables for the number of sheep, goats, tropical livestock units, and the total value of livestock are all positive and statistically significant. Tropical livestock units increase by 24 percent, and total livestock value by 32 percent relative to the advisory visits only group. Compared to the midline results, there is some evidence of increased livestock ownership in the management plan only group, but this is statistically significant only for goats, and the impact in the cash transfer group is always larger than in the management plan only group. However, despite the fact that the Group 3 coefficients are consistently larger than the Group 2

coefficients, at endline we can no longer reject that they are equal. The CDF for total livestock value (Figure 3b) clearly shows the distribution of the transfer group lying to the right of the other two groups, and here we can reject that the Group 3 distribution is equal to Group 1 (p-value = 0.024) and Group 2 (p-value = 0.011) distributions.

Turning to assets and expenditures in Table 6, the results no longer show an increase in agricultural expenditures with the cash transfer in the second year, but the impact on agricultural assets (though not total assets) is maintained. This result is consistent with a story in which farmers are not making further investments in their farm in the second year but have preserved the investments they made with proceeds from production after receiving the transfer. In addition, the results for nonagricultural consumption and expenditure show that the transfer led to a 10 percent increase in food expenditures in the second year, suggesting that the program may have some wider impacts on household well-being beyond agricultural investment. While there are no statistically significant impacts of the management plan only on any of these measures in year 2, large standard errors also do not allow us to reject that the impact on Groups 2 and 3 are equal.

Finally, we examine whether increases in chemical fertilizer use are maintained from midline to endline. The results are presented in the bottom panel of Table 7. Chemical fertilizer use in the transfer group is 9 percentage points higher than in the visits only group, a difference that falls short of statistical significance. It is, however, statistically different from fertilizer usage in the management plan group. Over the full sample, fertilizer use went up in the second year, increasing by 6 percentage points in the visits only group, perhaps limiting the scope for continued differential impact in the transfer group. Overall the results from the second year show that although increased investments into crop production were not sustained, households that received the cash transfer continued to benefit from larger stocks of livestock and other productive assets.

Exposure to the farm management plan alone does not have a significant impact on agricultural outcomes, with only very suggestive evidence of increased livestock holdings in year 2.

## 6. Discussion

The results presented in this section show that the combination of advisory services, farm management planning, and cash transfers had a robust impact on crop production after the first year and persistent impacts on livestock stocks and agricultural equipment. Although the impacts on crop production were not sustained into the second year, households had significantly larger productive savings stocks that both generated income and served as buffers against negative shocks. The lack of lasting improvements in crop production can be explained in a variety of ways. First, 2016 was a good year for rainfed agriculture in the study region. Average rainfall in the 12 months preceding the endline survey was 609 millimeters, compared with 360 millimeters in the year preceding the midline. Production was also higher in all groups in 2016: GVAO in the advisory visits only group was US$1,417 at endline, compared with US$973 at midline. Given the large increase in savings, it is possible that crop production impacts, particularly after the first year, may be evident only in more difficult years.[31]

An additional possibility, instead of or in conjunction with that considered above, is that livestock is simply the preferred investment among the majority of sample households. Given that the lasting increase in livestock for those receiving transfers is the most significant impact of the project, we further investigate this result by examining the livestock flows within the household. Specifically, for tropical livestock units and total livestock value at midline and endline, we examine livestock gifts, births, purchases, losses and thefts, home consumption, and sales, as well as aggregate flows. The averages for each category by treatment group are presented in Figures 5

[31] See Rosenzweig and Udry (2016) for a description of how returns to investment in agriculture and other sectors can vary with aggregate shocks.

(tropical livestock units) and 6 (total livestock value). Although not all results are statistically different, these figures suggest the cash transfer treatment led to a large increase in the flow of livestock at midline, driven primarily by increased births and purchases and reduced losses. At endline, there is continued evidence of positive flows in the transfer group relative to the other two treatment groups, driven almost entirely by increased births. Births are, by far, the most important component of livestock flows, as such households in the transfer group have the potential to see their investments continue to grow over time.

While these benefits accrue to households in the transfer group, the results are less promising for households in the management plan only group. Although there is evidence of a similarly sized increase in crop production in the first year for the management plan only households, there is no evidence that the management plan had any impact on the other measures we examine related to livestock and investment. The increase in crop production in year 1 was driven by mechanisms unrelated to the investment channels we examine here. Given the implementation of the plan in both years 1 and 2, the lack of increased crop production in year 2 is not encouraging evidence for the efficacy of the plan on its own. However, it is also possible that the design of the plan was less optimal for the specific conditions of year 2 than year 1.

To better understand how the plan may or may not have been effective, we use data collected during the endline survey regarding household experiences with different project components. First, we find the program was implemented as designed. 96 percent of households reported receiving advisory visits in the second year; the average number of visits reported is eight, which is quite close to the target of nine visits. These measures do not vary by treatment group, but that is not unexpected, as even households in the advisory visits only group received monthly visits. Households in management plan groups were much more likely to report that they

completed it and that it was discussed during their visits. They were also somewhat more likely to report discussing the participation of household members in agricultural decision making during the monthly visits. Further, households reported that the visits were approximately 10 percent longer on average in the management plan groups relative to the advisory plan group. These farmers were also more likely to report participating in a set of planning activities with the animateur.

These findings suggest that the management plan was implemented as directed and that it was, in fact, salient for households. However, the more interesting question is whether or not the plan had important effects on farmer behavior. Although the individualized nature of each plan makes creating appropriate indicators difficult, we can examine a set of survey questions, asked at endline, that measure whether the household engaged in a series of planning activities outside of the presence of their animateur, in between monthly visits. These activities were chosen to mirror topics included in the management plan process and include reducing or eliminating the causes and consequences of agriculture problems, anticipating yields and discussing how to improve production, planning the timing of specific activities, finding solutions in advance to periods of tension in the household budget, finding solutions in advance to periods of tension in household labor supply, and discussing the use of agricultural inputs like fertilizer.

The results are presented in Table 8. Column 1 presents results for the total number of planning activities (out of 6) in which the household reported participation. The results show increased planning among both Groups 2 and 3, and the coefficients are of similar magnitude. The effect is large, representing a 25 to 30 percent increase in the number of planning topics addressed compared to the relatively low mean of 1.5 in the advisory visits only group. This pattern is repeated when examining the impact on specific activities. Large, statistically significant impacts

are observed across categories, with the exception of finding solutions for labor supply and discussing fertilizer use.

These results show that the management plan has some impacts on farmer behavior, and those impacts were not affected by whether the household also received the transfer. The endline survey also contained questions that directly asked farmers if they completed the farm plan (column 8). While the cash transfer group and the management plan only group both report completing the plan in large numbers relative to the visits only group, households receiving cash transfers were 20 percentage points more likely to do so than those who completed the plan only. This finding suggests the cash transfer made the plan more salient and possibly more effective, at least from the perspective of the farmers themselves.

Analysis of qualitative evidence suggests the plan implementation could have been improved. For example, when asked why farmers did not refer to the plan, the most popular response (68 percent of households) was that they were unable to read it. Although the plan may have been salient, improvements for ease of use are essential in a population with low literacy skills. Otherwise, qualitative reports mirror the quantitative analysis. When asked whether the overall program led to positive household changes, those that received the transfer were 17 percentage points more likely to say yes, while there was no difference relative to the advisory visits only group for those that received the plan only (see Column 9 of Table 8). Indeed, when asked what changes could make the household visits more useful, most households (68 percent) reported that either input provision or other financial support would be useful. These reports are consistent with the results, suggesting that farm management plans may be most successful when combined with access to capital. However, it should also be noted that even though they did not complete a full management plan, those in the advisory visits only group received some level of

support services and advice. Indeed, even these households were enthusiastic about the program; 64 percent of the advisory visits only group reported that the program led to positive household changes, suggesting that better understanding the impact of this lighter touch treatment would be useful for the design of future programs. Further research is also needed to better understand whether improved management plans can be more successful without transfers, and, additionally, how important the management plan was to the success of the transfer treatment.

**7. Cost-Benefit Estimates**

The combination of advisory services and cash transfers provided to households in this project had substantial impacts on households over two years, suggesting that such a program is a good candidate for scaled implementation. However, it is important to understand whether the benefits are substantial enough to outweigh the costs of providing both transfers and management advice. To do so, we use partner budgets and expense reports to estimate the cost of implementing management advice using FONGS's tools, including the management plan. We compute a conservative measure of costs, including refresher trainings and policy workshops that would not be part of a scaled program. We estimate an average cost of about US$326 per household over the two years for the advisory services and management plans. Cash transfers, including transaction fees, were approximately US$212 per household. Thus, the total cost of a replicated two-year project with both benefits would be, on average, US$538 per household.

To estimate the benefits, we consider the one-time benefits from the increase in crop production, plus the benefits from increased productive asset holdings and increased livestock holdings. In addition, we need to estimate the expected stream of benefits to additional asset holdings. To do this, we assume that benefits accrue over a 15-year time horizon at a 5 percent discount rate. Next, we assume a 2 percent return to the increase in agricultural assets.

Ideally, we would have detailed cost data in order to concretely estimate returns to livestock holdings (see, for example, Anagol, Etang, and Karlan 2017; Attanasio and Augsburg 2017). However, we lack such cost data, and households in this sample increased holdings of both larger and smaller livestock.[32] Thus, we follow Lybbert and McPeak (2012) and estimate average returns as 3 percent for large livestock and 10 percent for smaller livestock; we then compute a weighted average of 4.5 percent based on the proportional gain in the total value of livestock between large and small livestock in our sample.

Based on these assumptions, we estimate average total benefits to participating households at approximately US$930. If we vary the returns to livestock holdings by 1 percentage point, then we estimate a range between US$850 and US$1,010. Converting to a rate of return, we estimate an average rate of return of 73 percent, with a range between 58 percent and 88 percent.[33] This cost-benefit ratio estimate of 173 percent is similar to the range of cost-benefit ratios estimated for graduation programs in Banerjee, Karlan, and Zinman (2015) and is higher than the 133 percent estimate for Ghana, the context most similar to the Senegalese context studied in this paper. These estimates suggest that a scaled implementation of this program could be successful, especially as implementation costs of the advisory visits are likely to fall. However, a better understanding of the importance of the advisory visits and management plans in conjunction with the cash transfers is key for designing the most cost-effective program. Ambler, de Brauw, and Godlonton (2017) address this question in a partner study in Malawi.

## 8. Conclusion

[32] Because larger livestock are more likely to be held throughout a drought in west Africa, they likely have somewhat more stable returns than smaller livestock (see, for example, Kazianga and Udry 2006), which reproduce faster and more quickly than large livestock.

[33] It is worth noting that we have only estimated benefits to direct project participants and that there are other categories of beneficiaries. For example, a number of benefits accrue to animateurs and other project personnel in the form of both salaries and capacity development, which we do not measure here. There may also be community-level spillovers from beneficiary households.

## 8. Conclusion

This paper examines the impacts of a program aimed at increasing agricultural production among smallholder farmers in Senegal. Although all farmers received some services, the evaluation was designed to differentiate the impacts of a farm management plan or a farm management plan plus a large cash transfer from a group that received only monthly advisory visits. We found that the treatment that included the farm plan plus the cash transfer led to large increases in crop production and increases in livestock ownership after the first year. An exploration of mechanisms suggests that farmers used the cash transfer to invest in their farms. This finding is supported by a demonstrated increase in the use of chemical fertilizer and increased expenditures on agriculture. While there is no increase in crop production after two years, investments in livestock and agricultural equipment are maintained. The management plans alone appear to have increased crop production in year 1, but did not lead to increased investments or savings.

These results show that large, one-time transfers aimed at agriculture can have large impacts on production, in contrast with Karlan et al. (2014) but consistent with Beaman et al. (2015). This difference may be due to the support and guidance that accompanied the transfers. Although there was no increase in agricultural production at endline, there was a sustained increase in the ownership of livestock and agricultural equipment, suggesting that farmers made a lasting investment in their farms. This study is one of the first to suggest that large cash transfers can be effective tools for small farms, particularly because the simplicity of implementation makes scaling more feasible relative to microfinance, insurance programs, and even programs that offer frequent, smaller transfers.

This paper also contributes to the literature on financial training for small businesses by moving that research to the agricultural sector. As with other types of businesses, overall, there is

little evidence that the management plan can be effective when not combined with the cash transfer. However, this paper does provide some evidence that the plan alone led to initial increases in production and that it promoted related planning behavior, suggesting that there may be room for similar projects to have impacts on a range of outcomes. Additionally, because all households receiving transfers also received the farm plan, further research should focus on the complementarities between support services and the provision of capital. Given the high estimated rates of return, this program has the potential to be transformative for farmers and scalable for governments and nongovernmental organizations across sub-Saharan Africa. Further research into how to design these programs to maximize impacts over time is needed.

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**Figure 1: Project time line**

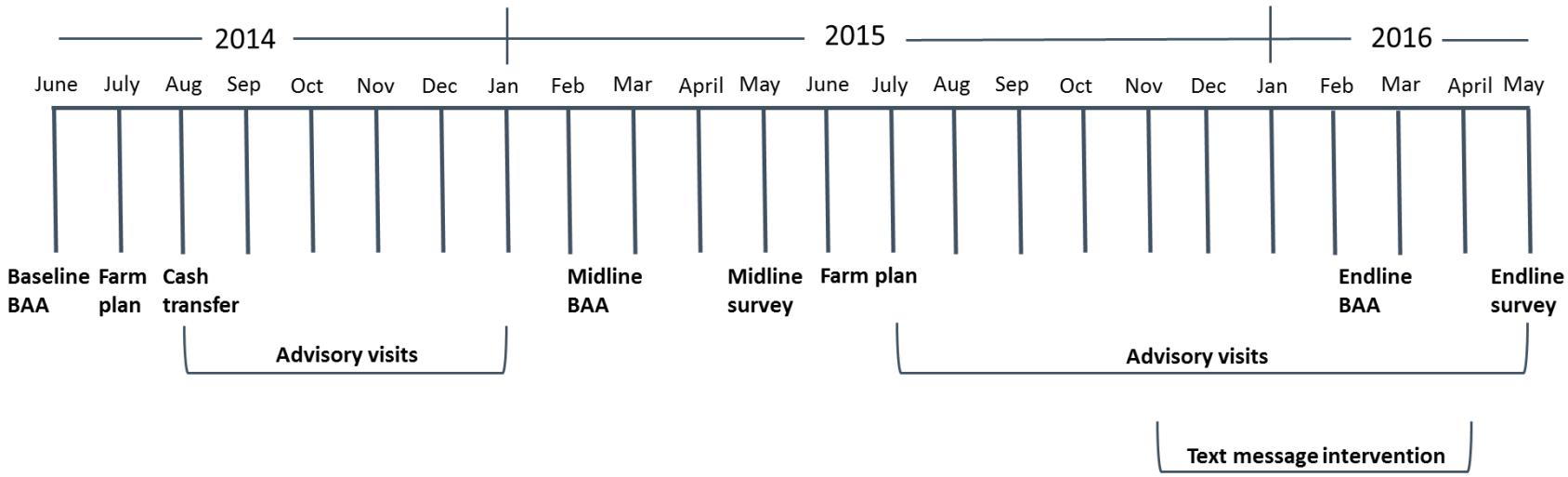


**Figure 2: Gross value of agricultural output: Cumulative distribution functions**

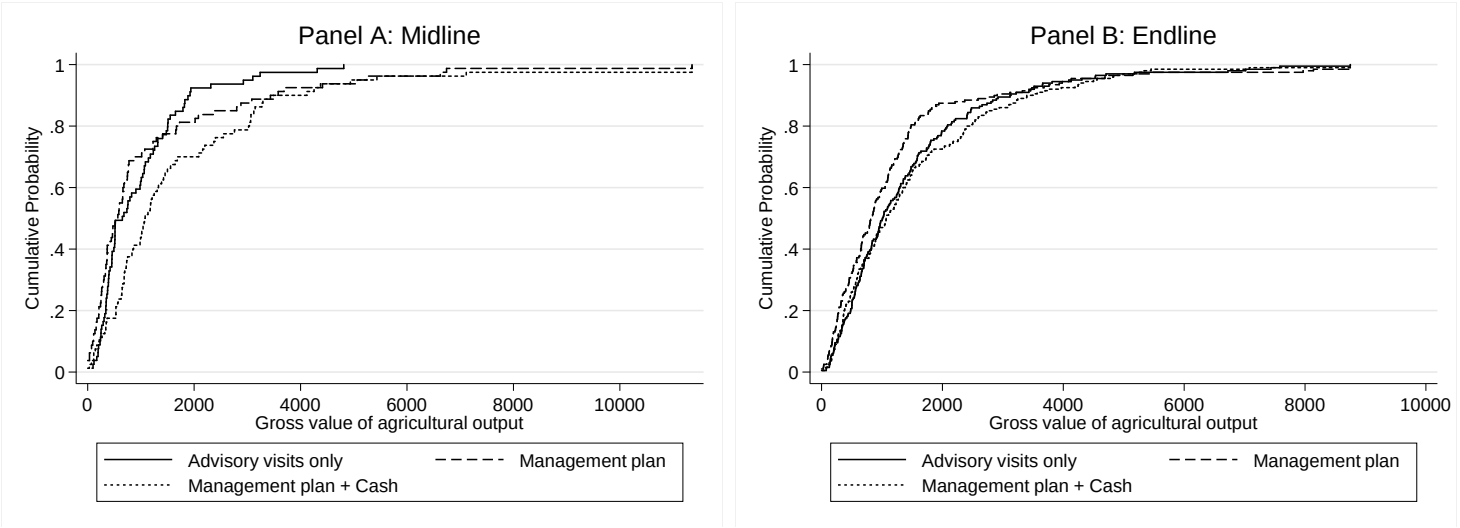



**Figure 3: Total livestock value: Cumulative distribution functions**

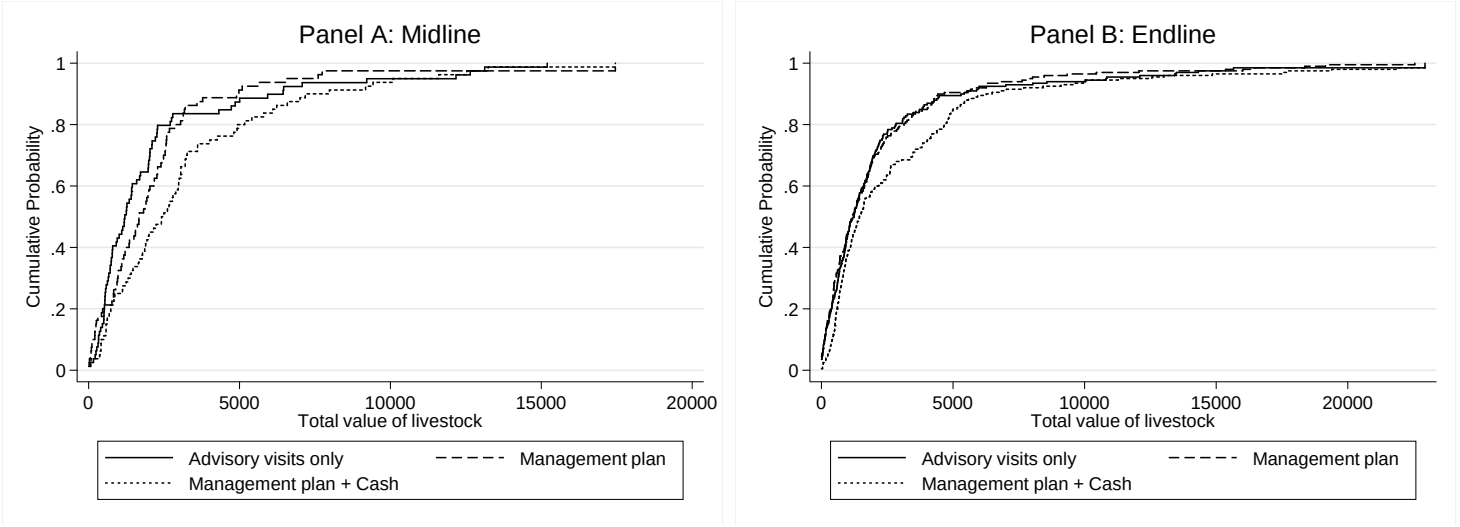


**Figure 4: Reported use of cash transfer**

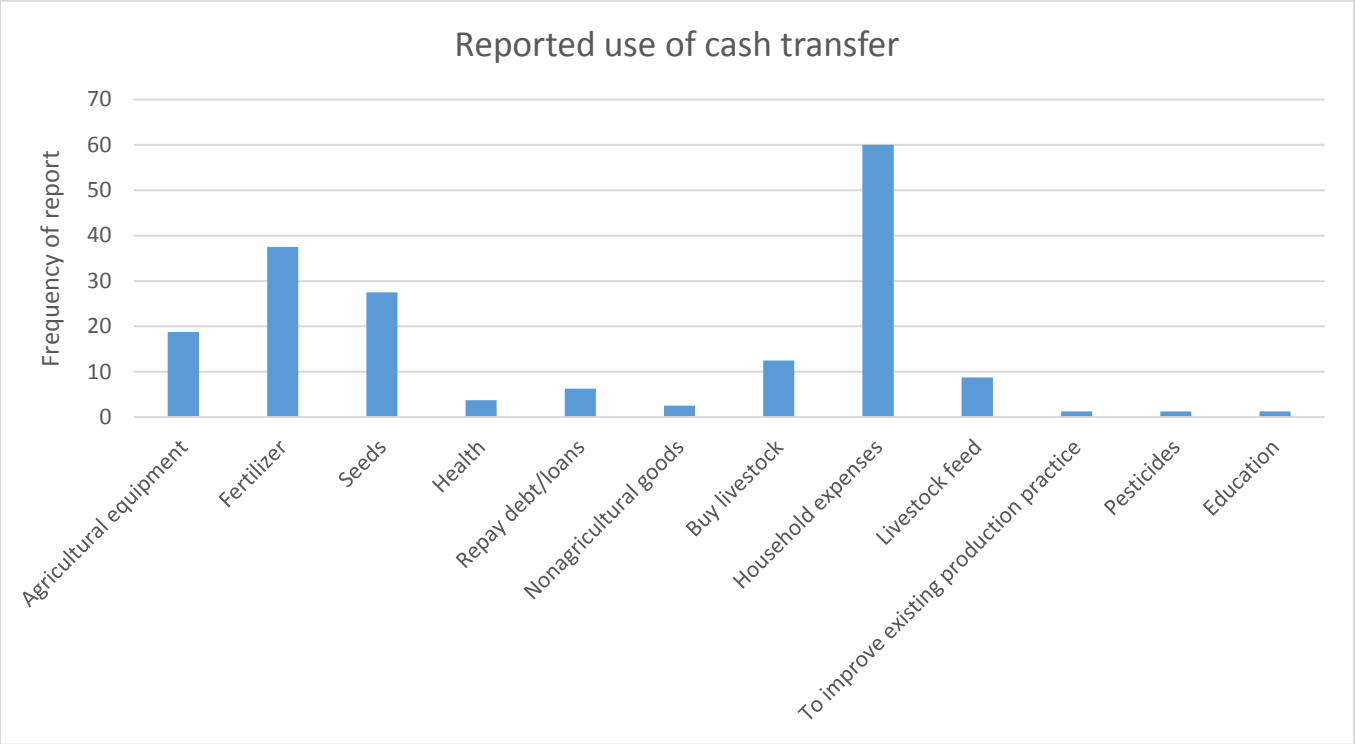


**Figure 5: Tropical livestock units: Flow measures**

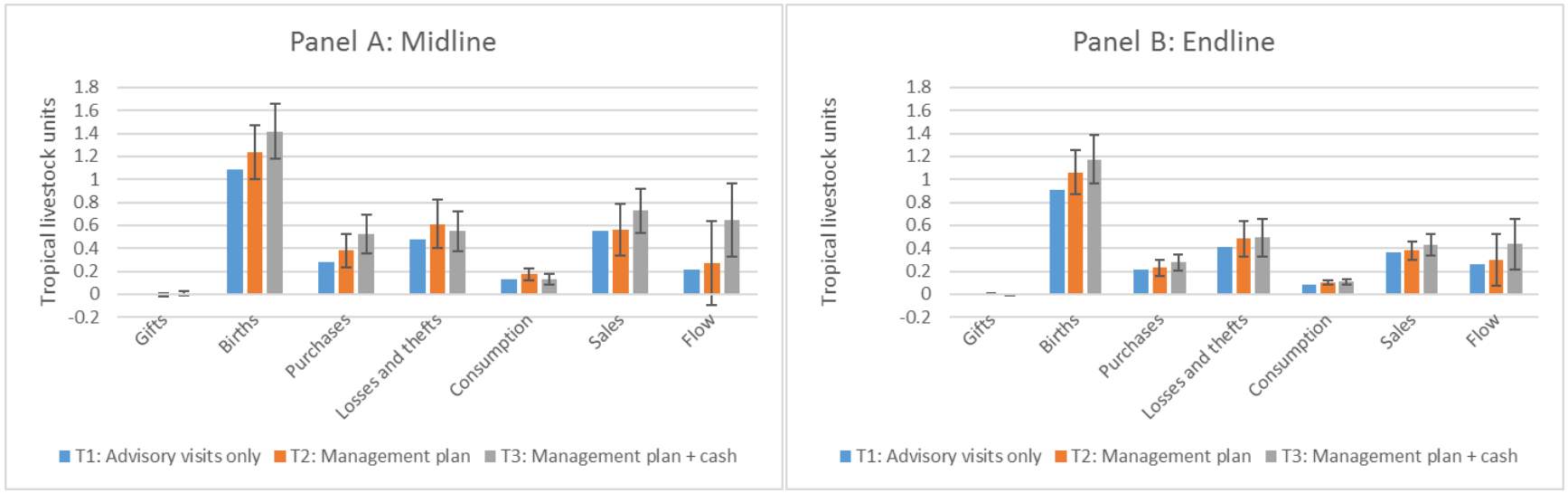
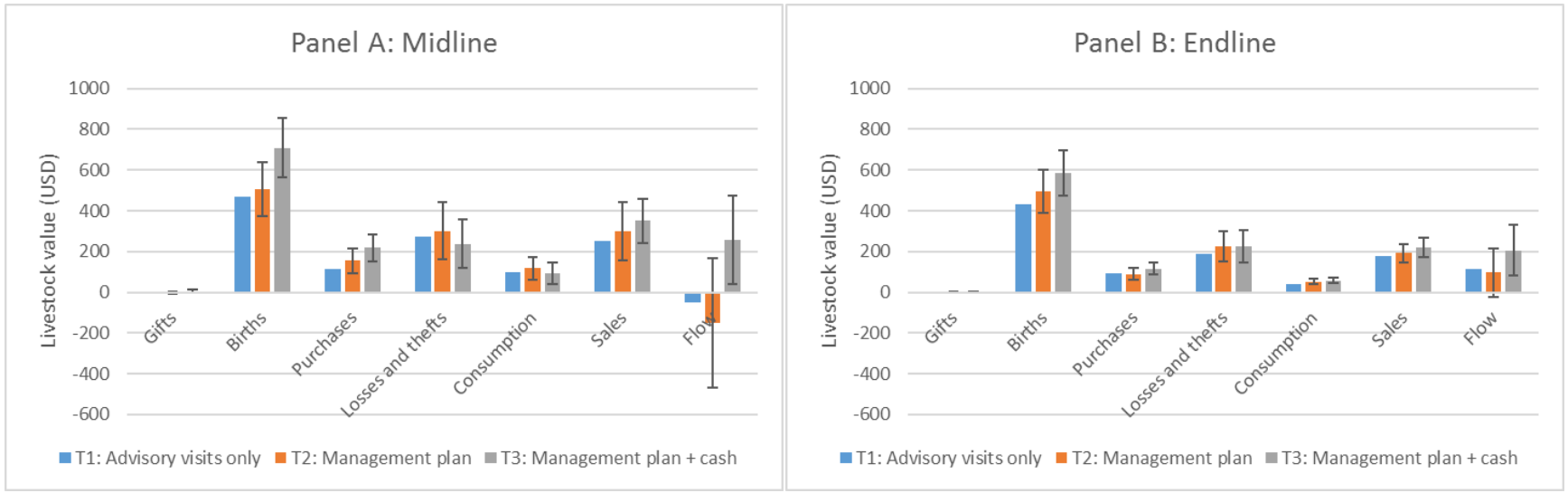



**Figure 6: Total livestock value: Flow measures**



## Table 1: Baseline balance by treatment

| | Advisory visits only | Visits + management plan | Visits + management plan + cash transfer | p-value for test that 1 = 2 | p-value for test that 1 = 3 | p-value for test that 2 = 3 | p-value for test that 1 = 2 = 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **Main household composition characteristics** | | | | | | | |
| Household head is female | 0.15 | 0.08 | 0.14 | 0.040 | 0.774 | 0.076 | 0.068 |
| Age of household head | 53.0 | 52.0 | 54.4 | 0.427 | 0.257 | 0.062 | 0.167 |
| Household head is polygamous | 0.39 | 0.42 | 0.44 | 0.542 | 0.311 | 0.687 | 0.594 |
| Household head has at least some education | 0.32 | 0.26 | 0.41 | 0.197 | 0.077 | 0.002 | 0.009 |
| Household size | 17.0 | 15.4 | 17.2 | 0.033 | 0.780 | 0.018 | 0.029 |
| **Agricultural measures** | | | | | | | |
| Total land area (ha) | 8.9 | 8.8 | 7.7 | 0.938 | 0.058 | 0.345 | 0.139 |
| Number of crops grown | 3.3 | 3.1 | 3.2 | 0.025 | 0.172 | 0.350 | 0.081 |
| Gross value of agricultural output | 1,520 | 1,415 | 1,450 | 0.618 | 0.703 | 0.846 | 0.877 |
| Gross value of agricultural output per hectare | 212 | 171 | 256 | 0.315 | 0.472 | 0.074 | 0.133 |
| Total value of crops sold | 634 | 651 | 591 | 0.886 | 0.705 | 0.592 | 0.855 |
| Tropical livestock units | 4.2 | 3.2 | 3.4 | 0.182 | 0.246 | 0.715 | 0.386 |
| Total value of livestock owned | 2,650 | 2,160 | 2,003 | 0.470 | 0.261 | 0.736 | 0.525 |
| Total agricultural equipment value | 1,552 | 1,513 | 1,468 | 0.810 | 0.529 | 0.795 | 0.820 |
| Total value of agricultural expenditures | 604 | 560 | 589 | 0.523 | 0.814 | 0.661 | 0.811 |
| **Animateur characteristics (animateur level)** | | | | | | | |
| Animateur is female | 0.11 | 0.09 | 0.22 | 0.695 | 0.259 | 0.135 | 0.322 |
| Age of animateur | 41.9 | 42.3 | 39.0 | 0.849 | 0.247 | 0.177 | 0.363 |
| Animateur is Muslim | 0.89 | 0.97 | 0.88 | 0.167 | 0.895 | 0.146 | 0.188 |
| Animateur is polygamous | 0.49 | 0.31 | 0.25 | 0.146 | 0.044 | 0.565 | 0.120 |
| Total months working as animateur | 174.1 | 174.1 | 134.3 | 0.999 | 0.139 | 0.177 | 0.228 |

Notes: All values are from the BAA 2014. Sample varies slightly with missing values for age (598), education (599), and GVAO per hectare (599). Sample for animateur characteristics is 102 animateurs. All money amounts are in USD.

**Table 2: Midline survey sample balance**

| | Full sample (N=600) | Households not in midline survey sample (N=361) | Households in midline survey sample (N=239) | p-value for test that 2=3 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Main household composition characteristics** | | | | |
| Household head is female | 0.12 | 0.12 | 0.12 | 0.861 |
| Age of household head | 53.1 | 53.6 | 52.3 | 0.230 |
| Household head is polygamous | 0.42 | 0.41 | 0.43 | 0.684 |
| Household head has at least some education | 0.33 | 0.31 | 0.36 | 0.260 |
| Household size | 16.5 | 16.2 | 17.1 | 0.136 |
| **Agricultural measures** | | | | |
| Total land area (ha) | 8.5 | 8.8 | 8.0 | 0.319 |
| Number of crops grown | 3.2 | 3.2 | 3.2 | 0.771 |
| Gross value of agricultural output | 1,461 | 1,421 | 1,523 | 0.512 |
| Gross value of agricultural output per hectare | 213 | 176 | 269 | 0.073 |
| Total value of crops sold | 625 | 581 | 692 | 0.249 |
| Tropical livestock units | 3.6 | 3.3 | 3.9 | 0.291 |
| Total value of livestock owned | 2,271 | 2,254 | 2,295 | 0.925 |
| Total agricultural equipment value | 1,511 | 1,447 | 1,607 | 0.257 |
| Total value of agricultural expenditures | 584 | 538 | 654 | 0.039 |

Notes: All values are from the BAA 2014. Sample varies slightly with missing values for age (598), education (599), and GVAO per hectare (599). All money amounts are in USD.

## Table 3: Treatment impact on crop production

| | *Production in kg of…* | | | | | Gross value of agricultural output |
|---|---|---|---|---|---|---|
| | Groundnuts | Millet | Sorghum | Maize | Manioc | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Midline survey** | | | | | | |
| Household received management plan (Group 2) | 373.7 | 261.7 | 10.31 | 39.23 | -17.86 | 413.6* |
| | [255.8] | [173.1] | [15.03] | [33.60] | [14.30] | [240.5] |
| Household received management plan and cash transfer (Group 3) | 259 | 278.7* | 13.98 | 84.80** | -19.07 | 558.8** |
| | [184.4] | [159.0] | [19.25] | [34.86] | [13.63] | [211.5] |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 |
| R-squared | 0.701 | 0.462 | 0.423 | 0.669 | 0.291 | 0.575 |
| Control mean | 924.0 | 990.3 | 46.8 | 79.0 | 20.0 | 973.3 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.655 | 0.926 | 0.854 | 0.091 | 0.856 | 0.554 |
| **Endline survey** | | | | | | |
| Household received management plan (Group 2) | 110.7 | 42.03 | -38.65** | 15.88 | 2.941 | -23.09 |
| | [255.2] | [86.19] | [15.63] | [23.66] | [11.55] | [143.7] |
| Household received management plan and cash transfer (Group 3) | -163.4 | 48.12 | -22.01 | 41.67 | -0.0631 | 68 |
| | [198.7] | [94.85] | [15.92] | [27.30] | [12.65] | [141.3] |
| Observations | 598 | 598 | 598 | 598 | 598 | 598 |
| R-squared | 0.524 | 0.450 | 0.349 | 0.496 | 0.387 | 0.431 |
| Control mean | 1,766.0 | 1,218.0 | 80.4 | 100.9 | 24.1 | 1,447.5 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.176 | 0.950 | 0.192 | 0.291 | 0.843 | 0.468 |
| Includes baseline value of outcome | YES | YES | YES | YES | YES | YES |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include the baseline value of outcome and enumerator fixed effects. All money amounts are in USD.

*** p<0.01, ** p<0.05, * p<0.10

**Table 4: Treatment impact on value yields**

| | *Crop value per ha…* | | |
|---|---|---|---|
| | Groundnuts | Millet | GVAO per ha |
| | (1) | (2) | (3) |
| **Midline survey** | | | |
| Household received management plan (Group 2) | -14.91 | 2.97 | -1.664 |
| | [31.49] | [20.78] | [21.31] |
| Household received management plan and cash transfer (Group 3) | 13.99 | 34.99 | 49.08* |
| | [30.73] | [26.67] | [26.22] |
| Observations | 218 | 214 | 238 |
| R-squared | 0.234 | 0.216 | 0.457 |
| Control mean | 169.3 | 140.8 | 137.7 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.398 | 0.208 | 0.112 |
| **Endline survey** | | | |
| Household received management plan (Group 2) | -74.88 | 161.9 | 94.55 |
| | [207.9] | [155.7] | [99.92] |
| Household received management plan and cash transfer (Group 3) | -153.1 | -3.26 | 25.84 |
| | [129.2] | [49.03] | [36.77] |
| Observations | 552 | 598 | 594 |
| R-squared | 0.041 | 0.052 | 0.071 |
| Control mean | 410.3 | 135.8 | 195.3 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.579 | 0.300 | 0.520 |
| Includes baseline value of outcome | YES | YES | YES |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include the baseline value of outcome and enumerator fixed effects. All money amounts are in USD.
*** p<0.01, ** p<0.05, * p<0.10

**Table 5: Treatment impact on livestock ownership**

| | *Number of…* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Cows | Sheep | Goats | Poultry | Donkeys | Horses | Tropical livestock units | Total livestock value |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Midline survey** | | | | | | | | |
| Household received management plan (Group 2) | 0.309 | 0.000606 | -0.331 | -0.0216 | 0.0365 | 0.0375 | 0.369 | 234.2 |
| | [0.742] | [1.405] | [0.704] | [1.692] | [0.250] | [0.211] | [0.655] | [460.5] |
| Household received management plan and cash transfer (Group 3) | 1.057** | 1.955 | 1.006 | 3.993** | -0.277 | 0.663*** | 1.494*** | 829.1** |
| | [0.509] | [1.177] | [0.633] | [1.644] | [0.224] | [0.219] | [0.515] | [349.0] |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 | 239 | 239 |
| R-squared | 0.589 | 0.499 | 0.492 | 0.214 | 0.268 | 0.311 | 0.622 | 0.501 |
| Control mean | 2.9 | 6.5 | 4.4 | 11.1 | 1.6 | 1.4 | 5.2 | 2,290.4 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.260 | 0.035 | 0.024 | 0.042 | 0.131 | 0.008 | 0.051 | 0.178 |
| **Endline survey** | | | | | | | | |
| Household received management plan (Group 2) | 0.767 | 0.735 | 0.957** | -0.593 | 0.109 | -0.0662 | 0.83 | 362.3 |
| | [0.598] | [0.551] | [0.477] | [1.062] | [0.137] | [0.130] | [0.525] | [309.5] |
| Household received management plan and cash transfer (Group 3) | 0.905 | 1.061** | 1.583*** | 0.256 | -0.0106 | 0.175 | 1.186* | 752.7** |
| | [0.732] | [0.524] | [0.550] | [1.069] | [0.149] | [0.132] | [0.634] | [317.4] |
| Observations | 598 | 598 | 598 | 598 | 598 | 598 | 598 | 598 |
| R-squared | 0.441 | 0.493 | 0.429 | 0.143 | 0.165 | 0.294 | 0.476 | 0.453 |
| Control mean | 3.1 | 5.3 | 4.0 | 8.9 | 1.2 | 1.4 | 5.0 | 2,382.3 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.872 | 0.599 | 0.293 | 0.442 | 0.364 | 0.048 | 0.633 | 0.305 |
| Includes baseline value of outcome | YES | YES | YES | YES | NO | NO | YES | YES |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include enumerator fixed effects and (where noted) the baseline value of the outcome. All money amounts are in USD.

*** p<0.01, ** p<0.05, * p<0.10

## Table 6: Treatment impact on investment, consumption, and expenditures

| | Agriculture expenditure | Agriculture equipment value | Non agricultural assets value | Total assets value | Household monthly consumption and expenditure | | |
|---|---|---|---|---|---|---|---|
| | | | | | Total | Food | Non-food |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **Midline survey** | | | | | | | |
| Household received management plan (Group 2) | -0.239 | 11.45 | 195 | 217 | -22.71 | -11.57 | -8.438 |
| | [38.41] | [26.00] | [167.2] | [187.5] | [56.13] | [30.02] | [29.52] |
| Household received management plan and cash transfer (Group 3) | 106.8** | 92.97* | 148.7 | 264.7* | 83.39 | 12.55 | 59.94* |
| | [43.27] | [46.41] | [140.9] | [156.5] | [61.20] | [33.99] | [32.33] |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 | 239 |
| R-squared | 0.410 | 0.357 | 0.291 | 0.317 | 0.286 | 0.385 | 0.196 |
| Control mean | 294.3 | 273.8 | 934.0 | 1,208.3 | 560.4 | 324.7 | 234.1 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.050 | 0.120 | 0.794 | 0.821 | 0.099 | 0.454 | 0.061 |
| **Endline survey** | | | | | | | |
| Household received management plan (Group 2) | -29.99 | 24.61 | 106.3 | 115.1 | 15.92 | 16.58 | -0.968 |
| | [30.85] | [24.59] | [155.4] | [182.8] | [27.15] | [11.70] | [16.05] |
| Household received management plan and cash transfer (Group 3) | -2.944 | 76.40** | 3.678 | 71.32 | 8.301 | 25.16** | -13.7 |
| | [38.30] | [34.37] | [145.8] | [165.6] | [26.56] | [12.60] | [15.23] |
| Observations | 598 | 598 | 598 | 598 | 598 | 598 | 598 |
| R-squared | 0.374 | 0.448 | 0.241 | 0.248 | 0.325 | 0.347 | 0.259 |
| Control mean | 369.4 | 454.8 | 1,088.9 | 1,553.4 | 483.3 | 259.8 | 219.8 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.463 | 0.124 | 0.425 | 0.783 | 0.772 | 0.522 | 0.394 |
| Includes baseline value of outcome | YES | YES | NO | NO | NO | NO | NO |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include enumerator fixed effects and (where noted) the baseline value of the outcome. All money amounts are in USD.

*** p<0.01, ** p<0.05, * p<0.10

**Table 7: Treatment impact on usage of fertilizer and pesticides**

| | Used chemical fertilizer | Kg of chemical fertilizer used | Used non-chemical fertilizer | Used pesticides |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Midline survey** | | | | |
| Household received management plan (Group 2) | -0.043 | -33.27 | 0.00926 | -0.129* |
| | [0.0663] | [46.82] | [0.0722] | [0.0713] |
| Household received management plan and cash transfer (Group 3) | 0.169** | 102.4 | -0.0342 | -0.0949 |
| | [0.0828] | [65.33] | [0.0807] | [0.0730] |
| Observations | 239 | 239 | 239 | 239 |
| R-squared | 0.234 | 0.262 | 0.157 | 0.278 |
| Control mean | 0.4 | 165.9 | 0.7 | 0.9 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.020 | 0.024 | 0.637 | 0.703 |
| **Endline survey** | | | | |
| Household received management plan (Group 2) | -0.018 | -32.7 | -0.0083 | -0.012 |
| | [0.0630] | [30.80] | [0.0448] | [0.0418] |
| Household received management plan and cash transfer (Group 3) | 0.0952 | 3.4 | 0.0336 | 0.0194 |
| | [0.0606] | [31.04] | [0.0422] | [0.0407] |
| Observations | 598 | 598 | 598 | 598 |
| R-squared | 0.203 | 598.000 | 0.181 | 0.244 |
| Control mean | 0.5 | 187.3 | 0.8 | 0.9 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.049 | 0.229 | 0.300 | 0.462 |
| Includes baseline value of outcome | NO | NO | NO | NO |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include enumerator fixed effects.

*** p<0.01, ** p<0.05, * p<0.10

**Table 8: Treatment impact on management indicators**

| | In the last 12 months, did you or anyone in your household make plans regarding … when your animateur was not present? | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total number of planning topics dicussed without animateur | …the causes and consequenses of agricultural problems… | …how to improve production before/at planting… | …when hh would perform specific agricultural activities… | …periods of tension in the hh budget… | …periods of tension in hh labor supply… | …fertilizer and/or pesticides … | Completed management plan | Report that program has resulted in positive hh changes |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| **Endline survey** | | | | | | | | | |
| Household received management plan (Group 2) | 0.397** | 0.0853* | 0.0980** | 0.0717* | 0.106*** | 0.0368 | -0.00159 | 0.559*** | -0.00484 |
| | [0.181] | [0.0438] | [0.0453] | [0.0380] | [0.0373] | [0.0334] | [0.0402] | [0.0663] | [0.0569] |
| Household received management plan and cash transfer (Group 3) | 0.454** | 0.101** | 0.128*** | 0.117** | 0.0353 | 0.0471 | 0.0256 | 0.755*** | 0.173*** |
| | [0.218] | [0.0476] | [0.0470] | [0.0487] | [0.0440] | [0.0400] | [0.0459] | [0.0518] | [0.0562] |
| Observations | 597 | 597 | 597 | 597 | 597 | 597 | 597 | 598 | 598 |
| R-squared | 0.51 | 0.388 | 0.346 | 0.45 | 0.406 | 0.323 | 0.389 | 0.5 | 0.197 |
| Control mean | 1.49 | 0.29 | 0.19 | 0.27 | 0.27 | 0.19 | 0.29 | 0.12 | 0.64 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.782 | 0.742 | 0.547 | 0.357 | 0.118 | 0.763 | 0.542 | 0.001 | 0.001 |

Notes: Robust standard errors in brackets are clustered by animateur. Household control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. Animateur controls include sex, age, indicator for high school education, and months working as animateur. All regressions include enumerator fixed effects. Question text is paraphrased. See paper text for full text.

*** p<0.01, ** p<0.05, * p<0.10

**Online Appendix for:**

# Cash Transfers and Management Advice for Agriculture: Evidence from Senegal

Kate Ambler, IFPRI

Alan de Brauw, IFPRI

Susan Godlonton, IFPRI

**Appendix Table A1: Animateur Characteristics**

| | |
|---|---|
| Animateur is female | 0.14 |
| Age | 41.4 |
| Speaks Wolof | 0.96 |
| Speaks Sereer | 0.6 |
| Speaks French | 0.88 |
| Number of languages spoken | 2.6 |
| Number of languages written | 2.2 |
| Animateur is Muslim | 0.91 |
| Animateur is in polygamous marriage | 0.35 |
| Animateur has high school education | 0.44 |
| Animateur has grown groundnuts | 0.91 |
| Number of crops grown by animateur | 4.52 |
| Months working with association | 120.3 |
| Months working as animateur | 161.5 |
| Math score (max 3) | 2.1 |
| Recall score (max 10) | 5.1 |

Notes: Authors' calculations from animateur survey.

## Appendix Table A2: Baseline balance by treatment: Midline survey sample

| | Advisory visits only | Visits + management plan | Visits + management plan + cash transfer | p-value for test that 1 = 2 | p-value for test that 1 = 3 | p-value for test that 2 = 3 | p-value for test that 1 = 2 = 3 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **Main household composition characteristics** | | | | | | | |
| Household head is female | 0.18 | 0.08 | 0.10 | 0.052 | 0.161 | 0.578 | 0.149 |
| Age of household head | 52.2 | 51.2 | 53.7 | 0.643 | 0.455 | 0.229 | 0.472 |
| Household head is polygamous | 0.35 | 0.41 | 0.51 | 0.454 | 0.044 | 0.206 | 0.127 |
| Household head has at least some education | 0.39 | 0.29 | 0.39 | 0.164 | 0.950 | 0.183 | 0.280 |
| Household size | 17.1 | 16.1 | 18.2 | 0.423 | 0.438 | 0.125 | 0.302 |
| **Agricultural measures** | | | | | | | |
| Total land area (ha) | 7.5 | 8.2 | 8.3 | 0.475 | 0.406 | 0.918 | 0.659 |
| Number of crops grown | 3.3 | 3.2 | 3.1 | 0.334 | 0.304 | 0.932 | 0.532 |
| Gross value of agricultural output | 1,476 | 1,246 | 1,845 | 0.368 | 0.212 | 0.027 | 0.085 |
| Gross value of agricultural output per hectare | 274 | 165 | 368 | 0.282 | 0.534 | 0.082 | 0.128 |
| Total value of crops sold | 644 | 508 | 923 | 0.371 | 0.174 | 0.025 | 0.078 |
| Tropical livestock units | 4.4 | 3.5 | 3.9 | 0.455 | 0.719 | 0.546 | 0.698 |
| Total value of livestock owned | 2,408 | 1,936 | 2,544 | 0.458 | 0.841 | 0.256 | 0.488 |
| Total agricultural equipment value | 1,381 | 1,604 | 1,832 | 0.436 | 0.078 | 0.516 | 0.189 |
| Total value of agricultural expenditures | 607 | 633 | 721 | 0.813 | 0.304 | 0.455 | 0.573 |

Notes: All values are from the BAA 2014. Sample varies slightly with missing values for age (238) and GVAO per hectare (238). All money amounts are in USD.

## Appendix Table A3: Comparison to Representative Data Souce

| | Project baseline data | ESPS data: Peanut basin only | p-value for test that 1=2 |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Main household composition characteristics** | | | |
| Household head is female | 0.120 | 0.140 | 0.200 |
| Age of household head | 53.092 | 51.756 | 0.029 |
| Household head is polygamous | 0.417 | 0.370 | 0.031 |
| Household head has at least some education | 0.177 | 0.080 | 0.000 |
| Household size | 16.542 | 10.937 | 0.000 |
| Number of children in household | 8.368 | 5.626 | 0.000 |
| **Agricultural measures** | | | |
| Number of crops grown in past 12 months | 3.212 | 3.008 | 0.001 |
| Household grew groundnuts | 0.947 | 0.843 | 0.000 |
| Household grew millet | 0.950 | 0.919 | 0.010 |
| Crop area for groundnuts (ha) | 3.507 | 2.450 | 0.000 |
| Crop area for millet (ha) | 3.319 | 2.655 | 0.000 |
| Production of groundnuts (kg) | 1430.983 | 1500.494 | 0.462 |
| Production of millet (kg) | 1315.129 | 1218.855 | 0.183 |
| Groundnut sales (kg) | 966.365 | 668.068 | 0.000 |
| Millet sales (kg) | 111.825 | 63.373 | 0.000 |
| Total value of crops sold | 605.448 | 430.700 | 0.000 |
| Tropical livestock units for cows, sheep, goats, and poultry only | 3.351 | 598.0 | 0.010 |
| *Number of observations* | 600 | 3167 | |

Notes: Data from project baseline and Enquête de suivi de la Pauvreté au Sénégal (ESPS) 2011. The ESPS sample includes only households in the peanut basin that report growing at least one crop. All money amounts are in USD.

## Appendix Table A4: Treatment impact on crop sales

| | *Sales in kg of…* | | | | | |
|---|---|---|---|---|---|---|
| | Groundnuts | Millet | Sorghum | Maize | Manioc | Gross value of agricultural output sold |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Midline survey** | | | | | | |
| Household received management plan (Group 2) | 329.9* | 125.0* | 1.028 | 6.508 | -19.2 | 229.2 |
| | [194.2] | [64.83] | [4.895] | [6.478] | [14.86] | [138.0] |
| Household received management plan and cash transfer (Group 3) | 187.8 | 48.19 | 5.789 | -2.767 | -22.14 | 213.3* |
| | [136.7] | [58.56] | [7.291] | [5.549] | [13.72] | [107.2] |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 |
| R-squared | 0.714 | 0.163 | 0.207 | 0.103 | 0.296 | 0.609 |
| Control mean | 623.2 | 72.3 | 8.7 | 7.5 | 20.0 | 413.7 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.460 | 0.301 | 0.363 | 0.128 | 0.648 | 0.912 |
| **Endline survey** | | | | | | |
| Household received management plan (Group 2) | 88.35 | 11.63 | -6.858 | 3.823 | -0.664 | 7.84 |
| | [196.4] | [30.53] | [4.525] | [3.372] | [10.77] | [97.75] |
| Household received management plan and cash transfer (Group 3) | -182.4 | -37.72* | -6.775 | 8.739** | -1.243 | -34.92 |
| | [145.8] | [19.50] | [4.420] | [4.218] | [11.78] | [82.68] |
| Observations | 598 | 598 | 598 | 598 | 598 | 598 |
| R-squared | 0.489 | 0.139 | 0.092 | 0.150 | 0.389 | 0.398 |
| Control mean | 1,167.1 | 84.2 | 12.5 | 6.1 | 23.0 | 620.9 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.085 | 0.087 | 0.978 | 0.183 | 0.968 | 0.600 |
| Includes baseline value of outcome | YES | YES | YES | YES | YES | YES |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include the baseline value of outcome and enumerator fixed effects. All money amounts are in USD.

*** p<0.01, ** p<0.05, * p<0.10

## Appendix Table A5: Treatment impact on chemical fertilizer use by crop

| | *Used any chemical fertilizer on…* | | | | *Amount of chemical fertilizer (kg) used on…* | | | |
|---|---|---|---|---|---|---|---|---|
| | Groundnuts (1) | Millet (2) | Sorghum (3) | Maize (4) | Groundnuts (5) | Millet (6) | Sorghum (7) | Maize (8) |
| **Midline survey** | | | | | | | | |
| Household received management plan (Group 2) | -0.0116 | 0.0198 | -0.0212 | -0.0117 | -12.5 | -3.309 | -6.904 | 2.955 |
| | [0.0639] | [0.0681] | [0.0400] | [0.0424] | [21.42] | [21.92] | [5.387] | [7.399] |
| Household received management plan and cash transfer (Group 3) | 0.135** | 0.193** | 0.0365 | 0.0747 | 11.59 | 28.25 | -4.09 | 13.86 |
| | [0.0668] | [0.0880] | [0.0568] | [0.0509] | [20.69] | [25.63] | [7.111] | [9.307] |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 | 239 | 239 |
| R-squared | 0.163 | 0.307 | 0.187 | 0.359 | 0.154 | 0.280 | 0.228 | 0.293 |
| Control mean | 0.2 | 0.3 | 0.1 | 0.1 | 48.9 | 73.4 | 11.4 | 12.0 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.058 | 0.056 | 0.233 | 0.094 | 0.215 | 0.160 | 0.572 | 0.161 |
| **Endline survey** | | | | | | | | |
| Household received management plan (Group 2) | -0.0735 | -0.0561 | -0.0346 | 0.0121 | -20.6 | 2.326 | -4.583** | -3.936 |
| | [0.0472] | [0.0614] | [0.0209] | [0.0332] | [14.78] | [14.74] | [2.044] | [6.329] |
| Household received management plan and cash transfer (Group 3) | -0.0164 | 0.0018 | -0.0281 | 0.018 | -19.23 | 6.128 | -4.154* | 3.394 |
| | [0.0476] | [0.0579] | [0.0259] | [0.0274] | [12.11] | [14.91] | [2.388] | [6.521] |
| Observations | 598 | 598 | 598 | 598 | 598 | 598 | 598 | 598 |
| R-squared | 0.156 | 0.213 | 0.105 | 0.294 | 0.226 | 0.262 | 0.100 | 0.274 |
| Control mean | 0.3 | 0.4 | 0.1 | 0.1 | 69.2 | 79.2 | 5.6 | 21.9 |
| p-value for equality of coefficients: Group 2 = Group 3 | 0.188 | 0.262 | 0.684 | 0.845 | 0.903 | 0.772 | 0.729 | 0.271 |
| Includes baseline value of outcome | NO | NO | NO | NO | NO | NO | NO | NO |

Notes: Robust standard errors in brackets are clustered by animateur. Control variables are baseline values of household size, whether household head is polygamous, whether household head is female, and whether the household head has any education. All regressions include enumerator fixed effects.

*** p<0.01, ** p<0.05, * p<0.10

## Annex A: Imputations

To maintain consistent sample size, missing values in the main outcome variables are imputed throughout the analysis. Imputation is done by replacing the missing value with the median in the advisory visits only group. In most cases, only very few observations are imputed. Below see a listing of the number of imputed observations for each outcome variable. The full midline sample is 239 observations and the full endline sample is 598 observations.

Number of observations with imputed values

| | 2015 | 2016 |
|---|---|---|
| *Crop production* | | |
| Groundnuts | 1 | 1 |
| Millet | 0 | 0 |
| Sorghum | 1 | 0 |
| Maize | 0 | 0 |
| Manioc | 2 | 27 |
| Gross value of output | 19 | 37 |
| *Crop value per ha* | | |
| Groundnuts | 3 | 1 |
| Millet | 0 | 0 |
| Gross value of output | 44 | 37 |
| *Livestock* | | |
| Cows | 0 | 0 |
| Sheep | 1 | 0 |
| Goats | 0 | 0 |
| Poultry | 0 | 0 |
| Donkeys | 0 | 0 |
| Horses | 0 | 0 |
| Tropical livestock units | 1 | 0 |
| Total livestock value | 1 | 0 |
| *Investment and expenditures* | | |
| Agriculture expenditures | 40 | 2 |
| Agriculture equipment value | 4 | 1 |
| Non agricultural assets value | 8 | 1 |
| Total assets value | 9 | 9 |
| Total consumption expenditure | 38 | 1 |
| Total consumption expenditure: Food | 18 | 0 |
| Total consumption expenditure: Non-food | 20 | 1 |
| *Input use* | | |
| Used chemical fertilizer | 3 | 0 |
| Kg of chemical fertilizer used | 2 | 1 |
| Used non-chemical fertilizer | 3 | 1 |
| Used pesticides | 2 | 1 |

It is also important to note that in most cases, for composite measures, the number of elements of each observation that is imputed is quite low. Below see a listing of the principal composite measures considered in the paper and the number of components imputed in each.

| Number of components imputed per observation | | |
|---|---|---|
| | 2015 | 2016 |
| Gross value of agricultural output | | |
| 0 | 220 | 561 |
| 1 | 14 | 34 |
| 2 | 4 | 2 |
| 3 | 1 | 1 |
| Gross value of agricultural output per ha | | |
| 0 | 195 | 561 |
| 1 | 26 | 34 |
| 2 | 11 | 2 |
| 3 | 3 | 1 |
| 4 | 3 | 0 |
| 6 | 1 | 0 |
| Tropical livestock units | | |
| 0 | 238 | 598 |
| 1 | 1 | 0 |
| Total livestock value | | |
| 0 | 238 | 598 |
| 1 | 1 | 0 |
| Agriculture expenditures | | |
| 0 | 199 | 596 |
| 1 | 35 | 1 |
| 2 | 5 | 1 |
| Agriculture equipment value | | |
| 0 | 235 | 597 |
| 1 | 0 | 1 |
| 3 | 2 | 0 |
| 4 | 2 | 0 |
| Total consumption expenditure | | |
| 0 | 201 | 597 |
| 1 | 13 | 0 |
| 2 | 11 | 1 |
| 3 | 6 | 0 |
| 4 | 3 | 0 |
| 6 | 2 | 0 |
| 8 | 1 | 0 |
| 28 | 1 | 0 |

| | | |
|---|---|---|
| 30 | 1 | 0 |
| Total consumption expenditure: Food | | |
| 0 | 221 | 598 |
| 1 | 7 | 0 |
| 2 | 1 | 0 |
| 3 | 5 | 0 |
| 4 | 1 | 0 |
| 6 | 1 | 0 |
| 8 | 1 | 0 |
| 28 | 1 | 0 |
| 30 | 1 | 0 |
| Total consumption expenditure: Non-food | | |
| 0 | 219 | 597 |
| 1 | 6 | 0 |
| 2 | 10 | 1 |
| 3 | 1 | 0 |
| 4 | 2 | 0 |
| 6 | 1 | 0 |

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